[6450-01-P]

DEPARTMENT OF ENERGY

10 CFR Part 430

EERE-2019-BT-STD-0039

RIN 1904-AE32

Energy Conservation Program: Energy Conservation Standards for Dishwashers

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

ACTION: Notice of proposed rulemaking and request for comment.

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. EPCA also requires the U.S. Department of Energy ("DOE" or "the Department") to periodically determine whether more-stringent standards would be technologically feasible and economically justified and would result in significant energy savings. In this notice of proposed rulemaking ("NOPR"), DOE proposes amended energy conservation standards for dishwashers, and requests comment on these proposed standards and associated analyses and results.

DATES:

Comments: DOE will accept comments, data, and information regarding this NOPR no later than [**INSERT DATE 60 DAYS AFTER DATE OF PUBLICATION IN THE *FEDERAL REGISTER***].

Meeting: DOE will hold a public meeting via webinar on June 8, 2023, from 1:00 p.m. to 4:00 p.m. See section VII, "Public Participation," for webinar registration information, participant instructions and information about the capabilities available to webinar participants.

Comments regarding the likely competitive impact of the proposed standard should be sent to the Department of Justice contact listed in the **ADDRESSES** section on or before [**INSERT DATE 30 DAYS AFTER DATE OF PUBLICATION IN THE *FEDERAL REGISTER***].

ADDRESSES: Interested persons are encouraged to submit comments using the Federal eRulemaking Portal at *www.regulations.gov* under docket number EERE–2019–BT–STD-0039. Follow the instructions for submitting comments. Alternatively, interested persons may submit comments, identified by docket number EERE–2019–BT–STD-0039, by any of the following methods. Individuals who are deaf or hard of hearing, or who have speech and other communication disabilities may use a relay service to reach the telephone numbers in this section and farther below in this notice. To learn more about how to make an accessible telephone call, visit the webpage for Federal Communications Commission at *https://www.fcc.gov/consumers/guides/telecommunications-relay-service-trs*.

1) *Email: DW2019STD0039@ee.doe.gov. Include the docket number EERE–2019–BT–STD-0039 in the subject line of the message.*

2) *Postal Mail: Appliance and Equipment Standards Program, U.S. Department of Energy, Building Technologies Office, Mailstop EE-5B, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. Telephone: (202) 287-1445. If possible, please submit all items on a compact disc ("CD"), in which case it is not necessary to include printed copies.*

3) *Hand Delivery/Courier: Appliance and Equipment Standards Program, U.S. Department of Energy, Building Technologies Office, 950 L'Enfant Plaza, SW., 6th Floor, Washington, DC, 20024. Telephone: (202) 287-1445. If possible, please submit all items on a CD, in which case it is not necessary to include printed copies.*

No telefacsimiles ("faxes") will be accepted. For detailed instructions on submitting comments and additional information on this process, see section VII of this document.

Docket: The docket for this activity, which includes *Federal Register* notices, 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?D=EERE-2019-BT-STD-0039*. The docket web page contains instructions on how to access all

documents, including public comments, in the docket. See section VII of this document for information on how to submit comments through *www.regulations.gov*.

EPCA requires the Attorney General to provide DOE a written determination of whether the proposed standard is likely to lessen competition. 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 proposed standard. Interested persons may contact the Division at *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 rulemaking notice.

FOR FURTHER INFORMATION CONTACT:

Dr. Carl Shapiro, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office, EE-5B, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. Telephone: (202) 287-5649 Email: *ApplianceStandardsQuestions@ee.doe.gov*.

Ms. Amelia Whiting, U.S. Department of Energy, Office of the General Counsel, GC-33, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. Telephone: (202) 586-2588. Email: *Amelia.Whiting@hq.doe.gov*.

For further information on how to submit a comment, review other public comments and the docket, or participate in the public meeting, contact the Appliance and

Equipment Standards Program staff at (202) 287-1445 or by email:

ApplianceStandardsQuestions@ee.doe.gov.

SUPPLEMENTARY INFORMATION:

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I. Synopsis of the Proposed Rule

The Energy Policy and Conservation Act, Pub. L. 94-163, as amended ("EPCA"),[1] authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. (42 U.S.C. 6291–6317) Title III, Part B of EPCA[2] established the Energy Conservation Program for Consumer Products Other Than Automobiles. (42 U.S.C. 6291–6309) These products include dishwashers, the subject of this document. (42 U.S.C. 6292(a)(6))

Pursuant to EPCA, any new or amended energy conservation standard must be designed to achieve the maximum improvement in energy efficiency that DOE determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) Furthermore, the new or amended standard must result in a significant conservation of energy. (42 U.S.C. 6295(o)(3)(B)) EPCA also provides that not later than 6 years after issuance of any final rule establishing or amending a standard, DOE must publish either a notice of determination that standards for the product do not need to be amended, or a notice of proposed rulemaking including new proposed energy conservation standards (proceeding to a final rule, as appropriate). (42 U.S.C. 6295(m)) Not later than 3 years after issuance of a final determination not to amend standards, DOE must publish either a notice of determination that standards for the product do not

[1] All references to EPCA in this document refer to the statute as amended through the Energy Act of 2020, Pub. L. 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.

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)(3)(B))

In accordance with these and other statutory provisions discussed in this document, DOE proposes amended energy conservation standards for dishwashers. The proposed standards shall not exceed the estimated annual energy use, as expressed in kilowatt hours per year ("kWh/year"), and water consumption, as expressed in gallons per cycle ("gal/cycle") shown in Table I.1. These proposed standards, if adopted, would apply to all dishwashers listed in Table I.1 manufactured in, or imported into, the United States starting on the date 3 years after the publication of the final rule for this rulemaking.

Table I.1 Proposed Energy Conservation Standards for Dishwashers

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

* Using appendix C2

A. Benefits and Costs to Consumers

Table I.2 presents DOE's evaluation of the economic impacts of the proposed standards on consumers of dishwashers, as measured by the average life-cycle cost ("LCC") savings and the simple payback period ("PBP").[3] The average LCC savings are

[3] The average LCC savings refer to consumers that are affected by a standard and are measured relative to the efficiency distribution in the no-new-standards case, which depicts the market in the compliance year in the absence of new or amended standards (see section IV.F.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).

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 Proposed Energy Conservation Standards on Consumers of Dishwashers

Product Class	Average LCC Savings *(2021$)*	Simple Payback Period *(years)*
Standard-Size	$17	2.4
Compact-Size	$30	0.0

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

B. Impact on Manufacturers[4]

The industry net present value ("INPV") is the sum of the discounted cash flows to the industry from the NOPR publication year through the end of the analysis period (2023–2056). 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 $713.6 million. Under the proposed standards, the change in INPV is estimated to range from -$134.9 million to -$89.5 million, which represents a change of -18.9 percent to -12.5 percent. To bring products into compliance with amended standards, it is estimated that the industry would incur total conversion costs of approximately $125.6 million.

[4] All monetary values in this document are expressed in 2021 dollars.

DOE's analysis of the impacts of the proposed standards on manufacturers is described in section IV.J of this document. The analytic results of the manufacturer impact analysis ("MIA") are presented in section V.B.2 of this document.

C. National Benefits and Costs

DOE's analyses indicate that the proposed 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.[5] This represents a savings of 2.7 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 proposed standards for dishwashers ranges from $1.11 billion (at a 7-percent discount rate) to $2.77 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 in 2027–2056.

In addition, the proposed standards for dishwashers are projected to yield significant environmental benefits. DOE estimates that the proposed standards would

[5] The quantity refers to full-fuel-cycle ("FFC") energy savings. FFC energy savings includes the energy consumed in extracting, processing, and transporting primary fuels (*i.e.*, coal, natural gas, petroleum fuels), and, thus, presents a more complete picture of the impacts of energy efficiency standards. For more information on the FFC metric, see section IV.H.2 of this document.

result in cumulative emission reductions (over the same period as for energy savings) of 12.54 million metric tons ("Mt")[6] of carbon dioxide ("CO_2"), 3.38 thousand tons of sulfur dioxide ("SO_2"), 25.15 thousand tons of nitrogen oxides ("NO_X"), 112.88 thousand tons of methane ("CH_4"), 0.09 thousand tons of nitrous oxide ("N_2O"), and 0.02 tons of mercury ("Hg").[7]

DOE estimates the value of climate benefits from a reduction in greenhouse gases ("GHG") using four different estimates of the social cost of CO_2 ("SC-CO_2"), the social cost of methane ("SC-CH_4"), and the social cost of nitrous oxide ("SC-N_2O"). Together these represent the social cost of GHG ("SC-GHG").[8] DOE used interim SC-GHG values developed by an Interagency Working Group on the Social Cost of Greenhouse Gases ("IWG").[9] 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 $0.60 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.

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

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

[8] 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 Interagency Working Group on the Social Cost of Greenhouse Gases (IWG).

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

DOE estimated the monetary health benefits of SO_2 and NO_X emissions reductions using benefit per ton estimates from the scientific literature, as discussed in section IV.L of this document. DOE estimated the present value of the health benefits would be $0.35 billion using a 7-percent discount rate, and $0.94 billion using a 3-percent discount rate.[10] DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions.

Table I.3 summarizes the monetized benefits and costs expected to result from the proposed 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.

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

Table I.3 Summary of Monetized Benefits and Costs of Proposed Energy Conservation Standards for Dishwashers (TSL 3)

	Billion $2021
3% discount rate	
Consumer Operating Cost Savings	2.92
Climate Benefits*	0.60
Health Benefits**	0.94
Total Benefits†	4.47
Consumer Incremental Product Costs‡	0.15
Consumer Net Benefits	2.77
Total Net Benefits	4.32
7% discount rate	
Consumer Operating Cost Savings	1.19
Climate Benefits* (3% discount rate)	0.60
Health Benefits**	0.35
Total Benefits†	2.14
Consumer Incremental Product Costs‡	0.08
Consumer Net Benefits	1.11
Total Net Benefits	2.06

Note: This table presents the costs and benefits associated with product name shipped in 2027–2056. These results include benefits to consumers which accrue after 2056 from the products shipped in 2027–2056.
* Climate benefits are calculated using four different estimates of the social cost of carbon (SC-CO_2), methane (SC-CH_4), and nitrous oxide (SC-N_2O) (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate) (see section IV.L of this document). Together these represent the global SC-GHG. For presentational purposes of this table, the climate benefits associated with the average SC-GHG at a 3-percent discount rate are shown, but DOE does not have a single central SC-GHG point estimate. 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 Interagency Working Group on the Social Cost of Greenhouse Gases (IWG).
** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. See section IV.L of this document for more details.
† Total and net benefits include those consumer, climate, and health benefits that can be quantified and monetized. For presentation purposes, total and net benefits for both the 3-percent and 7-percent cases are presented using the average SC-GHG with 3-percent discount rate.
‡ Costs include incremental equipment costs as well as installation costs.

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

The national operating 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 proposed 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. Estimates of SC-GHG values are presented for all four discount rates in section V.B.8 of this document.

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

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

Using a 7-percent discount rate for consumer benefits and costs and health benefits from reduced NO_X and SO_2 emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the standards proposed in this rule is $8.6 million per year in increased product costs, while the estimated annual benefits are $125.8 million in reduced product operating costs, $34.6 million in climate benefits, and $37.0 million in health benefits. In this case, the net benefit would amount to $188.8 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the proposed standards is $8.5 million per year in increased product costs, while the estimated annual benefits are $167.8 million in reduced operating costs, $34.6 million in climate benefits, and $54.3 million in health benefits. In this case, the net benefit would amount to $248.1 million per year.

Table I.4 Annualized Monetized Benefits and Costs of Proposed Energy Conservation Standards for Dishwashers (TSL 3)

	Million 2021$/year		
	Primary Estimate	**Low-Net-Benefits Estimate**	**High-Net-Benefits Estimate**
3% discount rate			
Consumer Operating Cost Savings	167.8	166.8	169.5
Climate Benefits*	34.6	33.8	35.3
Health Benefits**	54.3	53.1	55.4
Total Benefits†	256.6	253.7	260.2
Consumer Incremental Product Costs‡	8.5	9.8	8.2
Net Benefits	248.1	243.8	251.9
7% discount rate			
Consumer Operating Cost Savings	125.8	125.0	127.0
Climate Benefits* (3% discount rate)	34.6	33.8	35.3
Health Benefits*	37.0	36.3	37.7
Total Benefits†	197.3	195.1	199.9
Consumer Incremental Product Costs‡	8.6	9.7	8.3
Net Benefits	188.8	185.3	191.6

Note: This table presents the costs and benefits associated with dishwashers shipped in 2027−2056. These results include benefits to consumers which 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 AEO2022 Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental equipment costs reflect a medium decline rate in the Primary Estimate, a low decline rate in the Low Net Benefits Estimate, and a high decline rate in the High Net Benefits Estimate. The methods used to derive projected price trends are explained in sections IV.F.1 and IV.H.1 of this document. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

* Climate benefits are calculated using four different estimates of the global SC-GHG (see section IV.L of this notice). For presentational purposes of this table, the climate benefits associated with the average SC-GHG at a 3-percent discount rate are shown, but the Department does not have a single central SC-GHG point estimate, and it emphasizes the importance and value of considering the benefits calculated using all four sets of SC-GHG estimates. 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 Interagency Working Group on the Social Cost of Greenhouse Gases (IWG).

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

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

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

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

D. Conclusion

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

Using a 7-percent discount rate for consumer benefits and costs and health benefits from NO_X and SO_2 reduction, and a 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the proposed standards for dishwashers is $8.6 million per year in increased dishwasher costs, while the estimated annual benefits are $125.8 million in reduced equipment operating costs, $34.6 million in climate benefits, and $37.0 million in health benefits. The net benefit amounts to $188.8 million per year.

The significance of energy savings offered by a new or amended energy conservation standard cannot be determined without knowledge of the specific circumstances surrounding a given rulemaking.[12] For example, some covered products and equipment have most of their energy consumption occur during periods of peak

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

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 proposed standards are projected to result in estimated national energy savings of 0.31 quads FFC, the equivalent of the primary annual energy use of 3.3 million homes. The NPV of consumer benefit for these projected energy savings is $1.11 billion using a discount rate of 7 percent, and $2.77 billion using a discount rate of 3 percent. The cumulative emissions reductions associated with these energy savings are 12.56 Mt of CO_2, 3.39 thousand tons of SO_2, 25.20 thousand tons of NO_x, 0.02 tons of Hg, 113.10 thousand tons of CH_4, and 0.09 thousand tons of N_2O. The estimated monetary value of the climate benefit from reduced GHG emissions (associated with the average SC-GHG at a 3-percent discount rate) is $0.6 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_x emissions is $0.35 billion using a 7-percent discount rate and $0.94 billion using a 3-percent discount rate. As such, DOE has initially determined the energy savings from the proposed standard levels are "significant" within the meaning of 42 U.S.C. 6295(o)(3)(B).[13] A more detailed discussion of the basis for these tentative conclusions is contained in the remainder of this document and the accompanying technical support document ("TSD").

[13] See section III.D.2 of this document for further discussion of how DOE determines whether energy savings are "significant" within the context of the statute.

DOE also considered more-stringent energy efficiency levels as potential standards, and is still considering them in this proposed rulemaking. However, DOE has tentatively concluded that the potential benefits of the more-stringent energy efficiency levels would outweigh the projected burdens.

Based on consideration of the public comments DOE receives in response to this document and related information collected and analyzed during the course of this rulemaking effort, DOE may adopt energy efficiency levels presented in this document that are either higher or lower than the proposed standards, or some combination of level(s) that incorporate the proposed standards in part.

II. Introduction

The following section briefly discusses the statutory authority underlying this proposed 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 standards for these products (42 U.S.C. 6295(g)(1) and 10(A)), and directs 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)) Not later than 3 years after issuance of a final determination not to amend standards, 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)(3)(B))

The energy conservation program under EPCA consists essentially of four parts: (1) testing, (2) labeling, (3) the establishment of Federal energy conservation standards, and (4) certification and enforcement procedures. Relevant provisions of EPCA specifically include definitions (42 U.S.C. 6291), test procedures (42 U.S.C. 6293), labeling provisions (42 U.S.C. 6294), energy conservation 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 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 42 U.S.C. 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 Code of Federal Regulations ("CFR") part 430, subpart B, appendix C1 ("appendix C1") and appendix C2 ("appendix C2").

DOE must follow specific statutory criteria for prescribing new or amended standards for covered products, including dishwashers. Any new or amended standard for a covered product must be designed to achieve the maximum improvement in energy efficiency that the Secretary of Energy determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A) and 42 U.S.C. 6295(o)(3)(B)) Furthermore, DOE may not adopt any standard that would not result in the significant conservation of energy. (42 U.S.C. 6295(o)(3))

Moreover, DOE may not prescribe a standard 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)(2)(B)(i)) DOE must make this determination after receiving comments on the proposed standard, and by considering, to the greatest extent practicable, the following seven statutory factors:

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

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

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

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

(5) The impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from the standard;

(6) The need for national energy and water conservation; and

(7) Other factors the Secretary of Energy ("Secretary") considers relevant.

(42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII))

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

Additionally, EPCA specifies requirements when promulgating an energy conservation standard for a covered product that has two or more subcategories. DOE must specify a different standard level for a type or class of product 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 the feature and other factors DOE deems

appropriate. *Id.* Any rule prescribing such a standard must include an explanation of the basis on which such higher or lower level was established. (42 U.S.C. 6295(q)(2))

Finally, pursuant to the amendments contained in the Energy Independence and Security Act of 2007 ("EISA 2007"), Pub. L. 110-140, any final rule for new or amended energy conservation standards promulgated after July 1, 2010, is required to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) Specifically, when DOE adopts a standard for a covered product after that date, it must, if justified by the criteria for adoption of standards under EPCA (42 U.S.C. 6295(o)), incorporate standby mode and off mode energy use into a single standard, or, if that is not feasible, adopt a separate standard for such energy use for that product. (42 U.S.C. 6295(gg)(3)(A)–(B)) DOE's current test procedures for dishwashers address standby mode and off mode energy use. In this rulemaking, DOE intends to incorporate such energy use into any amended energy conservation standards that it may adopt.

B. Background

1. Current Standards

In a direct final rule published on May 30, 2012 ("May 2012 Direct Final Rule"), DOE prescribed the current energy conservation standards for dishwashers manufactured on or after May 30, 2013. 77 FR 31918. 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 current 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

2. History of Standards Rulemaking for Dishwashers

The current energy conservation standards for dishwashers were submitted to DOE by groups representing manufacturers, energy and environmental advocates, and consumer groups on July 30, 2010. This collective set of comments, titled "Agreement on Minimum Federal Efficiency Standards, Smart Appliances, Federal Incentives and Related Matters for Specified Appliances" (the "Joint Petition")[14], recommended specific energy conservation standards for dishwashers that, in the commenters' view, would satisfy the EPCA requirements. (42 U.S.C. 6295(o)) DOE analyzed the benefits and burdens of multiple standard levels for residential dishwashers, including a standard level that corresponded to the recommended levels in the Joint Petition. 77 FR 31945, 31945-6. In the May 2012 Direct Final Rule, DOE established energy conservation standards for

[14] DOE Docket No. EERE–2011–BT–STD–0060-0001.

dishwashers manufactured on or after May 30, 2013, consistent with the levels suggested in the Joint Petition. 77 FR 31918.

In the December 2016 Final Determination, DOE concluded that amended energy conservation standards would not be economically justified at that time 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.

On March 21, 2018, the Competitive Enterprise Institute ("CEI") submitted a petition for rulemaking requesting that DOE establish a new product class for dishwashers with a cycle time of less than one hour. DOE granted the petition and proposed a new product class for dishwashers with a "normal" cycle time of 60 minutes or less. 84 FR 33869 (July 16, 2019). On October 30, 2020, DOE published a final rule establishing a separate product class for standard-size dishwashers with a cycle time for the "normal" cycle of 60 minutes or less from washing through drying ("short cycle dishwashers"). 85 FR 68723 ("October 2020 Final Rule").

Subsequently, in a final rule published on January 19, 2022, DOE revoked the final rule that established the new product class for dishwashers as it was improperly promulgated. 87 FR 2673.

EPCA requires that, not later than 3 years after the issuance of a final determination not to amend standards, 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)(3)(B)) DOE must make the analysis on which a determination is based publicly available and provide an opportunity for written comment. (42 U.S.C. 6295(m)(2))

DOE is examining whether to amend the current standards pursuant to its obligations under EPCA. In an early assessment request for information published on October 14, 2020 ("October 2020 RFI"), DOE initiated the current rulemaking with an early assessment review to determine whether any new or amended standards would satisfy the relevant requirements of EPCA for a new or amended energy conservation standard for dishwashers. 85 FR 64981.

Subsequently, 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. In that notification, DOE sought comment on the analytical framework, models, and tools that DOE used to evaluate potential standards for dishwashers, the results of preliminary analyses performed, and the potential energy and water conservation standard levels derived from these analyses, which DOE presented in the accompanying preliminary TSD ("January 2022 Preliminary TSD").[15] *Id.*

Prior to the publication of the January 2022 Preliminary Analysis, DOE published proposed amendments to the dishwashers test procedure at appendix C1 and proposed a

[15] January 2022 Dishwashers Energy Conservation Standards Preliminary Technical Support Document. Available online at *www.regulations.gov/document/EERE-2019-BT-STD-0039-0015*.

new appendix C2 in a test procedure NOPR published on December 22, 2021 ("December 2021 TP NOPR"). 86 FR 72738. On January 18, 2023, DOE published the final test procedure rulemaking ("January 2023 TP Final Rule") amending appendix C1 and establishing a new appendix C2. 88 FR 3234.The new appendix C2 specifies updated annual cycles and low-power mode hours, both of which are used to calculate the estimated annual energy use ("EAEU") metric, and introduces a cleaning performance threshold requirement.

DOE held a public meeting on February 22, 2022 ("January 2022 Preliminary Analysis webinar"), to solicit feedback from stakeholders concerning the January 2022 Preliminary Analysis, and received comments in response from the interested parties listed in Table II.2.

Table II.2 January 2022 Preliminary Analysis Written Comments for Dishwashers

Commenter(s)	Abbreviation	Comment No. in the Docket	Commenter Type
Westview and Global Guideway	Westview and Global Guideway	17	Individual
Whirlpool Corporation	Whirlpool	21	Manufacturer
Samsung Electronics America, Inc.	Samsung	22	Manufacturer
Appliance Standards Awareness Project, American Council for an Energy-Efficient Economy, Consumer Federation of America, Natural Resources Defense Council	Joint Commenters	23	Efficiency Advocates
Northwest Energy Efficiency Alliance	NEEA	24	Efficiency Advocates
GE Appliances, a Haier Company	GEA	25	Manufacturer
Association of Home Appliance Manufacturers	AHAM	26, 31[16]	Trade Association
Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison (collectively, the California Investor Owned Utilities)	CA IOUs	27	Utilities

A parenthetical reference at the end of a comment quotation or paraphrase provides the location of the item in the public record.[17] To the extent that interested parties have provided written comments that are substantively consistent with any oral comments provided during the February 22, 2022, public meeting, DOE cites the written comments throughout this final rule. Any oral comments provided during the webinar

[16] AHAM's supplemental comment (No. 31) was received 161 days after the comment submission deadline. DOE generally will not consider late filed comments, but may exercise its discretion to do so where necessary and appropriate. In this case, DOE is considering AHAM's comment because its tardiness has not disrupted DOE's consideration of this matter and because the comment regards a subject important to this matter.

[17] 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).

that are not substantively addressed by written comments are summarized and cited separately throughout this final rule.

C. Deviation from Appendix A

The timing of DOE's test procedures and energy conservation standards rulemakings are conducted in accordance with DOE's procedures at appendix A to subpart C of part 430, *Procedures, Interpretations, and Policies for Consideration of New or Revised Energy Conservation Standards and Test Procedures for Consumer Products and Certain Commercial/Industrial Equipment* ("appendix A"). Section 6(f)(2) of appendix A provides that the length of the public comment period for a notice of proposed rulemaking to amend an energy conservation standard will be at least 75 days. In accordance with section 3(a) of appendix A, DOE notes that it is deviating from the provision in appendix A regarding the pre- stages for an energy conservation standards rulemaking. DOE faces an overdue statutory deadline for this rulemaking and, furthermore, the analytical methods used for this NOPR are similar to those used in previous rulemaking notices. Consequently, DOE has determined it is necessary and appropriate to provide a 60-day comment period, which the Department has determined provides sufficient time for interested parties to review the NOPR and develop comments and for DOE to complete its analyses prior to the publication of the final rule by June 30, 2024, as required by a consent decree.

III. General Discussion

DOE developed this proposal after considering oral and written comments, data, and information submitted by stakeholders. The following discussion addresses issues raised by these commenters.

A. General Comments

This section summarizes general comments received from interested parties regarding rulemaking timing and process.

AHAM noted that DOE's comment period on the January 2022 Preliminary Analysis overlapped with the December 2021 TP NOPR comment period by 30 days. (AHAM, No. 26 at p. 28) AHAM commented that DOE should have received and considered stakeholder comments on the December 2021 TP NOPR, which proposed a significant change (*i.e.,* a cleaning index threshold as a condition for a valid test cycle), before proceeding with the energy conservation standard itself, including the January 2022 Preliminary Analysis. (*Id*.) AHAM commented that it supported DOE's interest in moving rulemakings forward, but to provide stakeholders with a real opportunity to evaluate proposals, DOE should have released the test procedure proposal for comment before conducting its preliminary analysis. (AHAM, No. 26 at p. 28)

AHAM commented that, regardless of the desire to rectify missed deadlines, DOE must ensure that its process allows early stakeholder engagement and that it meets other statutory criteria, such as ensuring that the standard is technically feasible and

economically justified. (AHAM, No. 26 at pp. 28–29) AHAM commented that the process DOE had chosen for the dishwashers test procedure and standards rulemakings significantly undercuts commenters' ability to provide critical, early feedback to DOE on both the proposed test procedure and the preliminary analysis. (AHAM, No. 26 at p. 28) AHAM commented that DOE's proposed dishwasher test procedure amendments would alter measured efficiency in many cases, that DOE did not fully analyze the impact of the December 2021 TP NOPR amendments on the standards rulemaking, and that DOE's process does not allow commenters sufficient time to analyze the implications. (*Id*.)

DOE notes that the timing of the test procedure and energy conservation standards rulemakings have been conducted in accordance with DOE's procedures at appendix A. The procedures at appendix A inherently recognize a certain amount of overlap between test procedure and energy conservation standards rulemakings. In particular, appendix A specifies that new test procedures and amended test procedures that impact measured energy use or efficiency will be finalized at least 180 days prior to the close of the comment period for a NOPR proposing new or amended energy conservation standards or a notice of proposed determination that standards do not need to be amended. Section 8(d)(1) of appendix A. Inherent to this requirement is a recognition that the earlier stages of the test procedure rulemaking (*i.e.*, the test procedure NOPR stage) would be conducted concurrently with the pre-NOPR stages of the energy conservation standards rulemaking (*i.e.*, the preliminary analysis stage). In other words, the implication of the timing established by appendix A is that a test procedure NOPR may provide the basis for a standards preliminary analysis; while a test procedure final rule provides the basis for a standards NOPR. DOE issued the January 2023 TP Final Rule on December 16,

2022. The comment period for this standards NOPR will end more than 180 days after the issuance of the January 2023 TP Final Rule, in accordance with the requirements of appendix A.

As acknowledged by AHAM, DOE is conducting this rulemaking in fulfillment of its statutory obligations under EPCA. Furthermore, DOE expects to publicly post the intended final rule for this rulemaking by June 30, 2024, in fulfillment of the terms of a consent decree,[18] which necessitates timely issuance of this NOPR. DOE recognizes and appreciates the information and data provided by stakeholders in response to the January 2022 Preliminary Analysis. As discussed throughout this NOPR, DOE has incorporated data and other information received during the prior rulemaking stages into the analyses conducted for this NOPR.

AHAM commented that DOE's test procedure proposal and preliminary analysis are missing key data and the data which are included are not transparent, which fails to meet EPCA, the Administrative Procedure Act, and the Data Quality Act requirements. (AHAM, No. 26 at p. 28)

[18] On October 30, 2020, Natural Resources Defense Council, Center for Biological Diversity, Consumer Federation of America, Massachusetts Union of Public Housing, and Sierra Club filed a lawsuit against DOE and the Secretary alleging that DOE failed to complete rulemakings by statutory deadlines for 25 consumer products and commercial equipment, including dishwashers. *See Natural Resources Defense Council, et al. v. Granholm, et al.,* No. 1:20-cv-09127 (S.D.N.Y.) On November 9, 2020, the States of New York, California, Colorado, Connecticut, Illinois, Maine, Maryland, Minnesota, New Jersey, Oregon, Vermont, Washington, the Commonwealth of Massachusetts, the People of the State of Michigan, the District of Columbia, and the City of New York filed a similar complaint, amended on January 29, 2021 to include the Commonwealth of Pennsylvania and the States of New Mexico and Nevada. *See State of New York, et al. v. Granholm, et al.,* No. 1:20-cv-09362 (S.D.N.Y.) Under the terms of a negotiated consent decree to settle these lawsuits, entered on September 20, 2022, DOE is required, in part, to publicly post the intended final rule for dishwasher standards by June 30, 2024.

DOE understands AHAM's above comment to be discussing the cleaning performance requirement in the January 2023 TP Final Rule. As noted in the January 2023 TP Final Rule, DOE discussed in the December 2021 TP NOPR its justification for including a cleaning performance measurement and establishing a minimum cleaning index threshold to define what constitutes completely washing a full load of normally soiled dishes. 88 FR 3234. The December 2021 TP NOPR presented details of a rigorous analysis performed by DOE, building upon a comprehensive investigation and analysis of dishwasher cleaning performance conducted by DOE over the course of the development of the U.S. Environmental Protection Agency's ("EPA's") ENERGY STAR Cleaning Performance Test Method[19] and previous dishwasher energy conservation standards rulemakings, and using the best available data of which it was aware at the time of the December 2021 TP NOPR to tentatively determine the specific cleaning index threshold that aligns with consumer expectations for completely washing a full load of normally soiled dishes. 86 FR 72738, 72756-72759. DOE reiterated its results and analysis, and included additional resources, when it presented the final cleaning index threshold in newly established appendix C2 in the January 2023 TP Final Rule. 88 FR 3234. Similarly, in the January 2022 Preliminary TSD, DOE presented test results pertaining to energy use, water use, and cleaning performance by soil level (*i.e.,* heavy, medium, or light soil load) and efficiency level as determined by the rated energy and water use. *See* chapter 5, section 5.5.1 of the January 2022 Preliminary TSD. These aggregated data informed DOE's preliminary analysis and formed the basis for the efficiency levels presented in the January 2022 Preliminary TSD. Additionally, DOE

[19] Available at *www.energystar.gov/products/spec/residential_dishwashers_specification_pd*.

released test data, including model name and numbers, to individual manufacturers that requested this information for their own models that were tested. These data were released under a non-disclosure agreement ("NDA").

AHAM commented that dishwashers are an energy efficiency success story and that AHAM, DOE, EPA, and other interested parties should work to promote dishwasher ownership and proper use as the next step towards energy and water savings. (AHAM, No. 26 at pp. 1–2) AHAM suggested that non-regulatory options, such as government-industry partnerships, can significantly contribute to achieving the President's climate goals via non-regulatory programs to promote ownership and effective use of dishwashers, especially for low-income consumers. (AHAM, No. 26 at pp. 2-3) AHAM commented that DOE should amend standards to EL 1, but without the cleaning performance metric that was proposed in the December 2021 TP NOPR, and focus any additional resources on developing non-regulatory programs that will increase dishwasher ownership and proper use of dishwashers. (AHAM, No. 26 at pp. 3–4) AHAM commented that increasing dishwasher ownership and proper use of dishwashers has the potential to drive significant energy and water savings compared to savings attributable to amended standards. (AHAM, No. 26 at p. 16) AHAM commented that from an environmental perspective, the preferred consumer behavior from most preferred to least preferred is: no pre-rinsing and running full or partial loads in a dishwasher; pre-rinsing and running full or partial loads in a dishwasher; and, complete hand washing. AHAM commented that hand washing and pre-rinsing consumes substantially more water than running a dishwasher with partial loads even twice as often (*i.e.,* every day rather than an average of 185 loads per year). (*Id.*)

Whirlpool supported AHAM's recommendation to explore non-regulatory options to promote broader dishwasher ownership and optimal usage. (Whirlpool, No. 21 at p. 2) Whirlpool commented that DOE's efforts to further improve energy and water savings should focus on non-regulatory options. (Whirlpool, No. 21 at p. 6)

GEA also supported AHAM's comment proposing a partnership between DOE, EPA, industry, and energy efficiency advocates to encourage non-regulatory options to further improve energy and water savings. (GEA, No. 25 at p. 2)

DOE acknowledges that non-regulatory options may exist to promote dishwasher ownership and proper use to further push the potential for energy and water savings. However, under EPCA, DOE is statutorily required to conduct energy conservation standards rulemaking for dishwashers to determine whether amending the current standards would achieve the maximum improvement in energy efficiency and are technologically feasible and economically justified.[20] (42 U.S.C. 6295(g), (m), and (o)) Since DOE published the December 2016 Final Determination not to amend dishwasher standards, it has initiated this current process to evaluate whether amended standards are economically justified and technologically feasible, warranting a NOPR or a determination that standards for dishwashers do not need to be amended. As discussed throughout this document, unlike the 2016 Final Determination, DOE has preliminarily determined that amended standards are economically justified, technologically feasible, and would result in significant energy savings. The vast majority, 93 percent, of the

[20] DOE conducts an energy conservation standard every 3 to 6 years depending on whether DOE issued a determination not to amend standards or DOE amended standards. (42 U.S.C. 6295(m))

market currently meets or exceeds the ENERGY STAR V. 6.0[21] level, which corresponds to EL 1 in this document, compared to only 62 percent of the market that met or exceeded that level[22] in the December 2016 Final Determination. Further, as discussed in section IV.C.2 of this document, the anticipated requirement to increase dishwasher efficiency from EL 1 to EL 2 is estimated to be a zero-cost improvement in control strategies. Accordingly, DOE is proposing amended energy conservation standards for dishwashers in this NOPR.

In response to results shown in the preliminary analysis, Whirlpool and GEA noted the estimates of consumers experiencing net costs of greater than 40 percent for both product classes analyzed beyond EL 1. (Whirlpool, No. 21 at p. 3; GEA, No. 25 at p. 2)

DOE updated its preliminary analysis for this NOPR. Between publication of the preliminary analysis and this NOPR some of the inputs into DOE's analysis have changed, greatly reducing the percentage of customers experiencing net costs. DOE uses the most currently available information at each stage of an energy conservation standards rulemaking. Updates in the NOPR analysis, compared to the preliminary analysis, include changes to the consumer sample, energy prices, discount rate, product costs at each efficiency level and market shares for the product classes (see section IV.D and section IV.F.8), which in turn update the net costs experienced by consumers as

[21] ENERGY STAR Program Requirements. Product Specification for Residential Dishwashers. Eligibility Criteria. Version 6.0. Effective date: January 29, 2016.
[22] In the December 2016 Final Determination, EL 2 corresponded to the ENERGY STAR V. 6.0 level.

estimated in the LCC analysis (see Table V.2 through Table V.5). DOE's proposed standards are based on the updated analysis, as described in section V.

B. Scope of Coverage

This NOPR 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 NOPR.

C. Test Procedure

EPCA sets forth generally applicable criteria and procedures for DOE's adoption and amendment of test procedures. (42 U.S.C. 6293) Manufacturers of covered products must use these test procedures to certify to DOE that their product complies with energy conservation standards and to quantify the efficiency of their product. DOE's current energy conservation standards for dishwashers are expressed in terms of EAEU, in kWh/year, and water consumption, in gal/cycle, as measured using appendix C1. (*See* 10 CFR 430.32(f).)

As discussed, on January 18, 2023, DOE published a final rule amending the dishwashers test procedure at appendix C1 and adopting a new test procedure at appendix C2. 88 FR 3234. The amendments to appendix C1 establish requirements for water hardness, relative humidity, and loading pattern; update requirements for ambient temperature, detergent dosage, and standby power measurement; and include testing approaches from published waivers for dishwashers. *Id*. The new appendix C2 additionally includes updated annual number of cycles and low-power mode hours for the calculation of energy consumption, as well as provisions for a minimum cleaning index threshold of 70 to validate the selected test cycle. *Id*. 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[23]. 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 completely clean test load. In the final rule, DOE specified that the 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.[24] 88 FR 3234. The new appendix C2 will go into effect only at such time as compliance is required with any amended energy conservation standards. Accordingly, DOE used appendix C2 as finalized in the January 2023 TP Final Rule as

[23] Household Electric Dishwashers. AHAM DW-2-2020. Copyright 2020.
[24] 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. 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.

the basis for the analysis in this NOPR. Specifically, in this NOPR, DOE's EAEU analysis is based on 184 cycles/year as specified in appendix C2.

In response to the January 2022 Preliminary Analysis, Whirlpool commented that DOE had not shown that any cleaning index score correlates strongly to high consumer satisfaction or prevents consumers from performing more energy- and water-intensive behaviors. Whirlpool further cited its comments on the December 2021 TP NOPR regarding the relationship between the cleaning index as calculated using AHAM DW-2-2020 and real world consumer satisfaction.[25] (Whirlpool, No. 21 at p. 4) GEA stated that DOE lacked data on the reproducibility and repeatability of the proposed cleaning performance metric, as well as data that indicate the cleaning index threshold is relevant to DOE's stated goal. (GEA, No. 25 at p. 2) GEA also stated that a requirement to test the most energy-intensive cycle as a result of failing DOE's cleaning metric is effectively a change to the standard. (*Id.*)

AHAM stated it had concerns with DOE's cleaning performance metric, claiming that (1) EPCA does not authorize a cleaning performance metric in the test procedure; (2) DOE had failed to support its proposal with data; and (3) the December 2021 TP NOPR proposal was fraught with technical challenges and uncertainty. (AHAM, No. 26 at p. 12)[26] AHAM further commented that DOE had not proven that the December 2021 TP NOPR proposal to include a minimum cleaning index threshold of 65 as a condition for a

[25] This comment was addressed by DOE in the January 2023 TP Final Rule, as such, DOE is not responding to this comment here.
[26] DOE has addressed AHAM's bulleted comments in the January 2023 TP Final Rule.

test cycle to be valid will protect product performance in the event of increased standards. (AHAM, No. 26 at p. 11) AHAM commented that DOE's data were not transparent and DOE provided only summary information in graphs, which did not allow commenters to fully analyze the data and understand the relationship between cleaning indices and energy and water usage. (AHAM, No. 26 at pp. 12, 29) AHAM requested that DOE provide its full data set to facilitate complete evaluation by commenters. AHAM noted that failure to provide this data would be inconsistent with the requirements under the Data Quality Act and other applicable statutory provisions. AHAM requested that, if DOE provides its full data, it do so in a format that permits public comment for at least 60 days on both the December 2021 TP NOPR and the January 2022 Preliminary Analysis. (AHAM, No. 26 at p. 14) AHAM requested that DOE provide its full test data by model via a notice of data availability or other appropriate regulatory tool. AHAM requested that the data include, at a minimum, for each soil level, the following information: machine energy (in watt-hours ("Wh")), water energy (in Wh), power dry energy (in Wh), total cycle energy (in Wh), annual energy (in kWh), water use (in gal), per-cycle cleaning index, and water energy during rinse (in Wh). AHAM also requested DOE to share the model numbers because it would help AHAM and its members determine representativeness of the sample. (AHAH, No. 26 at pp. 29–30) AHAM commented that it could not support DOE's test procedure proposal to include a performance metric in the test procedure without DOE providing data and information to address the significant concerns AHAM raised in its comments on the December 2021 TP NOPR. (AHAM, No. 26 at p. 12) AHAM also commented that the impact of a test procedure amendment to include cleaning performance would be additional manufacturer

cost and redesign to comply with future amended standards, and DOE's analysis should account for these costs. (AHAM, No. 26 at p. 29)

The CA IOUs stated their support for the adoption of a cleaning index threshold to ensure dishwashers adequately clean dishes per consumer expectations while improving energy and water efficiency. The CA IOUs commented that greater satisfaction in dishwasher performance will increase the use and adoption of more-efficient dishwashers, resulting in a virtuous cycle that leads to even more significant real-world savings due to a reduction in pre-washing and pre-rinsing. (CA IOUs, No. 27 at p. 4) Samsung stated that it supports the cleaning index threshold of 65 as proposed in the December 2021 TP NOPR to incentivize adequate cleaning efficiency. (Samsung, No. 22 at p. 3) Samsung provided further comment acknowledging variability in the cleaning performance test method, but that variability could be compensated by adjusting the minimum threshold level using the observed standard deviation. (Samsung, No. 22 at p. 4)

DOE has responded to all of these comments in the January 2023 TP Final Rule when establishing the cleaning index threshold of 70 as a condition for a valid test cycle in new appendix C2. The December 2021 TP NOPR, stakeholder comments, January 2023 TP Final Rule, and supporting material are available on the docket at *https://www.regulations.gov/docket/EERE-2016-BT-TP-0012*.

D. 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 product that are the subject of the rulemaking. As the first step in such an analysis, DOE develops a list of technology options for consideration in consultation with manufacturers, design engineers, and other interested parties. DOE then determines which of those means for improving efficiency are technologically feasible. DOE considers technologies incorporated in commercially-available products or in working prototypes to be technologically feasible. Sections 6(b)(3)(i) and 7(b)(1) of appendix A.

After DOE has determined that particular technology options are technologically feasible, it further evaluates each technology option in light of the following additional screening criteria: (1) practicability to manufacture, install, and service; (2) adverse impacts on product utility or availability; (3) adverse impacts on health or safety, and (4) unique-pathway proprietary technologies. Sections 6(b)(3)(ii)–(v) and 7(b)(2)–(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 NOPR TSD.

2. Maximum Technologically Feasible Levels

When DOE proposes to adopt an amended standard for a type or class of covered product, it must determine the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible for such product. (42 U.S.C. 6295(p)(1)) Accordingly, in the engineering analysis, DOE determined the maximum technologically feasible ("max-tech") improvements in energy efficiency for 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 of this document and in chapter 5 of the NOPR TSD.

E. Energy Savings

1. Determination of Savings

For each trial standard level ("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 proposed standards (2027–2056).[27] The savings are measured over the entire lifetime of dishwashers purchased in the 30-year period. DOE quantified the energy savings attributable to each TSL as the difference in energy consumption between each standards case and the no-new-standards case. The no-new-standards case represents a projection of energy consumption that reflects how the market

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

for a product would likely evolve in the absence of amended energy conservation standards.

DOE used its national impact analysis ("NIA") spreadsheet model to estimate national energy savings ("NES") and national water savings ("NWS") from potential amended or new 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. DOE also calculates NES in terms of FFC energy savings. The FFC metric includes the energy consumed in extracting, processing, and transporting primary fuels (*i.e.*, coal, natural gas, petroleum fuels), and thus presents a more complete picture of the impacts of energy conservation standards.[28] DOE's approach is based on the calculation of an FFC multiplier for each of the energy types used by covered products or product. 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))

[28] 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).

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.[29] 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 discussed in section V.C of this document, DOE is proposing to adopt TSL 3, which would save an estimated 0.31 quads of energy (FFC) and 0.24 trillion gallons of water. DOE has initially determined the energy savings from the proposed standard levels are "significant" within the meaning of 42 U.S.C. 6295(o)(3)(B).

F. 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 NOPR.

[29] 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).

a. Economic Impact on Manufacturers and Consumers

In determining the impacts of a potential amended standard on manufacturers, DOE conducts an 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 expense (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 and Water 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 III.D 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 proposed in this document would not reduce the utility or performance of the products under consideration in this rulemaking.

e. Impact of Any Lessening of Competition

EPCA directs DOE to consider the impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from a proposed standard. (42 U.S.C. 6295(o)(2)(B)(i)(V)) It also directs the Attorney General to determine the impact, if any, of any lessening of competition likely to result from a proposed standard and to transmit such determination to the Secretary within 60 days of

the publication of a proposed rule, together with an analysis of the nature and extent of the impact. (42 U.S.C. 6295(o)(2)(B)(ii)) DOE will transmit a copy of this proposed rule to the Attorney General with a request that the Department of Justice ("DOJ") provide its determination on this issue. DOE will publish and respond to the Attorney General's determination in the final rule. DOE invites comment from the public regarding the competitive impacts that are likely to result from this proposed rule. In addition, stakeholders may also provide comments separately to DOJ regarding these potential impacts. See the **ADDRESSES** section for information to send comments to DOJ.

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 proposed 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 proposed 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. As part of the analysis of the need for

national energy and water conservation, 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 other factors that the Secretary deems to be relevant. (42 U.S.C. 6295(o)(2)(B)(i)(VII)) To the extent DOE identifies any relevant information regarding economic justification that does not fit into the other categories described previously, DOE could consider such information under "other factors."

2. Rebuttable Presumption

As set forth in 42 U.S.C. 6295(o)(2)(B)(iii), EPCA creates a rebuttable presumption that an energy conservation standard is economically justified if the additional cost to the consumer of a product that meets the standard is less than three times the value of the first year's energy savings resulting from the standard, as calculated under the applicable DOE test procedure. DOE's LCC and PBP analyses generate values used to calculate the effects that proposed energy conservation standards would have on the payback period for consumers. These analyses include, but are not limited to, the 3-year payback period contemplated under the rebuttable-presumption test. In addition, DOE routinely conducts an economic analysis that considers the full range of impacts to consumers, manufacturers, the Nation, and the environment, as required under

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

IV. Methodology and Discussion of Related Comments

This section addresses the analyses DOE has performed for this rulemaking regarding dishwashers. Separate subsections address each component of DOE's analyses.

DOE used several analytical tools to estimate the impact of the standards proposed 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. Additionally, this second spreadsheet 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-2019-BT-STD-0039*. Additionally, DOE used output from the latest version of the Energy Information Administration's ("EIA's")

Annual Energy Outlook ("*AEO*"), a widely known energy projection for the United States, 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 NOPR TSD for further discussion of the market and technology assessment.

1. Product Classes

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

such factors as the utility of the feature to the consumer and other factors DOE determines are appropriate. (*Id.*)

DOE currently defines separate energy conservation standards for the following two product classes of dishwashers (10 CFR 430.32(f)):

(1) Standard-size dishwashers (capacity equal to or greater than eight place settings plus six serving pieces); and

(2) Compact-size dishwashers (capacity less than eight place settings plus six serving pieces).

For these two classes of dishwashers, DOE's current test procedure measures the energy consumption in terms of EAEU, in kWh/year, and water consumption, in gal/cycle (*see* 10 CFR 430.32(f)).

As part of its rulemaking process, DOE considers, among other things, whether changes to the current product classes are warranted under the criteria in 42 U.S.C. 6295(q). In surveying the dishwasher market, DOE determined that, in addition to a "normal" cycle, many dishwasher models offer a variety of other cycles, *e.g.*, delicate cycles, eco wash cycles, heavy soil cycles, pots and pans cycles, and quick or short cycles. In order to establish a separate product class for dishwasher models that offer any of these other cycles, DOE would have to determine that: (1) the other cycle is a performance-related feature which other products within such type (or class) do not have;

and (2) such feature justifies a higher or lower standard. (42 U.S.C. 6295(q)(1)(B)) In making the latter determination, DOE considers such factors as the utility to the consumer of such a feature, and such other factors as the Department determines appropriate. *Id.*

With respect to the first criterion for establishing product classes, DOE has preliminarily determined that these other cycles may constitute performance-related features. For example, in 2020, DOE analyzed he average "normal" and "quick" cycle times for 31 dishwasher models. The average cycle time for a "normal" cycle was 131.1 minutes, while the average "quick" cycle time was 75.5 minutes.[30] DOE recognizes that "quick" cycle options, which are on average approximately an hour shorter than a "normal" cycle, allow consumers access to clean dishes in an expedited manner.

However, with respect to the second criterion for establishing product classes, DOE tentatively concludes that there is not a correlation between any of these additional cycles and energy and water use as measured by the DOE test procedure. In other words, DOE does not find a justification for setting a lower or higher standard for dishwasher models that offer any of these other cycles because only the "normal" cycle is tested pursuant to the DOE test procedure for compliance with the applicable standard. The current and proposed standards impose restrictions on energy or water use only when a

[30] The test results for the 31 units are available at: https://www.regulations.gov/document/EERE-2018-BT-STD-0005-3213.

dishwasher is operating in its "normal" cycle. Thus, there is no justification or need to establish separate product classes for dishwashers with these other cycles.

As a result, in this NOPR, DOE proposes to maintain the existing standard-size and compact-size product classes for dishwashers.

DOE requests comment on its preliminary determination to maintain the current product classes for dishwashers.

2. Technology Options

In the January 2022 Preliminary Analysis, DOE identified 19 technology options that would be expected to improve the efficiency of dishwashers, as measured by the DOE test procedure: condensation drying; control strategies;[31] desiccant drying; fan/jet drying; flow-through heating; improved fill control; improved food filter; improved motor efficiency; improved spray-arm geometry; increased insulation; low-standby-loss electronic controls; microprocessor controls and fuzzy logic, including adaptive or soil-sensing controls; modified sump geometry, with and without dual pumps; reduced inlet-water temperature; supercritical carbon dioxide washing; thermoelectric heat pumps; ultrasonic washing; variable washing pressures and flow rates; and, water re-use system. *See* chapter 3, section 3.14.2 of the January 2022 Preliminary Analysis.

[31] Control strategies refers to how manufacturers program the microprocessor to control a dishwasher to limit the amount of water used, or to reduce the set-point temperature of the wash or rinse water.

In the January 2022 Preliminary Analysis, DOE requested feedback on whether there are additional technologies available that may improve dishwasher performance. See chapter ES, section ES.4.3 of the January 2022 Preliminary Analysis.

Westview and Global Guideway commented that use of grey water and "back side heat recovery" design ideas from solar panels could be used to improve whole-home efficiency. (Westview and Global Guideway, No. 17 at p. 1) While DOE appreciates the comment, DOE notes that it identifies technology options that would improve the efficiency of the covered product itself, and typically, the technology exists as part of the product's design. Accordingly, DOE has not considered this technology option in this document.

Samsung commented that opportunities for improved energy efficiency beyond EL 1 exist, such as implementation of variable-speed motors. (Samsung, No. 22 at p. 2) DOE agrees and, as discussed in Chapter 5 of the January 2022 Preliminary TSD and this NOPR TSD, DOE implemented a 3-phase variable-speed motor design option at EL 3. Such a motor, along with more sophisticated electronic controls, allows the dishwasher to adjust the flow rate at which the water is pumped throughout the water system at different times during the cycle. Using the most energy-intensive pump operation only when needed eliminates excess energy consumption for portions of the wash cycle requiring less aggressive circulation.

AHAM commented that DOE should not be able to claim more efficient motors as a design option in this end-use product rulemaking and claim separate savings in a

potential future motors standards rulemaking for those same motors. AHAM stated that if DOE regulates special and definite purpose motors in spite of AHAM's objection, then DOE must remove the savings from motors from amended standards for dishwashers. (AHAM, No. 26 at p. 15) DOE acknowledges AHAM's comment, but notes that the drain and sump motors analyzed for this rulemaking are currently not subject to motor standards.

The CA IOUs encouraged DOE to reconsider its assumption that all dishwasher models above the baseline have the same standby power levels and recognize the potential for advanced electronics and power supplies to lower standby power. The CA IOUs commented that more advanced electronics and power supplies may translate to energy savings significantly greater than those calculated by DOE. (CA IOUs, No. 27 at p. 4) DOE used the efficiency-level approach to conduct its efficiency analysis for the engineering analysis, and identified the most likely design pathways to achieve the analyzed levels. DOE did not analyze incremental improvements to electronic controls because it implemented the improved electronic controls design option at EL 1.

DOE requests comment on specific technology options for reducing standby power, including the type of technologies implemented and the estimated improvement in standby power.

In this NOPR, DOE considered the same technology options as those considered in the January 2022 Preliminary Analysis. Additionally, DOE proposes to explicitly discuss variable-speed motors as a technology option in the market and technology

assessment, since DOE included it in its design options for EL 3 and higher in the engineering analysis for the January 2022 Preliminary Analysis as well as the December 2016 Final Determination. Chapter 3 of the NOPR TSD includes the detailed descriptions of each technology option.

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.

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

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 reasons for eliminating any technology are discussed in the following sections.

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

1. Screened-Out Technologies

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

a. Desiccant drying

Desiccant drying relies on a material such as zeolite[32] to adsorb moisture to aid in the drying process and reduce drying energy consumption. In the January 2022 Preliminary TSD, DOE noted that it is aware of dishwashers from one manufacturer on the market in the United States that use desiccant drying. *See* chapter 4, section 4.2.1.1 of the January 2022 Preliminary TSD.

DOE has screened out desiccant drying from further consideration because it would not be practicable to manufacture on the scale necessary for the dishwasher market. 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 accommodate newly purchased units incorporating this technology option. Therefore, DOE believes 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.

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

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 believes 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 ultrasonic consumer 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 research and development is still underway. Therefore, DOE believes 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.

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 believes 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 tentatively concludes that all of the other identified technologies listed in section IV.A.2 of this document, including variable-speed motors, met all five screening criteria to be examined further as design options in DOE's NOPR analysis. In summary, DOE did not screen out the following technology options: condensation drying; control strategies; fan/jet drying; flow-through heating; improved fill control; improved food filter; improved motor efficiency; variable-speed motors; improved spray-arm geometry; increased insulation; low-standby-loss electronic controls; 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 has initially 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.*, are practicable to manufacture, install, and service; do not result in adverse impacts on consumer utility, product availability, health, or safety; and are not unique-pathway proprietary technologies). For additional details, see chapter 4 of the NOPR 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 dishwashers, DOE considers technologies and design option combinations not eliminated by the screening analysis. For each product class, DOE estimates the baseline cost, as well as the incremental cost for the product at efficiency levels above the baseline. The output of the engineering analysis is a set of cost-efficiency "curves" that are used in downstream analyses (*i.e.*, the LCC and PBP analyses and the NIA).

1. Efficiency Analysis

DOE typically uses one of two approaches to develop energy efficiency levels for the engineering analysis: (1) relying on observed efficiency levels in the market (*i.e.*, the efficiency-level approach), or (2) determining the incremental efficiency improvements associated with incorporating specific design options to a baseline model (*i.e.*, the design-option approach). Using the efficiency-level approach, the efficiency levels established for the analysis are determined based on the market distribution of existing products (in other words, based on the range of efficiencies and efficiency level "clusters" that already exist on the market). Using the design-option approach, the efficiency levels established for the analysis are determined through detailed engineering calculations and/or computer simulations of the efficiency improvements from implementing specific design options that have been identified in the technology assessment. DOE may also rely on a

combination of these two approaches. For example, the efficiency-level approach (based on actual products on the market) may be extended using the design option approach to "gap fill" levels (to bridge large gaps between other identified efficiency levels) and/or to extrapolate to the max-tech level (particularly in cases where the max-tech level exceeds the maximum efficiency level currently available on the market).

For this analysis, DOE used a combination of these 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 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 NOPR TSD.

a. Baseline Efficiency

For each product/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 product class represents the characteristics of a product typical of that class (*e.g.*, capacity, physical size). Generally, a baseline model is one that just meets current energy conservation standards, or, if no standards are in place, the baseline is typically the most common or least efficient unit on the market.

For 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 NOPR analyses, including the engineering analysis, LCC analysis, PBP analysis, and NIA. To determine energy savings that will result from an amended energy conservation standard, DOE compares energy use at each of the higher energy efficiency levels to the energy 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 NOPR TSD.

Table IV.1 presents the baseline levels identified for each dishwasher product class in the January 2022 Preliminary Analysis, and Table IV.2 presents the baseline levels identified for each dishwasher product class in this NOPR.

Table IV.1 Baseline Dishwasher Efficiency Levels Evaluated in the January 2022 Preliminary Analysis[33]

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	178	3.5

* Using appendix C1
** Using appendix C2

Table IV.2 Baseline Dishwasher Efficiency Levels Proposed in this 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 updated the baseline efficiency level for the compact-size dishwasher product class from 178 kWh/year to 191 kWh/year, when using appendix C2, as shown in Table IV.1 and Table IV.2. In the January 2022 Preliminary Analysis, DOE translated the current compact-size product class standard level of 222 kWh/year, which is based on 215 annual cycles, to an EAEU based on 184 annual cycles using the baseline standby power energy use estimate of 2.3 watts from the December 2016 Final Determination (*See* chapter 7 of the December 2016 Final Determination TSD).[34] However, based on its most recent testing of compact-size dishwashers, conducted in October 2020, DOE

[33] *See* chapter 5, section 5.3.1 of the January 2022 Preliminary TSD for further information. The second Estimated Annual Energy Use column did not appear in the January 2022 Preliminary TSD, but has been added to reflect the changes in the January 2023 TP Final Rule.
[34] To translate the current dishwasher EAEU standards from 215 annual cycles to 184 annual cycles, 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.

determined for this 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 215 annual cycles to 184 annual cycles, DOE calculated an updated baseline EAEU value of 191 kWh/year for compact-size dishwashers. Accordingly, DOE is proposing the baseline compact-size dishwasher efficiency level to be 191 kWh/year and 3.5 gal/cycle.

DOE requests comment on the proposed baseline compact-size dishwasher EAEU of 191 kWh/year for this NOPR.

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.

Table IV.3 and Table IV.4 present the efficiency levels for standard-size and compact-size dishwashers, respectively, from the January 2022 Preliminary Analysis.

Table IV.3 Efficiency Levels for Standard-Size Dishwashers Evaluated in the January 2022 Preliminary Analysis[35]

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.4 Efficiency Levels for Compact-Size Dishwashers Evaluated in the January 2022 Preliminary Analysis

Efficiency Level	Estimated Annual Energy Use (*kWh/year*)*	Estimated Annual Energy Use (*kWh/year*)**	Per-Cycle Water Consumption (*gal/cycle)*
Baseline	222	178	3.5
1	203	174	3.1
2 (Max-Tech)	144	124	1.6

* Using appendix C1
** Using appendix C2

In the January 2022 Preliminary Analysis, DOE requested comment on whether the efficiency levels for each product class were appropriate. DOE also observed that the design options at baseline and EL 1 for compact-size dishwashers were the same and sought feedback on the differences, if any, between baseline and EL 1 compact-size dishwasher design options. *See* Executive Summary, section ES.4.4 of the January 2022 Preliminary TSD. DOE did not receive any comments on the similarities or differences in design options between baseline and EL 1 for compact-size dishwashers. The

[35] *See* chapter 5, section 5.3.2 of the January 2022 Preliminary TSD for further information. The second Estimated Annual Energy Use column did not appear in the January 2022 Preliminary TSD, but has been added to reflect the changes in the January 2023 TP Final Rule.

following paragraphs summarize the comments DOE received regarding the efficiency levels for each product class.

AHAM commented that energy conservation standards more stringent than ENERGY STAR V. 6.0 criteria are likely to result in limited energy savings, degraded performance, and, due to undesirable consumer behaviors such as increased handwashing and pre-rinsing, increased water and energy consumption. (AHAM, No. 26 at p. 2) Whirlpool commented that consumers would be dissatisfied with dishwasher performance at EL 2 and above, which will lead to compensatory behaviors, such as pre-rinsing, handwashing, using heavier cycles and options, and rewashing dishes, that lower the overall expected energy and water savings from such standards. Whirlpool requested that DOE assess and quantify this compensatory behavior in its analysis. (Whirlpool, No. 21 at p. 6)

AHAM commented that, if DOE did not include a cleaning index threshold in the dishwashers test procedure, the January 2022 Preliminary Analysis justified amended energy conservation standards for dishwashers up to, but not exceeding, EL 1. AHAM stated that products on the market have a demonstrated capability to achieve EL 1 while retaining consumer satisfaction with cleaning performance, drying performance, and cycle duration. (AHAM, No. 26 at p. 3) AHAM commented that DOE's data demonstrate that many models at EL 1 would not meet DOE's cleaning index threshold of 65 proposed in the December 2021 TP NOPR, and would require re-testing. (AHAM, No. 26 at p. 13) In late comments submitted after the close of the comment period, AHAM noted that its initial analysis indicating that many models at EL 1 would not meet

DOE's cleaning index threshold of 65 proposed in the December 2021 TP NOPR is unchanged by its updated comments, wherein AHAM commented that its data from the 2013 round robin testing was more relevant, given that the test variation in cleaning index based on the 2013 round robin testing was also 7. (AHAM, No. 31 at p. 4)

AHAM stated that dishwashers are nearing maximum efficiency under the available technology, and additional efficiency gains are not available without increasing costs or sacrificing performance or product functionality. (AHAM, No. 26 at p. 3) AHAM also commented that more radical or comprehensive the design change, the more likely retooling is necessary and the greater the product cost and the investment. AHAM also stated current dishwasher platforms are at the limit of energy and water use reduction achievable through changes in components. (AHAM, No. 26 at pp. 14–15)

DOE notes that its analyses account for consumer behaviors such as handwashing when conducting the energy and water use analyses.[36] DOE also notes that testing and teardowns showed that dishwashers that span a range of efficiencies are available currently, utilizing available technology options, and these models are capable of achieving a cleaning index of at least 70, as required by the test procedure adopted in the January 2023 TP Final Rule that would be applicable for any amended energy conservation standards. Additionally, DOE's teardown analysis showed that a product

[36] See section 10.4.2 in chapter 10 of the NOPR TSD.

platform change would not be necessary until the max-tech efficiency level for standard-size dishwashers.

Whirlpool commented that manufacturers typically underestimate product efficiency, meaning that the vast majority of existing dishwasher models already perform within the energy limit where DOE believes cleaning performance can be maintained, rendering amended energy conservation standards beyond EL 1 for standard-size dishwashers unnecessary. (Whirlpool, No. 21 at p. 4) Whirlpool provided an example to note that if manufacturers use a 3 to 5-percent safety factor, it will imply that units rated at EL 1 (*i.e.,* 270 kWh/year and 3.5 gal/cycle when testing according to the currently applicable appendix C1) already perform between 257–262 kWh/year and 3.3–3.4 gal/cycle. Whirlpool stated that this indicates that many models are already currently within the energy limit to where DOE believes that cleaning performance can be maintained. (*Id.*) DOE notes that it evaluated dishwasher cleaning performance based on the rated energy and water use values certified by manufacturers. These results showed that units up to the rated efficiencies at EL 3 achieved the specified cleaning index threshold. Additionally, during manufacturer interviews, some manufacturers acknowledged that DOE's cleaning index threshold was achievable at efficiency levels up to EL 3 for standard-size dishwashers. These manufacturers also stated that for certain models that may not meet the cleaning index threshold, the safety margin already built into the rated energy and water use values for such models could be narrowed to maintain the existing efficiency level without requiring recertification or to exceed the existing efficiency level without requiring a redesign.

GEA supported increasing the minimum efficiency standard for standard-size dishwashers to EL 1. (GEA, No. 25 at p. 2) But, GEA commented that it opposed an increase to EL 1 if it were coupled with a cleaning performance metric because, according to GEA, DOE's cleaning performance metric as proposed in the December 2021 TP NOPR is flawed. (*Id.*) GEA commented that the limited data provided by DOE indicate that at least 73 percent of units would fail the cleaning performance score at EL 1. (*Id.*)

The CA IOUs commented that EL 2 is an appropriate higher efficiency level for both standard-size and compact-size dishwashers. The CA IOUs stated that EL 1 would not provide significant enough energy and water savings due to the fact that 100 percent of standard-size dishwasher shipments in 2020 already met this efficiency level, according to ENERGY STAR. Further, for standard-size dishwashers, the CA IOUs stated that EL 2 would provide an average lifetime savings of $4 per consumer and a net benefit to the majority of consumers, with an estimated payback period of 7 years that is less than half of the average dishwasher lifetime of 15.2 years. For compact-size dishwashers, the CA IOUs stated that EL 2 is a reasonable standard level noting that it would provide average lifetime cost savings of $36 per consumer with 60 percent of consumers experiencing a net benefit and a payback period of 7.1 years. (CA IOUS, No. 27 at pp. 1–2) The CA IOUs further commented that DOE should amend standards to EL

2 to coordinate with the adoption of the ENERGY STAR V. 7.0[37] specification, which finalized more stringent energy and water use qualification criteria. (*Id.*)

The Joint Commenters stated that dishwashers are able to meet EL 3 while providing high consumer satisfaction across various areas of performance. The Joint Commenters noted that: DOE investigated, in the January 2022 Preliminary Analysis, the potential impact of reduced energy and water consumption on dishwasher cleaning performance and cycle time; and (2) EPA analyzed during the development of the ENERGY STAR V. 7.0 Specification how dishwashers meeting the proposed requirements perform across a range of metrics that impact consumer satisfaction. (Joint Commenters, No. 23 at p. 1) The Joint Commenters stated that EPA's analysis found that all dishwasher models rated by Consumer Reports that met the ENERGY STAR V. 7.0 requirements (*i.e.,* EL 3) received a cleaning performance rating of Very Good or Excellent. The Joint Commenters additionally noted that both DOE and EPA found no clear correlation between cycle time and energy and water consumption and that the average cycle time of models rated by Consumer Reports for models that meet ENERGY STAR V. 7.0 was 142 minutes, which is less than the average cycle time of 148 minutes across all models rated by Consumer Reports. The Joint Commenters additionally noted that higher efficiency models are rated better than average for noise performance and there were minimum differences in drying performance when comparing models that met the ENERGY STAR V. 7.0 requirements to other reviewed models. Finally, the Joint Commenters noted that the overall satisfaction rating for models meeting the ENERGY

[37] ENERGY STAR Program Requirements. Product Specification for Residential Dishwashers. Eligibility Criteria. Version 7.0. Effective date: July 19, 2023.

STAR V. 7.0 requirements was 4.36 compared to 3.56 for all models. (Joint Commenters, No. 23 at p. 2) NEEA commented that its consumer satisfaction data for high efficiency dishwashers supports DOE's conclusion regarding cleaning performance (*i.e.,* cleaning performance can be maintained up to EL 3 for standard-size dishwashers) and demonstrates that noise and cycle time do not increase up to EL 3. Specifically, NEEA commented that its market research found that consumer satisfaction was higher at EL 1 and EL 3 compared to the baseline (*i.e.,* EL 0) and it was likely that these units operated quietly compared to baseline units. (NEEA, No. 24 at pp. 2-3)

Whirlpool commented that amended standards beyond EL 1 would allow only a third or less of the total allowable energy usage for drying after allocating energy to cleaning, which is less than the half or more of total energy use that Whirlpool would want to allocate to drying to ensure excellent performance. (Whirlpool, No. 21 at p. 4) Whirlpool commented that manufacturers struggle to deliver consistent drying performance due to existing efficiency standards, and the problem would be exacerbated at all levels beyond EL 1. Whirlpool stated that there is not enough energy that can be allocated to drying performance after available energy is allocated to the core function of a dishwasher, cleaning performance, and that lower final rinse temperatures and shorter heated drying necessitated by efficiency standards make it difficult to completely dry all items in the consumer's load and the interior tub itself. (*Id.*) During the January 2022 Preliminary Analysis webinar, AHAM asked if DOE had evaluated the impact of potentially more stringent standards on drying performance, noise, or other factors. (AHAM, Public Meeting Transcript, No. 20 at p. 43) AHAM commented that in order to design dishwashers that meet the cleaning index threshold requirements proposed in the

December 2021 TP NOPR as well as potentially more stringent standards, it is likely that manufacturers will need to reduce drying energy, lengthen cycles, and potentially impact noise levels. (AHAM, No. 31 at p. 4)

Whirlpool commented that beyond EL 1, plastic tub dishwashers which are lower priced and common amongst lower-income consumers, may not be able to retain enough heat to keep the internal temperature high enough with lower rinse temperatures and shorter heated drying durations, to adequately remove water from dishes and the interior tub surfaces. (Whirlpool, No. 21 at p. 4) Whirlpool further commented that if manufacturers cannot offer competitive plastic tub dishwashers, it would force low-income consumers to spend approximately $200 or more on the purchase of a new dishwasher, negating potential lifetime energy and water savings for the consumer. (Whirlpool, No. 21 at p. 5)

DOE notes that appendix C2 regulates only the normal cycle, as long as the normal cycle meets the specified cleaning index threshold. As such, DOE expects that a variety of other, non-regulated cycles available on current dishwasher models would continue to be available even if DOE were to amend existing standards, given that such cycle types and/or cycle options have not been, and would continue to not be, subject to any water or energy limits as a result of any energy conservation standards. Specifically, DOE expects quick cycles, which often clean a load within 1 hour or less, would still be available on dishwasher models that currently offer such a cycle. DOE also expects existing drying options would continue to be available on dishwashers regardless of amended standards up to at least EL 3. DOE additionally expects 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.

Additionally, while DOE's teardown analysis shows that plastic tubs are available in dishwasher models at efficiency levels higher than EL 1, and DOE estimates that plastic tubs can be used up to EL 3 based on its testing and teardowns, DOE also recognizes potential utility concerns associated with implementing plastic tubs at higher efficiency levels. DOE received similar feedback during manufacturer interviews that some aspect of dishwasher performance could be compromised particularly at EL 3 and beyond and DOE considered this feedback during its analysis.

DOE additionally notes that its testing demonstrated that standard-size dishwashers can achieve the threshold cleaning performance on the normal cycle at all soil levels up to EL 3 and at least one of the three soil levels at the max-tech efficiency level (EL 4). Additionally, the ENERGY STAR Most Efficient 2022[38] database includes other models besides the max-tech unit that DOE tested that meet or exceed EL 4. To qualify for ENERGY STAR Most Efficient 2022, units need to meet a minimum cleaning index of 70, including scores for spots, streaks, and rack contact marks which are excluded from DOE's test procedure at appendix C2, at each soil level on the normal cycle. Accordingly, standard-size dishwashers that can achieve the threshold cleaning performance on the normal cycle at EL 4 currently exist on the market. DOE's testing

[38] ENERGY STAR Most Efficient 2022. Dishwashers. Available at: *www.energystar.gov/most-efficient/me-certified-dishwashers/results?is_most_efficient_filter=Most+Efficient* (last accessed October 28, 2022).

also indicated that compact-size dishwashers can achieve the threshold cleaning performance on the normal cycle even at the heavy soil load.[39]

During the January 2022 Preliminary Analysis webinar, AHAM asked if DOE had conducted any testing or crosswalk to evaluate the impact of the cleaning performance requirement proposed in the December 2021 TP NOPR on the efficiency levels presented in the January 2022 Preliminary Analysis. (AHAM, Public Meeting Transcript, No. 20 at p. 15) AHAM commented that if DOE included a cleaning performance metric, DOE would need to account for the changes in measured energy and water efficiency that would likely result from the amendment and repeat its analysis to re-establish the baseline and examine the distribution of higher-efficiency models. (AHAM, No. 26 at pp. 3, 14) AHAM commented that, based on the data DOE presented in the January 2022 Preliminary TSD, most dishwashers would need to be re-rated, and many may be rated at lower efficiency levels because the cleaning index threshold proposed in the December 2021 TP NOPR would require the products be tested at their highest energy consuming cycle. (AHAM, No. 26 at p. 13)

DOE notes that the January 2023 TP Final Rule has established the cleaning performance requirement in the dishwasher test procedure that will be required to demonstrate compliance with any amended standards. That is, any dishwasher manufactured or sold in the United States on or after the compliance date of any such

[39] All of the compact units in DOE's test sample were non-soil sensing dishwashers, which are not required under appendix C2 to be tested with lesser soil loads if the cleaning performance threshold is met with the heavy soil load.

amended standards will be required to meet a minimum cleaning index threshold of 70 as a condition of a valid test cycle. As such, no products would have to be re-rated to comply with the current standards. Based on an analysis of DOE's test data (presented previously in the December 2021 TP NOPR, January 2022 Preliminary TSD, and January 2023 TP Final Rule), dishwasher models that can meet or exceed the cleaning index threshold of 70 on the normal cycle for all test cycles are already available up to EL 3. Additionally, as mentioned elsewhere in this notice, during manufacturer interviews, some manufacturers acknowledged that DOE's cleaning index threshold was achievable at efficiency levels up to EL 3 for standard-size dishwashers and, for certain models that may not meet this threshold, the rated energy and water use values have an allowance to allow potential increases in energy and water consumption without requiring models to be re-rated at a higher energy and water consumption value. Accordingly, DOE has not adjusted its baseline or higher efficiency levels in this NOPR.

Whirlpool reiterated its comments from the October 2020 RFI that until water filtration technology changes and poor water dilution issues were resolved by a new technology, Whirlpool expects cleaning performance will degrade at increasing efficiency levels. (Whirlpool, No. 21 at p. 3) While DOE recognizes that poor water dilution can impact cleaning performance, as mentioned elsewhere in this document, DOE's testing and analysis indicates that satisfactory cleaning performance is achievable at all efficiencies. 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.

The Joint Commenters commented that DOE should evaluate an additional intermediate efficiency level for compact-size dishwashers between EL 1 and EL 2 to cover a significant gap of models that meet the requirements of EL 1, but do not meet EL 2. The Joint Commenters noted that over half of the models listed in CCMS meet the requirements of EL 1, but fall short of EL 2. (Joint Commenters, No. 23 at pp. 2–3) NEEA also commented on the lack of gradation between EL 1 and EL 2 and stated that DOE should consider adding an efficiency level between EL 1 and EL 2 for compact-size dishwashers for similar reasons. NEEA stated that the TSD shows a group of products at 1.75 gal/cycle and 155 kWh/year as the water and energy values for the potential intermediate level. (NEEA, No. 24 at p. 2) DOE considered whether to include an additional gap-fill level between EL 1 and EL 2 for compact-size dishwashers in the NOPR analysis. However, DOE found only 11 compact-size basic models out of 65 compact-size basic models, excluding "ultra-compact" units with capacities less than 4 place settings[40], that could be considered for such a gap-fill level, with EAEUs ranging from 155 kWh/year to 144 kWh/year and water consumption from 1.8 gal/cycle to 1.7 gal/cycle. Given that compact-size dishwashers comprise roughly 2 percent of the market, and the even smaller share of dishwashers at such an intermediate level, DOE determined that an additional gap-fill efficiency level is not warranted.

The CA IOUs commented that DOE should revisit its analysis of the max-tech efficiency level for standard-size dishwashers. The CA IOUs commented that they reviewed DOE's Compliance Certification Database ("CCD") and observed that the

[40] DOE did not include "ultra-compact" compact-size dishwashers when considering a gap-fill efficiency level because these dishwashers could limit utility for certain consumers given their small capacity.

current market exceeds the max-tech level specified in the January 2022 Preliminary TSD. The CA IOUs noted that even though DOE screened out some technologies, it appeared that the max-tech units observed by the CA IOUs represent levels of efficiency available in today's market beyond DOE's max-tech level. (CA IOUs, No. 27 at pp. 5-6) DOE notes that while units exist that exceed the max-tech efficiency level presented in the January 2022 Preliminary TSD, DOE did not consider these units for the max-tech efficiency level for the following reasons: (1) they utilize a cold-water connection, which DOE eliminated from consideration as a technology option in the screening analysis; (2) they have a rated capacity of eight place settings, but do not use a typical standard dishwasher configuration (*i.e.,* they have an 18-inch width instead of the more common 24-inch width); (3) they are no longer available on the market; or (4) there is an inconsistency between the rated EAEU in DOE's CCD and the EAEU listed on the model's EnergyGuide label. DOE reviewed the CCD and proposes to maintain the current EL 4 level for the reasons stated.

Table IV.5 shows the efficiency levels DOE evaluated for standard-size dishwashers in this NOPR analysis.

Table IV.5 Efficiency Levels for Standard-Size Dishwashers Proposed in this 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

DOE selected EL 1 to correspond to the current ENERGY STAR V. 6.0 qualification criteria for standard-size dishwashers. Seventy percent of standard-size dishwasher basic models, as included in DOE's CCD,[41] are rated at EL 1. DOE considered an intermediate level between ENERGY STAR V. 6.0 and the baseline, but determined it to be unnecessary, since only 5 percent of standard-size dishwasher basic models do not meet the water and energy use criteria of the ENERGY STAR V. 6.0 level. Therefore, further disaggregation of such a small portion of the market is not warranted. DOE selected EL 3 as the level that corresponds to the energy and water consumption levels that correspond to the 2022 ENERGY STAR Most Efficient[42] qualification criteria as well as the finalized ENERGY STAR V. 7.0 criteria which have a scheduled effective date of July 2023.[43] Additionally, 10 percent of standard-size dishwasher basic models meet the EL 3 criteria according to DOE's CCD. DOE established EL 2 as a gap-fill level by identifying product efficiency "clusters" when analyzing the range of efficiencies available on the market. The EAEU and water consumption values associated with a significant cluster, comprising approximately 14 percent of basic models, between EL 1 and EL 3 served as the basis for selecting EL 2. DOE also defines a "max-tech" efficiency level to represent the maximum possible efficiency for a given product. EL 4 is the max-tech efficiency level, as defined by the maximum available technology that DOE identified on the market at the time of its analysis, excluding from

[41] U.S. Department of Energy's Compliance Certification Database. Dishwashers (last accessed: July 19, 2022).
[42] 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*
[43] ENERGY STAR Program Requirements for Residential Dishwashers: *www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Version%207.0%20Residential%20Dishwasher%20Final%20Specification.pdf*

consideration those models discussed previously. DOE did not identify any working prototypes that were more efficient than this maximum available technology.

Table IV.6 shows the efficiency levels DOE evaluated for compact-size dishwashers in this NOPR analysis.

Table IV.6 Efficiency Levels for Compact-Size Dishwashers Proposed in this 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

DOE evaluated two incremental efficiency levels above the baseline for compact-size dishwashers. DOE selected EL 1 to correspond to the current ENERGY STAR V. 6.0 qualification criteria for compact-size dishwashers. Sixty-six percent of compact-size dishwasher models in DOE's CCD are rated at EL 1. DOE identified EL 2 as the max-tech efficiency level, defined by the maximum available technology that DOE identified on the market at the time of its analysis.[44] Based on its analysis of the CCD, DOE identified EAEU and water consumption levels of 144 kWh/year, based on 215 annual cycles, and 1.6 gal/cycle for EL 2. Approximately 21 percent of compact-size basic models in DOE's CCD are rated at EL 2. At EL 2, all units in DOE's CCD are either

[44] For reasons similar to those described in the consideration of a potential compact-size dishwasher gap-fill level, ultra-compact dishwashers were excluding from consideration as the compact-size max-tech level. Additionally, as discussed previously, DOE did not consider those compact-size models with a discrepancy between the rated EAEU in the CCD and the value on the EnergyGuide label.

under-counter drawer units or ultra-compact units with rated capacities of 1 or 2 place settings. DOE is not aware of any countertop compact-size dishwasher basic models on the market with rated capacities of 4 or more place settings beyond EL 1. However, based on its analysis, DOE understands that it is technologically feasible to design countertop compact-size dishwashers with 4 or more place settings that can meet the energy and water consumption requirements at EL 2.

DOE requests feedback on the efficiency levels analyzed for each product class in this proposal.

2. Manufacturer Production Cost Analysis

The cost analysis portion of the engineering analysis is conducted using one or a combination of cost approaches. The selection of cost approach depends on a suite of factors, including the availability and reliability of public information, characteristics of the regulated product, the availability and timeliness of purchasing the product 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 the present case, 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 develop the incremental MPCs associated with improving product efficiency, 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.7 and Table IV.8 show incremental manufacturing costs developed in the January 2022 Preliminary Analysis for standard-size and compact-size dishwashers, in 2020 dollars.

Table IV.7 Efficiency Levels and Incremental Manufacturer Production Costs for Standard-Size Dishwashers Evaluated in the January 2022 Preliminary Analysis[45]

Efficiency Level	**Estimated Annual Energy Use** (*kWh/year*)*	**Per-Cycle Water Consumption** *(gal/cycle)*	**Incremental MPC** (*2020$*)
Baseline	263	5.0	-
1	232	3.5	$18.27
2	223	3.3	$27.53
3	206	3.2	$71.12
4 (Max-Tech)	193	2.4	$113.86

* Using appendix C2

Table IV.8 Efficiency Levels and Incremental Manufacturer Production Costs for Compact-Size Dishwashers Evaluated in January 2022 Preliminary Analysis[46]

Efficiency Level	**Estimated Annual Energy Use** (*kWh/year*)*	**Per-Cycle Water Consumption** *(gal/cycle)*	**Incremental MPC** (*2020$*)
Baseline	178	3.5	-
1	174	3.1	-
2 (Max-Tech)	124	1.6	$37.41

* Using appendix C2

In the January 2022 Preliminary Analysis, DOE sought comment on whether the MPCs at each efficiency level were appropriate given the associated incremental changes manufacturers would likely make to meet these levels.

[45] See Chapter ES section ES.3.3.4 of the January 2022 Preliminary Analysis.
[46] See Chapter ES section ES.3.3.5 of the January 2022 Preliminary Analysis.

The Joint Commenters and NEEA commented that DOE may be overestimating the incremental costs to meet intermediate efficiency levels for standard-size dishwashers, citing EPA's analysis of prices of available models on the market meeting the EL 3 level which is equivalent to the ENERGY STAR V. 7.0 criteria. While both commenters acknowledged that EPA's methodology is based on retail pricing instead of MPCs, the Joint Commenters and NEEA concluded that DOE should reevaluate the incremental costs at EL 3 since DOE's preliminary analysis showed an incremental cost of more than two times the EPA estimate. (Joint Commenters, No. 23 at p. 2; NEEA, No. 24 at pp. 1-2)

DOE notes that its incremental MPCs, which were determined from teardowns and reviewed with manufacturers during interviews, estimate the manufacturing cost of dishwashers including any necessary redesigns to meet potential standards. Topics of discussion with manufacturers included the design options that would be used to reach each efficiency level for standard-size products as well as the costs associated with those design options. DOE also reviewed its design options assumptions and cost estimates for all components at each EL to identify if any changes to its preliminary estimates would be appropriate. Based on these discussions and additional analysis, DOE estimated its standard-size dishwasher EL 3 costs to be the same as those presented in the January 2022 Preliminary TSD, adjusted to 2022$.

For the other efficiency levels above the baseline for standard-size dishwashers, DOE received manufacturer feedback that DOE had identified all of the design options manufacturers would use to improve efficiencies. Manufacturers also generally agreed with the design options DOE assumed for each efficiency level, but some manufacturers

asserted that the distinction between EL 1 and EL 2 is less than DOE's preliminary estimates. Upon reviewing its teardown sample again, DOE observed that the same technology options exist at both EL 1 and EL 2, with the EL 2 units often being rated with a smaller tolerance on the rated EAEU and water consumption. In general, DOE observed that EL 2 units reduce rated energy and water use primarily by improving the control strategy and design tolerances that are implemented to more closely control water temperature, water fill volumes, *etc.* Accordingly, in this NOPR, DOE revised its estimated design options and MPC for standard-size dishwashers at EL 2. Specifically, DOE estimates that the same design options would be implemented at EL 2 as are used at EL 1, but with improved control strategies. Under this approach, the MPC at EL 2 would be the same as that at EL 1.

Table IV.9 shows the baseline MPCs for standard-size and compact-size dishwashers estimated for this NOPR. Table IV.10 and Table IV.11 show the incremental MPCs from the baseline for standard-size and compact-size dishwashers, respectively, that were estimated for this NOPR.

Table IV.9 Baseline Manufacturer Production Costs Estimated for this NOPR

Product Class	**Estimated Annual Energy Use** (*kWh/year*)*	**Per-Cycle Water Consumption** *(gal/cycle)*	**Manufacturer Production Cost** (*2022$*)
Standard-size	263	5.0	184.35
Compact-size	191	3.5	215.17

* Using appendix C2

Table IV.10 Incremental Manufacturer Production Costs for Standard-size Dishwashers Proposed for this NOPR

Efficiency Level	Estimated Annual Energy Use (*kWh/year*)*	Per-Cycle Water Consumption *(gal/cycle)*	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.11 Incremental Manufacturer Production Costs for Compact-size Dishwashers Proposed for this NOPR

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

* Using appendix C2

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

DOE requests comment on the baseline MPCs and incremental MPCs developed for each dishwasher product class.

3. Manufacturer Selling Price

To account for manufacturers' non-production costs and 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.[47] See chapter 12 of the NOPR TSD for additional detail on the manufacturer markup.

D. Markups Analysis

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

For dishwashers, DOE further developed baseline and incremental markups for each link in the distribution chain (after the product leaves the manufacturer). Baseline markups are applied to the price of products with baseline efficiency, while incremental markups are applied to the difference in price between baseline and higher-efficiency models (the incremental cost increase). The incremental markup is typically less than the baseline markup and is designed to maintain similar per-unit operating profit before and after new or amended standards.[48]

[47] U.S. Securities and Exchange Commission, *Electronic Data Gathering, Analysis, and Retrieval (EDGAR) system.* Available at *www.sec.gov/edgar/search/* (last accessed September 27, 2022).
[48] 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.

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.[49]

AHAM commented that it objects to DOE's use of incremental markups in translating manufacturer costs to retail prices. AHAM stated that it has offered a wide range of actual results demonstrating that DOE's theoretical model has no empirical justification. (AHAM, No. 26 at p. 10)

DOE's incremental markup approach assumes that an increase in profitability, which is implied by keeping a fixed markup when the product price goes up, is unlikely to be viable over time in reasonably competitive markets. DOE recognizes that retailers are likely to seek to maintain the same markup on appliances in response to changes in manufacturer sales prices after an amendment to energy conservation standards for dishwashers. However, DOE believes that retail pricing is likely to adjust over time as retailers 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.

DOE acknowledges that retailer markup practices in response to amended standards are complex and vary with business conditions. However, DOE's analysis necessarily only considers changes in appliance offerings that occur in response to

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

amended standards. DOE continues to maintain that its assumption that standards do not facilitate a sustainable increase in profitability is reasonable.

Chapter 6 of the NOPR TSD provides additional detail on DOE's development of the baseline and incremental retail markups.

E. Energy and Water Use Analysis

The purpose of the energy and water use analysis is to determine the annual energy consumption of dishwashers at different efficiencies in representative U.S. single-family homes, multi-family residences, and mobile homes, and to assess the energy savings potential of increased dishwasher efficiency. The energy use analysis estimates the range of energy 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.

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. In the January 2022 Preliminary Analysis, DOE used the Energy Information Administration ("EIA")'s 2015 *Residential Energy Consumption Survey* ("*RECS*") data to calculate an estimate of annual number of cycles.[50] Having determined

[50] U.S. Department of Energy-Energy Information Administration, Residential Energy Consumption Survey, 2015 Public Use Microdata Files, 2015. Washington, DC. Available online at: *www.eia.doe.gov/emeu/recs/recspubuse15/pubuse15.html*.

number of cycles of dishwasher use per year for each RECS household, DOE determined the corresponding annual energy and water consumption. In the January 2022 Preliminary Analysis, DOE determined the average annual cycles of operation for dishwashers to be 185 cycles per year based on *RECS 2015*.

The CA IOUs recommended that DOE reconsider its decision to use 185 average cycles per year in its analysis, and stated that *RECS 2015* may not accurately represent current consumer usage suggesting that later surveys may find that use bounces back. Additionally, the CA IOUs requested that DOE conduct a new survey on consumer usage to capture current usage patterns and dishwasher load levels. (CA IOUs, No. 27 at p. 3)

For this NOPR analysis, DOE primarily used data from *RECS 2020*, which provides information on the frequency of dishwasher usage per week for each household, to determine dishwasher utilization.[51] *RECS 2020* is the most recent data available regarding consumer usage that is based on a nationally representative sample of housing units.[52] For surveyed households with a dishwasher for which usage was greater than zero, *RECS 2020* showed an increase, relative to *RECS 2015*, to an average of 197 cycles per year, which was used in this analysis. [53] A report from Sun *et al*. showed that the average annual dishwasher cycle counts obtained from Pecan Street field metered data

[51] U.S. Department of Energy-Energy Information Administration, Residential Energy Consumption Survey, 2015 Public Use Microdata Files, 2015. Washington, DC. Available online at: www.eia.gov/consumption/residential/data/2020/

[52] Compared to *RECS 2015*, *RECS 2020* has a 72-percent larger sample and more refined definition of household demographics, which provides more granular information for the LCC analyses about the presence of dishwashers in U.S. households and the variability of their use.

[53] DOE notes the 6-percent difference in annual cycle values used in the test procedure final rule for dishwashers (88 FR 3234) and this NOPR analysis. Appendix 8G shows the LCC results using the *RECS 2015* sample.

based on a limited household sample size and limited geographic locations were comparable with the average cycle counts reported by *RECS 2015* and *RECS 2020*.[54] DOE is not aware of any publicly available data source in which dishwasher load levels are reported.

NEEA stated that both market and field data analysis reveal typical gas water heater efficiency factor is 0.62 to 0.70 EF, much lower than the 0.78 EF used in the January 2022 Preliminary TSD. NEEA recommended DOE to revisit the gas water heater efficiency value to ensure it is nationally representative and to provide justification for the typical gas water heat efficiency value in the final TSD. (NEEA, No. 24 at pp. 4–5) The Joint Commenters also urged DOE to reevaluate the assumed water heater efficiencies to better reflect actual efficiencies in the field in order to more accurately capture the energy savings associated with reduced hot water consumption. The Joint Commenters stated that DOE is overestimating the efficiencies of current water heaters in the field and therefore underestimating the real-world energy savings for dishwashers. The Joint Commenters estimated that the shipment-weighted efficiencies for new water heaters are 92 percent and 64 percent for electric and gas water heaters, respectively, and that average efficiencies of water heaters found in the existing housing stock are likely lower than those of new shipments. (Joint Commenters, No. 23 at pp. 3–4)

In its analyses for consumer water heaters, DOE calculates the energy use of water heaters using a simplified energy equation, the water heater analysis model

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

("WHAM"). WHAM accounts for a range of operating conditions and energy efficiency characteristics of water heaters. To describe energy efficiency characteristics of water heaters, WHAM uses three parameters that also are used in the DOE test procedure: recovery efficiency, standby heat-loss coefficient, and rated input power. The January 2022 Preliminary TSD states that DOE used a recovery efficiency of 78 percent for gas water heaters, not 0.78 EF, for the calculation of hot water energy savings. The hot water energy savings are almost directly proportional to the recovery efficiency, and the NOPR analysis uses the most recent data reported for the 2022 consumer water heater rulemaking.[55] DOE requests comment on the efficiency characteristics used in the consumer water heater rulemaking described here and encourages comment in both rulemakings.

Chapter 7 of the NOPR TSD provides details on DOE's energy use analysis for dishwashers.

DOE requests comment on the amount of water and energy used for pre-rinsing dishes and flatware before their placement into a dishwasher.

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. The

[55] DOE, 2022-03 Preliminary Analysis Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Consumer Water Heaters, March 2022. EERE-2017-BT-STD-0019-0018. Available at: *www.regulations.gov/document/EERE-2017-BT-STD-0019-0018* (last accessed June 21, 2022).

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

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

For any given efficiency level, DOE measures the change in LCC relative to the LCC in the no-new-standards case, which reflects the estimated efficiency distribution of 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 *RECS 2020*. For each sample household, DOE determined the energy consumption for dishwashers and the appropriate energy price. By developing a representative sample of households, the analysis captured the variability in energy consumption and energy prices associated with the use of 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 consumption, energy prices and price projections, repair and maintenance costs, product lifetimes, and discount rates. DOE created distributions of values for product lifetime, discount rates, and sales taxes, with probabilities attached to each value, to account for their uncertainty and variability.

The computer model DOE uses to calculate the LCC relies on a Monte Carlo simulation to incorporate uncertainty and variability into the analysis. The Monte Carlo simulations randomly sample input values from the probability distributions and dishwashers user samples. For this rulemaking, the Monte Carlo approach is implemented in MS Excel together with the Crystal Ball™ add-on.[56] The model

[56] Crystal Ball™ is commercially-available software tool to facilitate the creation of these types of models by generating probability distributions and summarizing results within Excel, available at *www.oracle.com/technetwork/middleware/crystalball/overview/index.html* (last accessed October 22, 2021).

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 all consumers of dishwashers as if each were to purchase a new product in the expected year of compliance with new or amended standards. Amended standards would 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)) At this time, DOE estimates publication of a final rule in 2024. Therefore, for purposes of its analysis, 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 NOPR TSD and its appendices.

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	Assumed no change in installation costs with efficiency level.
Annual Energy and Water Use	The standby wattage multiplied by the hours per year in standby mode. Average number of cycles based on *RECS 2020* data. Variability: Based on the *RECS 2020*.
Energy Prices	Electricity: Based on EEI 2021. Variability: Regional energy prices determined for 9 regions.
Energy Price Trends	Based on *AEO 2022* price projections.
Repair and Maintenance Costs	Assumed no change with efficiency level.
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 NOPR TSD.

AHAM stated that consumer costs and benefits from operating a dishwasher are impacted more by the methods used to clean dishes, such as washing by hand, pre-rinsing and then using a dishwasher, or using a dishwasher without pre-rinsing than the economics of running a dishwasher itself. AHAM further stated that instead of using the existing LCC model, DOE should analyze the cost to a consumer of these three principal modes of dish cleaning. (AHAM, No. 26 at pp. 7–8)

DOE included the water and energy volumes of washing dishes by hand as an alternative to washing dishes by machine in the NIA model and is described in section 10.4.2 in chapter 10 of the NOPR TSD. DOE acknowledges that a broader perspective on dish cleaning could be useful in identifying opportunities for energy and water conservation, but the type of analysis that AHAM proposes is outside the scope of the standards rulemaking process, which is focused on evaluating the economic justification

of potential standards on a particular product, in this case dishwashers, according to the criteria set by EPCA. In this rulemaking, DOE is only estimating the shipments of TSL3 would drop 0.01% compared to the no new standards case during the 30-year analysis period (2027-2056). DOE welcomes comment on the shipments estimation and publicly available data on the energy and water consumption from pre-rinsing dishes.

NEEA stated that efficiency improvements to an appliance can be considered capital investments, with "returns" being the money saved from utility bill reductions. NEEA commented that the return on investment ("ROI") is easy to calculate using this peer-reviewed method and adds additional insight for stakeholders and decision-makers and encouraged DOE to calculate and consider the ROI for each efficiency level in its analysis. (NEEA, No. 24 at p. 5)

DOE acknowledges that ROI is a metric that can be useful in evaluating investments in energy efficiency. However, the measures that DOE has historically used to evaluate the economic impacts of standards on consumers -- LCC savings and PBP -- are more closely related to the language in EPCA that 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)) Therefore, DOE finds it reasonable to continue to use those measures.

AHAM commented that DOE's use of the term "Net Cost" for impacted households is incomplete and misleading. AHAM suggested that the "Net Cost" should be calculated only among the affected households at a given standard level. (AHAM, No. 26 at p. 10)

DOE notes that EPCA requires DOE to consider the impact of standards on "consumers" of a product, not only those who would be affected by a standard.[57] Therefore, showing the share of all consumers purchasing dishwashers who would experience a net LCC cost or experience no impact at a given standard level is appropriate. The LCC spreadsheet provides information that allows calculation of the share of affected consumers that experience a net cost.

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 applied 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,

[57] Some dishwasher consumers would not be affected by a given standard if they already purchased a product at or above that efficiency level in the no-new-standards case.

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 dishwashers 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.[58] 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 25.1 percent.

NEEA supported DOE's approach to applying a learning rate for dishwasher prices and concluded that pre-rinsing of dishes remains consistent after an updated dishwasher standard. (NEEA, No. 24 at pp. 5–6)

[58] 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/*.

DOE assembled a time series of historical annual shipments of dishwashers for 1972–2020. The data for historical annual shipments were used to project future shipments and to estimate cumulative shipments (production). Projected shipments after 2020 were obtained from the no-new-standards case projections made for the NIA.

2. Installation Cost

Installation cost includes labor, overhead, and any miscellaneous materials and parts needed to install the product. DOE found no evidence that installation costs would be impacted with increased efficiency levels.

3. Annual Energy Consumption

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

4. Energy and Water Prices

Because it captures the incremental savings associated with a change in energy use from higher efficiency, a marginal electricity price more accurately represents an incremental change in consumer costs than would 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 2021 using data from EEI Typical Bills and Average Rates reports.[59] DOE used the EEI data to define a marginal price as the ratio of the change in the bill to the change in energy consumption.

To estimate energy prices in future years, DOE multiplied the 2021 energy prices by a projection of annual average price changes for each of the nine census divisions from the Reference case in *AEO 2022. AEO 2022* has an end year of 2050.[60] To estimate prices after 2050, a constant trend was used for all years.

DOE obtained data on public supply water prices for 2020 from the *Water and Wastewater Rate Survey* conducted by Raftelis Financial Consultants and the American Water Works Association.[61] The survey covers approximately 194 water utilities and 140 wastewater utilities, analyzing each industry (water and wastewater) separately. The water survey includes the cost to consumers of a given volume of water for each utility. The total consumer cost is divided into fixed and volumetric charges. DOE's calculation of water prices uses only volumetric charges, as only those charges would be affected by a change in water consumption. Including the fixed charge in the price average would lead to a higher water price. For wastewater utilities, the data format is similar except that the price represents the cost to treat a given volume of wastewater.

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[59] Edison Electric Institute. Typical Bills and Average Rates Report. 2021. Winter 2021, Summer 2021: Washington, D.C.

[60] EIA. *Annual Energy Outlook 2022 with Projections to 2050*. Washington, DC. Available at *www.eia.gov/forecasts/aeo/* (last accessed September 22, 2022).

[61] The American Water Works Association & Raftelis Financial Consultants, Inc., 2020 RFC/AWWA Water and Wastewater Rate Survey. 2021. Charlotte, NC.

5. Maintenance and Repair Costs

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

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. See chapter 8 of the NOPR TSD for further details.

DOE requests comment and information on dishwasher lifetime.

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.[62] DOE notes that the LCC does not analyze the appliance purchase decision, so the implicit discount rate is not relevant in this model. The LCC 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 lifetime scale into account. Given the 30-year analysis period modeled in the LCC analysis, 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

[62] The implicit discount rate is inferred from a consumer purchase decision between two otherwise identical goods with different first cost and operating cost. It is the interest rate that equates the increment of first cost to the difference in net present value of lifetime operating cost, incorporating the influence of several factors: transaction costs; risk premiums and response to uncertainty; time preferences; 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.

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 Finances[63] ("SCF") starting in 1995 and ending in 2019. Using the SCF and other sources, DOE developed a distribution of rates for each type of debt and asset by income group to represent the rates that may apply in the year in which amended standards would take effect. DOE assigned each sample household a specific discount rate drawn from one of the distributions. The average rate across all types of household debt and equity and income groups, weighted by the shares of each type, is 4.3 percent. See chapter 8 of the NOPR 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 CCD. DOE assumed no annual efficiency improvement for the no-new-standards case based on the current market evaluation and the efficiency distributions used in the December 2016

[63] U.S. Board of Governors of the Federal Reserve System. Survey of Consumer Finances. 1995, 1998, 2001, 2004, 2007, 2010, 2013, 2016, and 2019 (last accessed August 20, 2021). *www.federalreserve.gov/econresdata/scf/scfindex.htm.*

Final Determination. The estimated market shares for the no-new-standards case for dishwashers are shown in Table IV.13. See chapter 8 of the NOPR TSD for further information.

AHAM commented that it was inaccurate to use model counts from DOE's CCD as a means of determining the saturation of the efficiency levels. AHAM noted that the model count in the CCD substantially overstates the number of different models, and that, based upon AHAM's review, a majority of the apparently higher efficiency models in the CCD are in fact no longer widely available through retail channels or are for niche groups of consumers. AHAM stated that a comparison of AHAM shipments data to DOE's CCD model counts by efficiency show a significant difference between models being shipped for sale on the market versus what is listed in DOE's CCD. (AHAM, No. 26 at p. 4) Samsung recommended that DOE amend dishwasher standards to EL 1 or greater given the market penetration for ENERGY STAR V. 6.0 dishwashers (which represents units at EL 1 and above) was approximately 91 percent. (Samsung, No. 22 at p. 2)

For this NOPR, for the standard-size product class, DOE used information provided by the manufacturer interviews, and for the compact-size product class, counts of models in the DOE CCD as a means of determining the market shares of the efficiency levels because that is the best source that was available. DOE agrees that shipment-weighted efficiency distributions would be preferable to shares based on model counts, but such data were not available for compact dishwashers, and there is no publicly available data to support making an adjustment to the model count market shares. DOE's approach may well overstate the market share of higher-efficiency products in the

absence of new standards, but this would mean that the energy and economic benefits estimated by DOE for new standards are likely understated. The justification for the adopted standards could be even stronger if DOE were able to use actual shipment data for the model counts. DOE welcomes recent shipments data by efficiency level and will consider using such data for the final rule.

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* (k*Wh/year*)	Market Share (%)	Annual Energy Use* (k*Wh/year*)	Market Share (%)
Baseline	272	7	197	13
1	241	84	181	66
2	232	6	129	21
3	214	3		
4	202	0		

*Based on the assumption of 197 dishwasher cycles per year.

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

AHAM objected to DOE's use of random assignment of *RECS* households to the no-new-standards case and standard cases, which assumes that consumers are agnostic to energy costs. AHAM stated that DOE has never provided a justification for the assumption it uses that operating costs play no effect on consumer choice for dishwashers. AHAM added that it is very unlikely that consumers with very high potential LCC savings would not have already decided to purchase a more efficient

dishwasher (*i.e.,* in the no-new-standards case), and DOE's assumption that these consumers are indifferent to operating costs appears contrary to common sense and experience in the retail field. AHAM stated that the most appropriate solution is to have a much more robust consumer choice theory, and in the absence of such theory, DOE should use median, not mean values in its analysis and conclusions. (AHAM, No. 26 at pp. 8–9)

While DOE acknowledges that economic factors may 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 LCC or simple PBP most likely would not fully and 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 as described elsewhere in this document. DOE maintains that the method of assignment is a reasonable approach, one that reflects behavior in the dishwasher market, where market failures result in purchasing decisions not being perfectly aligned with economic interests, more realistically than relying only on apparent cost-effectiveness criteria derived from the information in *RECS*. DOE further emphasizes that its approach does not assume that all purchasers of dishwashers 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 minimizes any bias in the analysis by using random assignment, as opposed to assuming certain market conditions that are unsupported given the available evidence.

First, consumers are motivated by more than simple financial trade-offs. There are consumers who are willing to pay a premium for more energy-efficient products because they are environmentally conscious.[64] 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.[65] 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. 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.[66] These characteristics describe almost all purchasing situations of appliances and equipment, including dishwashers. The installation of a new dishwasher is done very infrequently. Additionally, it would take at least one full year for any impacts on operating costs to be fully apparent. Further, if the

[64] 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 Feb. 15, 2022).
[65] Id.
[66] Thaler, R.H., and Sunstein, C.R. (2008). Nudge: Improving Decisions on Health, Wealth, and Happiness. New Haven, CT: Yale University Press.

purchaser of the dishwasher is not the entity paying the energy costs (*e.g.,* a 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. 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. Davis and Metcalf[67] conducted an experiment demonstrating that the nature of the information available to consumers from EnergyGuide labels posted on air conditioning equipment 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 climate control equipment of their homes that do not result in the highest net present

[67] 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 Feb. 15, 2022).

value for their specific usage pattern (*i.e.,* their decision is based on imperfect information and, therefore, is not necessarily optimal).

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.

These market failures affect a sizeable share of the consumer population. A study by Houde[68] 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. However, the literature is not specific to dishwashers.

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 LCC or PBP, the resulting distribution of efficiencies within the household sample would not reflect any of the market failures or behavioral factors mentioned previously. DOE thus 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, the purchasing decision of

[68] 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 Feb. 15, 2022).

dishwasher efficiency can be highly complex and influenced by a number of factors not captured by the information available in the *RECS* samples. These factors can lead to households choosing a dishwasher efficiency that deviates from the efficiency predicted using only energy and water use or economic considerations such as LCC or PBP (as calculated using the information from *RECS*). However, DOE intends to investigate this issue further, and it welcomes suggestions as to how it might improve its assignment of appliance efficiency in its analyses.

DOE seeks data on the no-new-standards case efficiency distribution for the compact-size product class, and the efficiency distribution projection for both the standard-size and the compact-size product classes during the analysis period (2027-2056).

9. Payback Period Analysis

The PBP 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.

G. Shipments Analysis

DOE uses projections of annual product shipments to calculate the national impacts of potential amended or new energy conservation standards on energy use, NPV, and future manufacturer cash flows.[69] 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-

[69] 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.

2056, based on the housing stocks from *AEO 2022*. See chapter 9 of the NOPR TSD for details.

AHAM commented that more dishwashers meet ENERGY STAR V. 6.0 criteria now than during the last energy conservation standards rulemaking. (AHAM, No. 26 at p. 2) For this NOPR analysis, DOE used the CCD for dishwashers and noted a shift in the models now meeting the ENERGY STAR V. 6.0 criteria than for the January 2022 Preliminary Analysis. DOE also estimated the market share for compact-size dishwashers at 2 percent based on the information obtained from manufacturers.

DOE considers the impacts on shipments from changes in product purchase price associated with higher energy efficiency levels using a price elasticity. DOE employed a price elasticity of -0.45 in its shipments model.[70] The market impact is defined as the difference between the product of price elasticity of demand and the change in price due to a standard level.

DOE seeks comment on the approach and inputs used to develop no-new-standards case shipments projection,

H. National Impact Analysis

The NIA assesses the NES and the NPV from a national perspective of total consumer costs and savings that would be expected to result from new or amended

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

standards at specific efficiency levels.[71] ("Consumer" in this context refers to consumers of the product being regulated.) DOE calculates the NES and NPV for the TSLs considered based on projections of annual product shipments, along with the annual energy consumption and total installed cost data from the energy use and LCC analyses. For the present analysis, DOE projected the energy savings, operating cost savings, product costs, and NPV of consumer benefits over the lifetime of 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 use and consumer costs for each product class in the absence of new or amended energy conservation standards. For this projection, DOE considers historical trends in efficiency and various forces that are likely to affect the mix of efficiencies over time. DOE compares the no-new-standards case with projections characterizing the market for each product class if DOE adopted new or amended standards at specific energy efficiency levels (*i.e.*, the TSLs or standards cases) for that class. For the standards cases, DOE considers how a given standard would likely affect the market shares of products with efficiencies greater than the standard.

DOE uses a spreadsheet model to calculate the energy savings and the national consumer costs and savings from each TSL. Interested parties can review DOE's

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

analyses by changing various input quantities within the spreadsheet. The NIA spreadsheet model uses point values (as opposed to probability distributions) as inputs.

Table IV.14 summarizes the inputs and methods DOE used for the NIA analysis for the NOPR. Discussion of these inputs and methods follows the table. See chapter 10 of the NOPR TSD for further details.

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 Consumption per Unit	Calculated for no-new-standards case and each TSL based on inputs from energy use analysis.
Total Installed Cost per Unit	Calculated for no-new-standards case and each TSL based on inputs from the LCC analysis. Incorporated projection of future product prices based on historical data.
Repair and Maintenance Cost per Unit	Annual values do not change with efficiency level.
Energy and Water Price Trends	*AEO 2022* projections (to 2050) and constant value 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 *AEO 2022*.
Discount Rate	3 percent and 7 percent
Present Year	2022

1. Product Efficiency Trends

A key component of the NIA is the trend in energy efficiency projected for the no-new-standards case and each of the standards cases. Section IV.F.8 of this document describes how DOE developed an energy efficiency distribution for the no-new-standards case (which yields a shipment-weighted average efficiency) for each of the considered product classes for the year of anticipated compliance with an amended or new standard.

To project the trend in efficiency absent amended standards for dishwashers over the entire shipments projection period, DOE used the shipments-weighted standby power ("SWSP") as a starting point. DOE assumed that the shipment weighted efficiency would not increase annually for the 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 in 2027. In the year of compliance, the market shares of products in the no-new-standards case that do not meet the standard under consideration would "roll up" to meet the new standard level, and the market share of products above the standard would remain unchanged.

2. National Energy and Water Savings

The national energy and water savings analysis involves a comparison of national energy consumption of the considered products between each TSL and the case with no new or amended energy conservation standards. DOE calculated the national energy 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

AEO 2022. Cumulative energy and water savings are the sum of the NES and NWS for each year over the timeframe of the analysis.

In the NES and NWS analysis DOE accounted for the possible increase in energy and water use from handwashing dishes for those households that would not purchase a replacement dishwasher due to the higher purchase cost under the proposed standards. However, these energy and water use costs may be overestimated if, for example, households instead keep their current dishwasher longer than they otherwise would, instead use disposable plates and utensils, or are those households that use their dishwasher less frequently. Furthermore, for those households that still would forgo a replacement dishwasher, DOE did not account for the value of time required for handwashing. Consistent with an economic analysis responsive to EO 12866, DOE seeks comments and publicly-available data to improve its estimation of how the proposed standards may affect the rate at which dishwashers are replaced, and therefore the estimates of overall energy and water use, and to evaluate other potential effects on households that would no longer own a dishwasher. DOE is committed to developing a framework that can support empirical quantitative tools for improved assessment of the consumer welfare impacts of appliance standards, including dishwashers.

AHAM 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, that undercuts projected energy and water savings. AHAM added that DOE should not adopt energy conservation standards that could make it less likely

consumers will purchase or use their efficient dishwashers. (AHAM, No. 26 at p. 11) DOE has not found any evidence that the proposed standards would be likely to cause the types of consumer behavior suggested by AHAM. As discussed in section IV.B of this notice, DOE has initially determined that the technology options likely to be used to meet the proposed standards would not have a significant adverse impact on the utility of the product to subgroups of consumers.

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 NIA and emissions analyses included in future energy conservation standards rulemakings. 76 FR 51281 (Aug. 18, 2011). After evaluating the approaches discussed in the August 18, 2011 notice, DOE published a statement of amended policy in which DOE explained its determination that EIA's National Energy Modeling System ("NEMS") is the most appropriate tool for its FFC analysis and its intention to use NEMS for that purpose. 77 FR 49701 (Aug. 17, 2012). NEMS is a public domain, multi-sector, partial equilibrium model of the U.S. energy sector[72] that EIA uses to prepare its *AEO*. 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

[72] 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/* (last accessed October 22, 2021).

power plants. The approach used for deriving FFC measures of energy use and emissions is described in appendix 10B of the NOPR TSD.

3. Net Present Value Analysis

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

As discussed in section IV.F.1 of this document, DOE developed 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 25.1 percent relative to 2021. DOE's projection of product prices is described in appendix 10C of the NOPR 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 low price decline case based on the combined PPI series of "all other miscellaneous household appliances" and "primary

products of major household appliance manufacturing" from 2009 to 2021; and, (2) a high price decline scenario based on the same PPI series from 1988 to 2008, which shows a faster price decline than the full time series between 1988–2021. The derivation of these price trends and the results of these sensitivity cases are described in appendix 10C of the NOPR 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 *AEO 2022*, which has an end year of 2050. To estimate price trends after 2050, the 2050 value was used for all years. As part of the NIA, DOE also analyzed scenarios that used inputs from variants of the *AEO 2022* 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 10D of the NOPR TSD.

AHAM commented that DOE has never provided a justification for the assumption it uses that operating costs play no effect on consumer choice for dishwashers. Further, AHAM stated that the current LCC model does not address key issues affecting consumer economics for dishwashers, noting that consumer costs and benefits for dish cleaning are related not so much to the economics of running a dishwasher as they are to the broader differences in methods used to clean dishes whether

it be washing by hand, pre-rinsing and then using a dishwasher, or using a dishwasher without pre-rinsing. (AHAM, No. 26 at pp. 7–8)

DOE forecasted an initial drop in dishwasher shipments in response to an increase in purchase price attributable to potential standards-related efficiency increases. 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 NOPR TSD for details).[73] DOE did not account for differences in handwashing and pre-rinsing dishes among the considered efficiency levels due to the lack of data regarding consumer behavior.

In calculating the NPV, DOE multiplies the net savings in future years by a discount factor to determine their present value. For this NOPR, 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.[74] 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

[73] While TSD Chapter 9 includes information on projected shipments, DOE did not estimate the number of households that would forgo a dishwasher under a standards scenario. However, the analysis projects a 0.01 percent reduction in shipments over 30 years.
[74] United States Office of Management and Budget. *Circular A-4: Regulatory Analysis*. September 17, 2003. Section E. Available at *https://obamawhitehouse.archives.gov/omb/circulars_a004_a-4/* (last accessed November 21, 2022).

preference," which is the rate at which society discounts future consumption flows to their present value.

I. Consumer Subgroup Analysis

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

Samsung stated that the 2021 LBNL survey showed that as household income declines, higher value is placed on reductions in energy consumption and low-income and the senior-only households are more likely to prefer all energy efficiency improvement options compared to the national average. (Samsung, No. 22 at p. 2)

As stated above, DOE determines the extent to which identifiable subgroups of consumers are disproportionately affected by a new or amended national standard. In this NOPR analysis, DOE analyzed the impacts of the considered standard levels on low-income households and senior-only households.

AHAM stated that *RECS 2015* data shows only 67 percent of U.S. households have a dishwasher, and the percentage decreases among low-income households. AHAM commented that promoting dishwasher ownership and policies that increase dishwasher ownership in low-income communities will save those consumers money on energy and water bills, while also achieving water and energy savings. (AHAM, No. 26 at p. 6) AHAM commented that the existing LCC model is not relevant and does not address key issues affecting consumer economics. AHAM commented that DOE should carefully assess the consumer economic effects on several subgroups: Low-income households, including the effects of lost time used in handwashing versus using a dishwasher; rural households, including an accurate measure of the cost to the consumer of water and sewer; households with dishwashers that do not use them or use them only infrequently, to determine why they do not use a dishwasher and what can be done to increase dishwasher use; and households without dishwashers, to determine why they do not currently own a dishwasher and what can be done to make dishwasher access or ownership possible. (AHAM, No. 26 at pp. 7–8)

For the NOPR, DOE conducted an analysis of the impact of potential dishwasher standards on low-income households. DOE did not evaluate rural households as a subgroup, as it does not expect that these households would see a disproportionate impact

from potential standards. However, DOE included estimates of well water and septic costs in its calculations for rural households and households using well water and septic systems. DOE did not include households with dishwashers that do not use them or use them only infrequently or households without dishwashers as consumer subgroups, as the type of assessment suggested by AHAM is outside the scope of the analysis that DOE does to evaluate the economic justification of potential standards.

1. Low-income Households

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 NOPR 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.[75] 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

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

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

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

Type of Household*	Percentage of Low-Income Sample (Standard-Size Dishwashers)	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.

Whirlpool stated that with amended standards beyond EL 1, purchasing a new dishwasher may become out of reach for many low-income households, including those representing disadvantaged communities, or present them with options that do not help them save energy and water or end up costing them even more over the life of the appliance. Whirlpool stated that this would keep less efficient dishwashers in the stock or increase the time spent on household chores. Whirlpool further stated that making

dishwashers less affordable will not serve to increase the overall household penetration of dishwashers. (Whirlpool, No. 21 at pp. 5–6) AHAM commented that amended energy conservation standards beyond EL 1 are not justified because they will disproportionately and negatively affect low-income consumers, drive unintended consumer behaviors that negate predicted savings, and lead to consumer dissatisfaction with performance due to unavoidable performance declines with currently available technology. (AHAM, No. 26 at p. 3) AHAM also stated that lower-income consumers cannot pay more for a more efficient dishwasher and are less likely to own a dishwasher, and some consumers who cannot afford to purchase a new appliance may instead purchase a used, less efficient appliance, or more likely, forego what is seen as a discretionary purchase and, instead hand wash their dishes. As a result, AHAM contended that these consumers will use significantly more water and energy and spend more money on their water and electricity bill than other population segments, which is contrary to environmental justice goals. (AHAM, No. 26 at p. 6)

As shown in section V.B.1.b of this document, the proposed standard for standard-size dishwashers yields an LCC savings of $21 for low-income dishwasher users, and the percent of low-income dishwasher consumers experiencing a net LCC cost under the proposed standards is smaller than in the full LCC sample. The majority of low-income households using dishwashers are renters who do not have to pay the total cost of higher-efficiency dishwashers. While some of the incremental cost of a standards-compliant dishwasher could get passed on in rent, this would happen over time and would be far less than the energy and water cost savings received by renters who pay the energy and water bills. The alternatives to buying a new dishwasher mentioned by

Whirlpool and AHAM are possible options for non-renter households, but there is insufficient information to evaluate the extent to which they might occur or the consequences with respect to energy and water use.

As discussed in Section IV.H.2, DOE accounted for how higher product prices attributable to the proposed standards may reduce purchases of new dishwashers, and further assumed that households that would no longer purchase a dishwasher would instead handwash their dishes. Furthermore, Section IV.H.2 describes how households may alternatively respond to higher dishwasher prices, and welcomes comments providing data and analysis to improve is evaluation of these alternative responses. DOE did not account for how higher dishwasher prices may lead to low-income households forgoing the purchase or no longer having a dishwasher and the potential consequences. DOE welcomes comments specific to how low-income households may respond to higher dishwasher prices and in particular forgoing the purchase of a new dishwasher, which will allow DOE to improve its analysis, perhaps by bounding potential outcomes, of the potential impact of more stringent standards on these households if finalized. Also, the results of this analysis on consumers is uncertain as DOE does not account for potential differences in the marginal cost of energy or water for low-income households relative to the general population. For example, there may be differences in energy prices faced by these households due to reduced marginal electricity tariffs offered to lower income households prices or other programs that specifically reduce the energy or water expenses borne by these households (e.g., LIHEAP). DOE welcomes comment on how it may account for energy and water prices faced by low income, as well as senior, households.

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 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, MPCs, product shipments, manufacturer markups, and investments in R&D and manufacturing capital required to produce compliant products. The key GRIM output is the INPV, which is the sum of industry annual cash flows over the analysis period, discounted using the industry-weighted average cost of capital. 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 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 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 NOPR 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-Ks from the SEC,[76] corporate annual reports, the U.S. Census Bureau's *Annual Survey of Manufactures* ("*ASM*"),[77] and reports from Dun & Bradstreet.[78]

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

[76] U.S. Securities and Exchange Commission, *Electronic Data Gathering, Analysis, and Retrieval (EDGAR) system.* Available at: *www.sec.gov/edgar/search/* (last accessed September 27, 2022).
[77] U.S. Census Bureau, *Annual Survey of Manufactures.* "Summary Statistics for Industry Groups and Industries in the U.S (2020)." Available at: *www.census.gov/data/tables/time-series/econ/asm/2018-2020-asm.html* (last accessed September 27, 2022).
[78] The Dun & Bradstreet Hoovers login is available at: *app.dnbhoovers.com* (last accessed September 27, 2022).

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. See section IV.J.3 of this document for a description of the key issues raised by manufacturers during the interviews. 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 section VI.B of this document, "Review under the Regulatory Flexibility Act" and in chapter 12 of the NOPR TSD.

2. Government Regulatory Impact Model and Key Inputs

DOE uses the GRIM to quantify the changes in cash flow due to amended standards that result in a higher or lower industry value. The GRIM uses a standard, annual discounted cash-flow analysis that incorporates manufacturer costs, manufacturer markups, shipments, and industry financial information as inputs. The GRIM models changes in costs, distribution of shipments, investments, and manufacturer margins that could result from amended energy conservation standards. The GRIM spreadsheet uses the inputs to arrive at a series of annual cash flows, beginning in 2023 (the NOPR publication year) 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 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 analysis

and shipments analysis, and information used in the January 2022 Preliminary Analysis. 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 NOPR 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 a complete description of the MPCs, see chapter 5 of the NOPR TSD or section IV.C of this document.

b. Shipments Projections

The GRIM estimates manufacturer revenues based on total unit shipment projections and the distribution of those shipments by efficiency level. Changes in sales volumes and efficiency mix over time can significantly affect manufacturer finances. For this analysis, the GRIM uses the NIA's annual shipment projections derived from the shipments analysis from 2023 (the NOPR publication year) to 2056 (the end year of the analysis period). See chapter 9 of the NOPR TSD or section IV.G of this document for additional details.

c. Capital and Product Conversion Costs

Amended energy conservation standards could cause manufacturers to incur conversion costs to bring their production facilities and product designs into compliance. DOE evaluated the level of conversion-related expenditures that would be needed to comply with each considered efficiency level in each product class. For the MIA, DOE classified these conversion costs into two major groups: (1) capital conversion costs; and (2) product conversion costs. Capital conversion costs are investments in property, plant, and product 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 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 higher 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. At each efficiency level, DOE included the costs associated with re-rating compliant basic models in accordance with appendix C2. 88 FR 3234, 3271-2. 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 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.

d. Manufacturer Markup Scenarios

MSPs include manufacturer 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. For the MIA, DOE modeled two standards-case scenarios to represent the 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; (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. The industry cash flow analysis results in section V.B.2.a of this document present the impacts of the upper and lower bound scenarios on INPV.

Under the preservation of gross margin percentage scenario, DOE applied a single uniform "gross margin percentage" across all efficiency levels, which assumes that following amended standards, manufacturers would be able to maintain the same amount of profit as a percentage of revenue 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, results from the 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.[79] 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 costs due to standards to consumers.

[79] The gross margin percentage of 19.4 percent is based on a manufacturer markup of 1.24.

The tiered scenario starts with the three tiers of manufacturer markups wherein higher efficiency products have higher markup than low efficiency products. In the no-new-standards case, the three tiers are baseline efficiency, ENERGY STAR V. 6.0, and 2022 ENERGY STAR Most Efficient qualification criteria. 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 and 2022 ENERGY STAR Most Efficient manufacturer markups are assigned the baseline and ENERGY STAR markups, respectively. This scenario models reflects a concern about product commoditization at higher efficiency levels as efficiency differentiators are eliminated.

DOE requests comment on whether industry expects a compression of markups due higher standards, as reflected in the tiered scenario for manufacturer markups.

3. Manufacturer Interviews

DOE interviewed manufacturers representing approximately 90 percent of industry shipments. Participants included domestic-based and foreign-based original equipment manufacturers ("OEMs") with a range of different product offerings and market shares.

In interviews, DOE asked manufacturers to describe their major concerns regarding this rulemaking. The following section highlights manufacturer concerns that helped inform the projected potential impacts of an amended standard on the industry.

Manufacturer interviews are conducted under NDAs, so DOE does not document these discussions in the same way that it does public comments.

a. Test Procedure and Cleaning Index

In interviews, manufacturers expressed two main concerns about the proposed test procedure and cleaning index threshold as it relates to potential amended energy conservation standards.[80] First, multiple manufacturers asserted that the repeatability and reproducibility of the cleaning performance test varies between testing laboratories could lead to unintentional non-compliance (*i.e.,* a product meeting the cleaning performance threshold in one laboratory, but not meeting it for enforcement testing). To help guard against unintentional non-compliance, these manufacturers stated that they would need to invest in extensive technician training and conduct additional rounds of cleaning performance testing. Furthermore, these manufacturers suggested that they would need to potentially update product designs or build in safety margins to ensure that their products consistently test above the minimum cleaning index threshold. Second, several manufacturers questioned whether the cleaning index score correlates to consumer satisfaction. Some manufacturers noted that they have developed internal test methods to assess and improve the cleaning performance of their products, which they favor over DOE's proposed cleaning performance test. Therefore, they stated that imposing a

[80] The test procedure final rule had not been published at the time of the interviews. DOE finalized its proposal in the January 2023 TP Final Rule, including establishing a minimum cleaning index threshold of 70 as a condition of a valid test cycle in new appendix C2.

cleaning index threshold could limit their ability to conduct their preferred cleaning performance tests due to limited laboratory space and personnel.

One manufacturer supported implementing a cleaning performance threshold. A different manufacturer supported the concept of the cleaning performance threshold, but encouraged DOE to continue to work with manufacturers to improve the cleaning test so that it is repeatable and reproducible.

b. Balancing Dishwasher Attributes

Several manufacturers expressed concerns that the reduction of energy and water usage beyond EL 1 could lead to longer cycle times, more variation in dish cleanliness, and diminished drying of dishes. Manufacturers emphasized that energy and water use are interconnected to other key attributes of dishwashers that affect customer satisfaction. Manufacturers noted that these concerns about additional product attributes and consumer satisfaction are further exacerbated at max-tech.

4. Discussion of MIA Comments

In response to the January 2022 Preliminary Analysis, AHAM commented that shipments are currently concentrated at EL 1, and the lack of shipments above EL 1 indicates significant investment would be necessary to comply with standards above EL 1. (AHAM, No. 26 at p. 5) Whirlpool stated that the significant redesign and investment necessary to meet amended standards beyond EL 1 may lead to a corresponding significant increase in product cost that would affect low-income consumers. (Whirlpool, No. 21 at p. 5) AHAM commented that the cost effectiveness of technology options and

the incremental cost to achieve lower energy use must be assessed within a product platform. AHAM noted that changes to the dishwasher chassis size require expensive changes to tooling and may change the fundamental product manufacturing approach. AHAM suggested that technology options should only be considered if they can be physically accommodated within the product chassis as there is only so much room in a product that has a standard cutout and fits under the countertop. (AHAM, No. 26 at p. 15)

DOE recognizes that the majority of the domestic dishwasher shipments are currently at EL 1. To account for the level of redesign and investment required to meet amended standards above EL 1, DOE relied on manufacturer feedback and the engineering analysis to assess industry conversion costs at each analyzed efficiency level. As noted in section IV.J.3 of this document, DOE interviewed manufacturers representing approximately 90 percent of industry shipments. In interviews, manufacturers discussed the investments required to redesign their various product platforms and DOE incorporated those costs into its analysis. See section IV.J.2.c of this document for a description of the conversion cost methodology and section V.B.2.a of this document for the estimated product and capital conversion costs at the various analyzed standard levels. Regarding the impact on low-income consumers, section IV.I and section V.B.1.b of this document provides additional information on the consumer subgroup analysis of low-income consumers. As for changes in chassis size, DOE notes that the engineering analysis did not consider design options that would necessitate a width greater than the typical standard-size dishwasher width of 24 inches.

AHAM urged DOE to consider alternative approaches to cumulative regulatory burden. AHAM encouraged DOE to incorporate the financial results of the cumulative regulatory burden analysis into the MIA, stating that this could be done by adding the combined cost of complying with multiple regulations into the product conversion costs in GRIM. (AHAM, No. 26 at p. 30) AHAM noted other regulations impact dishwasher manufacturers such as residential and commercial clothes washers, residential clothes dryers, consumer refrigerator/freezers, miscellaneous refrigeration products, cooking products, room air conditioners, dehumidifiers, portable air conditioners, and electric motors. (AHAM, No. 26 at p. 31) Additionally, AHAM requested that DOE include the cost of monitoring test procedure and energy conservation standard rulemakings in its rulemaking analyses. (*Id*.)

If DOE were to combine the conversion costs from multiple regulations, as requested, it would be appropriate to match the combined conversion costs against combined revenues of the regulated products. DOE is concerned that combined results would make it more difficult to discern the direct impact of the amended standard on covered manufacturers.

Regarding the ongoing DOE rulemakings AHAM mentioned, DOE has not proposed amended energy conservation standards or compliance dates for some of the products identified. Table V.11 details the rulemakings and expected conversion expenses of Federal energy conservation standards, such as consumer clothes dryers, residential clothes washers, and refrigerators, refrigerator-freezers, and freezers, affecting

dishwasher OEMs. DOE will reassess and consider all relevant final rules contributing to cumulative regulatory burden in any subsequent analysis.

To consider the costs of monitoring test procedure and energy conservation standard rulemakings, DOE requests AHAM provide the costs of monitoring, which would be independent from the conversion costs required to adapt product designs and manufacturing facilities to an amended standard, for DOE to determine whether these costs would materially affect the analysis. In particular, a summary of the job titles and annual hours per job title at a prototypical company would allow DOE to construct a detailed analysis of AHAM's monitoring costs.

K. Emissions Analysis

The emissions analysis consists of two components. The first component estimates the effect of potential energy conservation standards on power sector and site (where applicable) combustion emissions of CO_2, NO_X, SO_2, and Hg. The second component estimates the impacts of potential standards on emissions of two additional greenhouse gases, CH_4 and N_2O, as well as the reductions to 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 power sector emissions of CO_2, NO_X, SO_2, and Hg uses marginal emissions factors that were derived from data in *AEO 2022*, as described in section IV.K of this document. Details of the methodology are described in the appendices to chapters 13 and 15 of the NOPR TSD.

Power sector emissions of CO_2, CH_4 and N_2O are estimated using Emission Factors for Greenhouse Gas Inventories published by the EPA.[81] The FFC upstream emissions are estimated based on the methodology described in chapter 15 of the NOPR TSD. The upstream emissions include both emissions from extraction, processing, and transportation of fuel, and "fugitive" emissions (direct leakage to the atmosphere) of CH_4 and CO_2.

The emissions intensity factors are expressed in terms of physical units per megawatt-hours ("MWh") or million British thermal units ("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 NIA.

1. Air Quality Regulations Incorporated in DOE's Analysis

DOE's no-new-standards case for the electric power sector reflects the *AEO 2022*, which incorporates the projected impacts of existing air quality regulations on emissions. *AEO 2022* generally represents current legislation and environmental regulations, including recent government actions that were in place at the time of preparation of *AEO 2022*, including the emissions control programs discussed in the following paragraphs.[82]

[81] Available at *www.epa.gov/sites/production/files/2021-04/documents/emission-factors_apr2021.pdf* (last accessed July 12, 2021).
[82] For further information, see the Assumptions to *AEO 2022* 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 October 15, 2021).

SO_2 emissions from affected electric generating units ("EGUs") are subject to nationwide and regional emissions cap-and-trade programs. Title IV of the Clean Air Act sets an annual emissions cap on SO_2 for affected EGUs in the 48 contiguous States and the District of Columbia (D.C.). (42 U.S.C. 7651 *et seq*.) SO_2 emissions from numerous States in the eastern half of the United States are also limited under the Cross-State Air Pollution Rule ("CSAPR"). 76 FR 48208 (Aug. 8, 2011). CSAPR requires these States to reduce certain emissions, including annual SO_2 emissions, and went into effect as of January 1, 2015.[83] *AEO 2022* 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).[84] Compliance with CSAPR is flexible among EGUs and is enforced through the use of tradable emissions allowances. Under existing EPA regulations, any excess SO_2 emissions allowances resulting from the lower electricity demand caused by the adoption of an efficiency standard could be used to permit offsetting increases in SO_2 emissions by another regulated EGU.

However, beginning in 2016, SO_2 emissions began to fall as a result of implementation of the Mercury and Air Toxics Standards ("MATS") for power plants.

[83] CSAPR requires states to address annual emissions of SO_2 and NO_X, precursors to the formation of fine particulate matter ($PM_{2.5}$) pollution, in order to address the interstate transport of pollution with respect to the 1997 and 2006 $PM_{2.5}$ National Ambient Air Quality Standards ("NAAQS"). CSAPR also requires certain states to address the ozone season (May-September) emissions of NO_X, a precursor to the formation of ozone pollution, in order to address the interstate transport of ozone pollution with respect to the 1997 ozone NAAQS. 76 FR 48208 (Aug. 8, 2011). EPA subsequently issued a supplemental rule that included an additional five states in the CSAPR ozone season program; 76 FR 80760 (Dec. 27, 2011) (Supplemental Rule), and EPA issued the CSAPR Update for the 2008 ozone NAAQS. 81 FR 74504 (Oct. 26, 2016).

[84] In Sept. 2019, the D.C. Court of Appeals remanded the 2016 CSAPR Update to EPA. In April 2021, EPA finalized the 2021 CSAPR Update which resolved the interstate transport obligations of 21 states for the 2008 ozone NAAQS. 86 FR 23054 (April 30, 2021); *see also*, 86 FR 29948 (June 4, 2021)(correction to preamble). The 2021 CSAPR Update became effective on June 29, 2021. The release of AEO 2022 in February 2021 predated the 2021 CSAPR Update.

77 FR 9304 (Feb. 16, 2012). In the MATS final rule, EPA established a standard for hydrogen chloride as a surrogate for acid gas hazardous air pollutants ("HAP"), and also established a standard for SO_2 (a non-HAP acid gas) as an alternative equivalent surrogate standard for acid gas HAP. The same controls are used to reduce HAP and non-HAP acid gas; thus, SO_2 emissions are being reduced as a result of the control technologies installed on coal-fired power plants to comply with the MATS requirements for acid gas. 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 SO_2 emissions. Because of the emissions reductions under the MATS, it is unlikely that excess SO_2 emissions allowances resulting from the lower electricity demand would be needed or used to permit offsetting increases in SO_2 emissions by another regulated EGU. Therefore, energy conservation standards that decrease electricity generation would generally reduce SO_2 emissions. DOE estimated SO_2 emissions reduction using emissions factors based on *AEO 2022.*

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 case, NOx emissions would remain near the limit even if electricity generation goes down. A different case could possibly result, depending on the configuration of the power sector in the different regions and the need for allowances, such that NO_X emissions might not remain at the limit in the case of lower electricity demand. In this case, energy conservation standards

might reduce NOx 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. Energy conservation standards would be expected to reduce NO_X emissions in the States not covered by CSAPR. DOE used *AEO 2022* data to derive NO_X emissions factors for the group of States not covered by CSAPR.[85]

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 *AEO 2022*, which incorporates the MATS.

L. Monetizing Emissions Impacts

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

[85] *See* footnote 41.

DOE requests comment on how to address the climate benefits and other non-monetized effects of the proposal.

1. Monetization of Greenhouse Gas Emissions

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

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

DOE estimated the global social benefits of CO_2, CH_4, and N_2O reductions (*i.e.,* "SC-GHGs") using the estimates presented in the Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order

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

The SC-GHGs estimates presented here were developed over many years, using transparent process, peer-reviewed methodologies, the best science available at the time of that process, and with input from the public. Specifically, in 2009, the IWG, that included the DOE and other executive branch agencies and offices was established to ensure that agencies were using the best available science and to promote consistency in the social cost of carbon ("SC-CO_2") values used across agencies. The IWG published SC-CO_2 estimates in 2010 that were developed from an ensemble of three widely cited integrated assessment models ("IAMs") that estimate global climate damages using highly aggregated representations of climate processes and the global economy combined into a single modeling framework. The three IAMs were run using a common set of

input assumptions in each model for future population, economic, and CO_2 emissions growth, as well as equilibrium climate sensitivity – a measure of the globally averaged temperature response to increased atmospheric CO_2 concentrations. These estimates were updated in 2013 based on new versions of each IAM. In August 2016, the IWG published estimates of the social cost of methane ("SC-CH_4") and nitrous oxide ("SC-N_2O") using methodologies that are consistent with the methodology underlying the SC-CO_2 estimates. The modeling approach that extends the IWG SC-CO_2 methodology to non-CO_2 GHGs has undergone multiple stages of peer review. The SC-CH_4 and SC-N_2O estimates were developed by Marten *et al.*[86] and underwent a standard double-blind peer review process prior to journal publication. In 2015, as part of the response to public comments received to a 2013 solicitation for comments on the SC-CO_2 estimates, the IWG announced a National Academies of Sciences, Engineering, and Medicine review of the SC-CO_2 estimates to offer advice on how to approach future updates to ensure that the estimates continue to reflect the best available science and methodologies. In January 2017, the National Academies released their final report, Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide, and recommended specific criteria for future updates to the SC-CO_2 estimates, a modeling framework to satisfy the specified criteria, and both near-term updates and longer-term research needs pertaining to various components of the estimation process (National Academies, 2017).[87] Shortly thereafter, in March 2017, President Trump issued Executive Order 13783, which

[86] Marten, A. L., E. A. Kopits, C. W. Griffiths, S. C. Newbold, and A. Wolverton. Incremental CH4 and N2O mitigation benefits consistent with the US Government's SC-CO2 estimates. *Climate Policy*. 2015. 15(2): pp. 272–298.
[87] National Academies of Sciences, Engineering, and Medicine. *Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide*. 2017. The National Academies Press: Washington, DC.

disbanded the IWG, withdrew the previous TSDs, and directed agencies to ensure SC-CO_2 estimates used in regulatory analyses are consistent with the guidance contained in OMB's Circular A-4, "including with respect to the consideration of domestic versus international impacts and the consideration of appropriate discount rates" (EO 13783, Section 5(c)). Benefit-cost analyses following E.O. 13783 used SC-GHG estimates that attempted to focus on the U.S.-specific share of climate change damages as estimated by the models and were calculated using two discount rates recommended by Circular A-4, 3 percent and 7 percent. All other methodological decisions and model versions used in SC-GHG calculations remained the same as those used by the IWG in 2010 and 2013, respectively.

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

E.O.13990. In particular, the IWG found that the SC-GHG estimates used under E.O. 13783 fail to reflect the full impact of GHG emissions in multiple ways.

First, the IWG found that the SC-GHG estimates used under E.O. 13783 fail to fully capture many climate impacts that affect the welfare of U.S. citizens and residents, and those impacts are better reflected by global measures of the SC-GHG. Examples of omitted effects from the E.O. 13783 estimates include direct effects on U.S. citizens, assets, and investments located abroad, supply chains, U.S. military assets and interests abroad, and tourism, and spillover pathways such as economic and political destabilization and global migration that can lead to adverse impacts on U.S. national security, public health, and humanitarian concerns. In addition, assessing the benefits of U.S. GHG mitigation activities requires consideration of how those actions may affect mitigation activities by other countries, as those international mitigation actions will provide a benefit to U.S. citizens and residents by mitigating climate impacts that affect U.S. citizens and residents. A wide range of scientific and economic experts have emphasized the issue of reciprocity as support for considering global damages of GHG emissions. If the United States does not consider impacts on other countries, it is difficult to convince other countries to consider the impacts of their emissions on the United States. The only way to achieve an efficient allocation of resources for emissions reduction on a global basis—and so benefit the U.S. and its citizens—is for all countries to base their policies on global estimates of damages. As a member of the IWG involved in the development of the February 2021 SC-GHG TSD, DOE agrees with this assessment and, therefore, in this proposed rule DOE centers attention on a global measure of SC-GHG. This approach is the same as that taken in DOE regulatory

analyses from 2012 through 2016. A robust estimate of climate damages that accrue only to U.S. citizens and residents does not currently exist in the literature. As explained in the February 2021 TSD, existing estimates are both incomplete and an underestimate of total damages that accrue to the citizens and residents of the U.S. because they do not fully capture the regional interactions and spillovers discussed above, nor do they include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature. As noted in the February 2021 SC–GHG TSD, the IWG will continue to review developments in the literature, including more robust methodologies for estimating a U.S.-specific SC–GHG value, and explore ways to better inform the public of the full range of carbon impacts. As a member of the IWG, DOE will continue to follow developments in the literature pertaining to this issue.

Second, the IWG found that the use of the social rate of return on capital (7 percent under current OMB Circular A-4 guidance) to discount the future benefits of reducing GHG emissions inappropriately underestimates the impacts of climate change for the purposes of estimating the SC-GHG. Consistent with the findings of the National Academies (2017) and the economic literature, the IWG continued to conclude that the consumption rate of interest is the theoretically appropriate discount rate in an intergenerational context,[88] and recommended that discount rate uncertainty and relevant

[88] Interagency Working Group on Social Cost of Carbon. *Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866*. 2010. United States Government (last accessed April 15, 2022). www.epa.gov/sites/default/files/2016-12/documents/scc_tsd_2010.pdf; Interagency Working Group on Social Cost of Carbon. *Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866*. 2013 (last accessed April 15, 2022). *www.federalregister.gov/documents/2013/11/26/2013-28242/technical-support-document-technical-update-of-the-social-cost-of-carbon-for-regulatory-impact*; Interagency Working Group on Social Cost of Greenhouse Gases, United States Government. Technical Support Document: Technical Update on the

aspects of intergenerational ethical considerations be accounted for in selecting future discount rates.

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

Social Cost of Carbon for Regulatory Impact Analysis-Under Executive Order 12866. August 2016 (last accessed January 18, 2022). *www.epa.gov/sites/default/files/2016-12/documents/sc_co2_tsd_august_2016.pdf*; Interagency Working Group on Social Cost of Greenhouse Gases, United States Government. Addendum to Technical Support Document on Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866: Application of the Methodology to Estimate the Social Cost of Methane and the Social Cost of Nitrous Oxide. August 2016 (last accessed January 18, 2022). *www.epa.gov/sites/default/files/2016-12/documents/addendum_to_sc-ghg_tsd_august_2016.pdf*.

discounting. There is wide support for this view in the academic literature, and it is recognized in Circular A-4 itself." Thus, DOE concludes that a 7 percent discount rate is not appropriate to apply to value the social cost of greenhouse gases in the analysis presented in this analysis.

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

As a member of the IWG involved in the development of the February 2021 SC-GHG TSD, DOE agrees with the above assessment and will continue to follow developments in the literature pertaining to this issue. While the IWG works to assess how best to incorporate the latest, peer reviewed science to develop an updated set of SC-GHG estimates, it set the interim estimates to be the most recent estimates developed by the IWG prior to the group being disbanded in 2017. The estimates rely on the same models and harmonized inputs and are calculated using a range of discount rates. As

explained in the February 2021 SC-GHG TSD, the IWG has recommended that agencies revert to the same set of four values drawn from the SC-GHG distributions based on three discount rates as were used in regulatory analyses between 2010 and 2016 and were subject to public comment. For each discount rate, the IWG combined the distributions across models and socioeconomic emissions scenarios (applying equal weight to each) and then selected a set of four values recommended for use in benefit-cost analyses: an average value resulting from the model runs for each of three discount rates (2.5 percent, 3 percent, and 5 percent), plus a fourth value, selected as the 95th percentile of estimates based on a 3 percent discount rate. The fourth value was included to provide information on potentially higher-than-expected economic impacts from climate change. As explained in the February 2021 SC-GHG TSD, and DOE agrees, this update reflects the immediate need to have an operational SC-GHG for use in regulatory benefit-cost analyses and other applications that was developed using a transparent process, peer-reviewed methodologies, and the science available at the time of that process. Those estimates were subject to public comment in the context of dozens of proposed rulemakings as well as in a dedicated public comment period in 2013.

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 intergenerational analysis in the context of climate change are likely to be less than 3 percent, near 2 percent or lower.[89]

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

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-CO_2 estimates. However, as discussed in the February 2021 TSD, the IWG has recommended that, taken together, the limitations suggest that the interim SC-GHG estimates used in this NOPR likely underestimate the damages from GHG emissions. DOE concurs with this assessment.

DOE's derivations of the SC-CO_2, SC-N_2O, and SC-CH_4 values used for this NOPR 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. of this document.

a. Social Cost of Carbon

The SC-CO_2 values used for this NOPR were based on the values in the IWG's February 2021 TSD. Table IV.16 shows the updated sets of SC-CO_2 estimates from the IWG's TSD in 5-year increments from 2020 to 2050. The full set of annual values used that DOE is presented in appendix 14A of the NOPR TSD. For purposes of capturing the uncertainties involved in regulatory impact analysis, DOE has determined it is appropriate include all four sets of SC-CO_2 values, as recommended by the IWG.[90]

Table IV.16: Annual SC-CO_2 Values from 2021 Interagency Update, 2020–2050 (2020$ per Metric Ton CO_2)

Year	Discount Rate and Statistic			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
2020	14	51	76	152
2027	17	56	83	169
2030	19	62	89	187
2035	22	67	96	206
2040	25	73	103	225
2045	28	79	110	242
2050	32	85	116	260

For 2051 to 2070, DOE used SC-CO_2 estimates published by EPA, adjusted to 2021$.[91] These estimates are based on methods, assumptions, and parameters identical to the 2020-2050 estimates published by the IWG (which were based on EPA modeling).

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

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

DOE multiplied the CO_2 emissions reduction estimated for each year by the SC-CO_2 value for that year in each of the four cases. DOE adjusted the values to 2021$ using the implicit price deflator for gross domestic product ("GDP") from the Bureau of Economic Analysis. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the four cases using the specific discount rate that had been used to obtain the SC-CO_2 values in each case.

AHAM cautioned against 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 to determine the appropriate standard noting that the values are constantly subject to change. 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. (AHAM, No. 26 at p. 15) As stated in section III.F.1.f of this document, DOE accounts for the environmental and public health benefits associated with the more efficient use of energy, including those connected to global climate change, when considering the need for national energy conservation. (See 42 U.S.C. 6295(o)(2)(B)(i)(IV)) In addition, Executive Order 13563, which was re-affirmed on January 21, 2021, stated that each agency must, among other things: "select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity)." For these reasons, DOE includes monetized emissions reductions in its evaluation of potential standard

levels. As previously stated, however, DOE would reach the same conclusion presented in this proposed rulemaking in the absence of the social cost of greenhouse gases.

b. Social Cost of Methane and Nitrous Oxide

The SC-CH_4 and SC-N_2O values used for this NOPR were based on the values developed for the February 2021 TSD.[92] Table IV.17 shows the updated sets of SC-CH_4 and SC- N_2O estimates from the latest interagency update in 5-year increments from 2020 to 2050. The full set of annual values used is presented in appendix 14A of the NOPR TSD. To capture the uncertainties involved in regulatory impact analysis, DOE has determined it is appropriate to include all four sets of SC-CH_4 and SC- N_2O values, as recommended by the IWG. DOE derived values after 2050 using the approach described above for the SC-CO_2.

Table IV.17: Annual SC-CH_4 and SC-N_2O Values from 2021 Interagency Update, 2020–2050 (2020$ per Metric Ton)

	SC-CH_4				SC-N_2O			
	Discount Rate and Statistic				Discount Rate and Statistic			
	5%	3%	2.5%	3%	5%	3%	2.5 %	3%
Year	Average	Average	Average	95th percentile	Average	Average	Average	95th percentile
2020	670	1500	2000	3900	5800	18000	27000	48000
2027	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

[92] Interagency Working Group on Social Cost of Greenhouse Gases, Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide.
Interim Estimates Under Executive Order 13990, Washington, D.C., February 2021.
www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf?source=email

DOE multiplied the CH_4 and N_2O emissions reduction estimated for each year by the SC-CH_4 and SC-N_2O estimates for that year in each of the cases. DOE adjusted the values to 2021$ using the implicit price deflator for 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-CH_4 and SC-N_2O estimates in each case. See chapter 13 of the NOPR TSD for the annual emissions reduction. See appendix 14A of the NOPR TSD for the annual SC-CH_4 and SC-N_2O values.

2. Monetization of Other Air Pollutants

For the NOPR, DOE estimated the monetized value of NO_X and SO_2 emissions reductions from electricity generation using the latest benefit-per-ton estimates for that sector from the EPA's Benefits Mapping and Analysis Program.[93] DOE used EPA's values for $PM_{2.5}$-related benefits associated with NO_X and SO_2 and for ozone-related benefits associated with NO_X for 2027, 2030, 2035, 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 2027 to 2040 period; for years beyond 2040 the values are held constant. DOE combined the EPA benefit per ton estimates with regional information on electricity consumption and emissions to define weighted-average national values for NO_X and SO_2 as a function of sector (see appendix 14B of the NOPR TSD)..

[93] *Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 21 Sectors*. www.epa.gov/benmap/estimating-benefit-ton-reducing-pm25-precursors-21-sectors

DOE multiplied the 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 *AEO 2022*. 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 *AEO 2022* Reference case and various side cases. Details of the methodology are provided in the appendices to chapters 13 and 15 of the NOPR 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 proposed 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 production and non-production employees of manufacturers of the products subject to standards.[94] The MIA addresses those impacts. Indirect employment impacts are changes in national employment that occur due to the shift in expenditures and capital investment caused by the purchase and operation of more-efficient appliances. Indirect employment impacts from standards consist of the net jobs created or eliminated in the national economy, other than in the manufacturing sector being regulated, caused by (1) reduced spending by consumers on energy, (2) reduced spending on new energy supply by the utility industry, (3) increased consumer spending on the products to which the new standards apply and other goods and services, and (4) the effects of those three factors throughout the economy.

One method for assessing the possible effects on the demand for labor of such shifts in economic activity is to compare sector employment statistics developed by the Labor Department's 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

[94] As defined in the U.S. Census Bureau's 2016 *Annual Survey of Manufactures*, production workers include "Workers (up through the line-supervisor level) engaged in fabricating, processing, assembling, inspecting, receiving, packing, warehousing, shipping (but not delivering), maintenance, repair, janitorial, guard services, product development, auxiliary production for plant's own use (*e.g.*, power plant), record keeping, and other closely associated services (including truck drivers delivering ready-mixed concrete)" Non-production workers are defined as "Supervision above line-supervisor level, sales (including a driver salesperson), sales delivery (truck drivers and helpers), advertising, credit, collection, installation, and servicing of own products, clerical and routine office functions, executive, purchasing, finance, legal, personnel (including cafeteria, *etc.*), professional and technical."

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.[95] 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 NOPR using an input/output model of the U.S. economy called Impact of Sector Energy Technologies version 4 ("ImSET").[96] ImSET is a special-purpose version of the "U.S. Benchmark National Input-Output" ("I-O") model, which was designed to estimate the national employment and income effects of energy-saving technologies. The ImSET software includes a computer- based I-O model having

[95] 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 *www.bea.gov/scb/pdf/regional/perinc/meth/rims2.pdf* (last accessed October 21, 2021).

[96] 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 Guide.* 2015. Pacific Northwest National Laboratory: Richland, WA. PNNL-24563.

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 over-estimate actual job impacts over the long run for this rule. Therefore, DOE used ImSET only to generate results for near-term timeframes, where these uncertainties are reduced. For more details on the employment impact analysis, see chapter 16 of the NOPR TSD.

V. Analytical Results and Conclusions

The following section addresses the results from DOE's analyses with respect to the considered energy conservation standards for 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 proposing to adopt in this NOPR. Additional details regarding DOE's analyses are contained in the NOPR TSD supporting this document.

A. Trial Standard Levels

In general, DOE typically evaluates potential amended standards for products and equipment by grouping individual efficiency levels for each class into TSLs. Use of TSLs allows DOE to identify and consider manufacturer cost interactions between the

product classes, to the extent that there are such interactions, and market cross elasticity from consumer purchasing decisions that may change when different standard levels are set. DOE analyzed the benefits and burdens of five TSLs for dishwashers. DOE developed TSLs that combine efficiency levels for each analyzed product class. DOE presents the results for the TSLs in this document, while the results for all efficiency levels that DOE analyzed are in the NOPR 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 2 for compact-size dishwashers. TSL 4 is the TSL that maximizes net benefits at a 3% discount rate; this TSL represents the highest efficiency levels providing positive LCC savings, which comprises the gap-fill efficiency level between the current ENERGY STAR V. 6.0 level and ENERGY STAR Most Efficient level (EL 2) for standard-size dishwashers and max-tech efficiency level (EL 2) for compact-size dishwashers. TSL 3 maximizes net benefits at a 7% discount rate; this TSL comprises the gap-fill efficiency level between the current ENERGY STAR V. 6.0 level and ENERGY STAR Most Efficient level (EL 2) for standard-size dishwashers and the current ENERGY STAR V. 6.0 level (EL 1) for compact-size dishwashers. TSL 2 comprises the current 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 current ENERGY STAR V. 6.0 level.

Table V.1 Trial Standard Levels for Dishwashers

Product Class	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
	Maximum allowable estimated annual energy use *(kWh/year)**				
PC 1: Standard-size dishwasher	232	232	223	223	193
PC 2: Compact-size dishwasher	174	124	174	124	124

* Based on appendix C2.

DOE constructed the TSLs for this NOPR to include ELs representative of ELs with similar characteristics (*i.e.*, using similar technologies and/or efficiencies, and having roughly comparable equipment availability). The use of representative ELs provided for greater distinction between the TSLs. 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.[97]

B. Economic Justification and Energy Savings

1. Economic Impacts on Individual Consumers

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

a. Life-Cycle Cost and Payback Period

In general, higher-efficiency products affect consumers in two ways: (1) purchase price increases and (2) annual operating costs decrease. Inputs used for calculating the

[97] Efficiency levels that were analyzed for this NOPR are discussed in section IV.C.3 of this document. Results by efficiency level are presented in TSD chapters 8, 10, and 12.

LCC and PBP include total installed costs (*i.e.*, product price plus installation costs), and operating costs (*i.e.*, annual energy use, energy prices, energy price trends, water prices, water price trends, repair costs, and maintenance costs). The LCC calculation also uses product lifetime and a discount rate. Chapter 8 of the NOPR TSD provides detailed information on the LCC and PBP analyses.

Table V.2 through Table V.5 show the default case LCC and PBP results for the TSLs considered for both product classes. The LCC and PBP results based on the incremental MPC sensitivity cases are presented appendix 8D of the NOPR TSD. In the first of each pair of tables, the simple payback is measured relative to the baseline product. In the second of each pair of tables, 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. DOE does not include price-sensitive consumers who do not purchase new dishwashers in the percent of consumers that experience a net cost. DOE seeks comment and publicly-available data to improve its analysis of the consumer effects of the proposed standards for dishwashers. DOE is committed to developing a framework that can support empirical quantitative tools for improved assessment of the consumer welfare impacts of appliance standards, including dishwashers.

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

TSL	EL	AEU* (*kWh/yr*)	Average Costs *2021$*				Simple Payback *years*	Average Lifetime *years*
			Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	263	$477	$44	$590	$1,067	--	15.2
1,2	1	232	$492	$39	$558	$1,050	3.0	15.2
3,4	2	223	$492	$38	$542	$1,034	2.4	15.2
5	4	193	$612	$33	$536	$1,148	12.4	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* *2021$*	Percent of Consumers that Experience Net Cost
1,2	1	$20	3%
3,4	2	$17	3%
5	4	($96)	94%

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

TSL	EL	AEU* (*kWh/yr*)	Average Costs *2021$*				Simple Payback *years*	Average Lifetime *years*
			Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	191	$532	$32	$468	$1,000	--	15.2
1,3	3	174	$532	$30	$438	$969	0.0	15.2
2,4,5	4	124	$590	$22	$378	$968	5.7	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* *2021$*	Percent of Consumers that Experience Net Cost
1,3	1	$30	0%
2,4,5	2	$6	49%

* The savings represent the average LCC for affected consumers.

b. Consumer Subgroup Analysis

In the consumer subgroup analysis, DOE estimated the impact of the considered TSLs on low-income households and senior-only households. Table V.6 and Table V.7 compare the average LCC savings and PBP at each efficiency level for the consumer subgroups with similar metrics for the entire consumer sample for both product classes. In most cases, the average LCC savings and PBP for low-income households and senior-only households at the considered efficiency levels are not substantially different from the average for all households. Chapter 11 of the NOPR 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§	All Households
Average LCC Savings* (2021$)			
TSL 1–2	$36	$6	$20
TSL 3-4	$20	$14	$17
TSL 5	($28)	($108)	($96)
Payback Period (years)			
TSL 1-2	1.3	3.7	3.0
TSL 3-4	1.0	2.9	2.4
TSL 5	5.5	14.9	12.4
Consumers with Net Benefit (%)			
TSL 1–2	4%	2%	3%
TSL 3-4	80%	87%	88%
TSL 5	32%	4%	6%
Consumers with Net Cost (%)			
TSL 1–2	2%	4%	3%
TSL 3-4	2%	4%	3%
TSL 5	59%	96%	94%

* 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.

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§	All Households
Average LCC Savings* (2021$)			
TSL 1,3	$33	$24	$30
TSL 2,4,5	$50	($10)	$6
Payback Period (years)			
TSL 1,3	0.0	0.0	0.0
TSL 2,4,5	2.6	6.8	5.7
Consumers with Net Benefit (%)			
TSL 1,3	11%	12%	12%
TSL 2,4,5	44%	23%	30%
Consumers with Net Cost (%)			
TSL 1,3	0%	0%	0%
TSL 2,4,5	28%	56%	49%

* 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.

c. Rebuttable Presumption Payback

As discussed in section III.E.2 of this document, EPCA establishes a rebuttable presumption that an energy conservation standard is economically justified if the increased purchase cost for a product that meets the standard is less than three times the value of the first-year energy savings resulting from the standard. (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 procedure 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 also considered whether the standard levels considered for the NOPR 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	2.1	2.1	1.8	1.8	9.4
PC 2: Compact-Size	0.0	4.6	0.0	4.6	4.6

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

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 NOPR 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 amended energy conservation standards.

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. [98] 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 2022 ENERGY STAR Most Efficient qualification criteria). This scenario models 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

[98] The gross margin percentage of 19.4 percent is based on a manufacturer markup of 1.24.

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 NOPR publication year through the end of the analysis period (2023–2056). 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 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 on the industry and generally result in lower free cash flow in the period between the publication of the 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 Manufacturer Impact Analysis Results for Dishwashers*

	Unit	No-New-Standards Case	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
INPV	*2021$ Million*	713.6	664.4 to 707.0	657.7 to 701.1	578.7 to 624.1	572.0 to 618.2	305.8 to 371.1
Change in INPV	*%*	-	(6.9) to (0.9)	(7.8) to (1.8)	(18.9) to (12.5)	(19.8) to (13.4)	(57.1) to (48.0)
Free Cash Flow (2026)	*2021$ Million*	56.0	51.7	47.8	5.7	1.7	(225.1)
Change in Free Cash Flow (2026)	*%*	-	(7.7)	(14.8)	(89.9)	(96.9)	(501.9)
Conversion Costs	*2021$ Million*	-	12.4	22.4	125.6	135.6	663.7

*Parentheses indicates negative (-) values.

At TSL 1, the standard represents EL 1 across both standard-size and compact-size dishwashers and the current ENERGY STAR V. 6.0 level. The change in INPV is expected to range from -6.9 to -0.9 percent. At this level, free cash flow is estimated to decrease by 7.7 percent compared to the no-new-standards case value of $56.0 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. 88 FR 3234. 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 $0.9 million and product conversion costs of $11.4 million. Conversion costs total $12.4 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 (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 is ENERGY STAR V. 6.0 compliant in the no-new-standards case.

At TSL 2, the standard represents the current 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 -7.8 to -1.8 percent. At this

level, free cash flow is estimated to decrease by 14.8 percent compared to the no-new-standards case value of $56.0 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 increased efficiency level required for compact-size dishwashers. At TSL 2, all manufacturers of compact-size countertop dishwashers with 4 or more place settings and in-sink dishwashers with less than 4 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 indicates 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 4 or more place settings and in-sink dishwashers with less than 4 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 $5.9 million and product conversion costs of $16.5 million. Conversion costs total $22.4 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 as they try 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 current ENERGY STAR V. 6.0 level and ENERGY STAR Most Efficient level (EL 2) for standard-size dishwashers and the current ENERGY STAR V. 6.0 level (EL 1) for compact-size dishwashers. The change in INPV is expected to range from -18.9 to -12.5 percent. At this level, free cash flow is estimated to decrease by 89.9 percent compared to the no-new-standards case value of $56.0 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 and 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 their dishwasher portfolio was a key design parameter, as it was part of their value proposition and marketing material. A different manufacturer emphasized that maintaining drying performance, particularly of plastic dishware, was a key concern for their 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 expects industry to incur more re-flooring costs compared to TSL 2. DOE estimates capital conversion costs of $68.9 million and product conversion costs of $56.7 million. Conversion costs total $125.6 million.

TSL 3 brings standards for standard-size dishwashers above current 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 as they seek 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 current ENERGY STAR V. 6.0 level and ENERGY STAR Most Efficient 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 -19.8 to -13.4 percent. At this level, free cash flow is estimated to decrease by 96.9 percent compared to the no-new-standards case value of $56.0 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 4 or more place settings and

in-sink dishwashers with less than 4 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 indicates 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 $73.9 million and product conversion costs of $61.7 million. Conversion costs total $135.6 million.

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 as they try 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 -57.1 to -48.0 percent. At this level, free cash flow is estimated to decrease by 501.9 percent compared to the no-new-standards case value of $56.0 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 includes additional design options such as the use of stainless steel tub, in-sump integrated heater, condensation drying, 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 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 $421.1 million and product conversion costs of $242.6 million. Conversion costs total $663.7 million.

At TSL 5, the large conversion costs result in a 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.

DOE seeks comments, information, and data on the capital conversion costs and product conversion costs estimated for each TSL.

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. DOE calculated these values using statistical data from the U.S. Census Bureau's 2020 *ASM*, results of the engineering analysis, and manufacturer interviews.

DOE calculated these values using statistical data from the 2020 *ASM*,[99] BLS employee compensation data,[100] 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

[99] U.S. Census Bureau, *Annual Survey of Manufactures*. "Summary Statistics for Industry Groups and Industries in the U.S (2020)." Available at: *www.census.gov/data/tables/time-series/econ/asm/2018-2020-asm.html* (last accessed July 15, 2022).
[100] U.S. Bureau of Labor Statistics. *Employer Costs for Employee Compensation*. June 16, 2022. Available at: *www.bls.gov/news.release/pdf/ecec.pdf* (last accessed August 1, 2022).

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.

Total 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 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 proposed rule.

Non-production workers account for the remainder of the direct employment figure. The 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 3,890 domestic workers for standard-size dishwashers in 2027. 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 discussion below provides a qualitative evaluation of the range of potential impacts presented in the table.

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)	3,890	3,923	3,923	3,923	3,923	4,601
Potential Changes in Direct Employment in 2027 *	-	(3,426) to 33	(3,426) to 33	(3,426) to 33	(3,426) to 33	(3,426) to 711

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

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 proposal. 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). 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 market noted concerns about the level of investment and indicated the potential need to relocate production lines in order to remain competitive.

Additional detail on the analysis of direct employment can be found in chapter 12 of the NOPR 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 NOPR 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 NOPR 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 would be needed to meet both the required efficiencies and their internal design standards. In interviews, several manufacturers expressed concerns that the 3-year time period between the announcement of the 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.

DOE seeks comment on whether manufacturers expect manufacturing capacity constraints would limit product availability to consumers in the timeframe of the amended standard compliance date (2027).

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 disproportionally 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 in section VI.B of this document as part of the Regulatory Flexibility Analysis. 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."[101] Based on this classification, DOE did not identify any domestic OEMs that qualify as a small business. For a discussion of the impacts on the small business manufacturer

[101] U.S. Small Business Administration. "Table of Small Business Size Standards." (Effective July 14, 2022). Available at: *www.sba.gov/document/support-table-size-standards* (last accessed September 28, 2022).

subgroup, see the Regulatory Flexibility Analysis in section VI.B of this document and chapter 12 of the NOPR TSD.

e. Cumulative Regulatory Burden

One aspect of assessing manufacturer burden involves looking at the cumulative impact of multiple DOE standards and the product-specific regulatory actions of other Federal agencies 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. Assessing the impact of a single regulation may overlook this cumulative regulatory burden. In addition to energy conservation standards, other regulations can significantly affect manufacturers' financial operations. 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. This information is presented in Table V.11. The combined sum of total industry conversion costs as a percentage of total product revenue during the conversion periods across all rulemakings listed in Table V.11 is 2.8 percent.

In response to the January 2022 Preliminary Analysis, stakeholders commented on the cumulative regulatory burden analysis. See section IV.J.4 of this document for a summary of stakeholder comments and DOE's initial responses.

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

Federal Energy Conservation Standard	Number of OEMs*	Number of OEMs Affected from Today's Rule**	Approx. Standards Year	Industry Conversion Costs *(Millions $)*	Industry Conversion Costs / Product Revenue***
Portable Air Conditioners 85 FR 1378 (January 10, 2020)	11	2	2025	$320.9 (2015$)	6.7%
Consumer Furnaces† 87 FR 40590 (July 7, 2022)	15	1	2029	$150.6 (2020$)	1.4%
Commercial Water Heating Equipment† 87 FR 30610 (May 19, 2022)	14	1	2026	$34.6 (2020$)	4.7%
Consumer Clothes Dryers† 87 FR 51734 (August 23, 2022)	15	11	2027	$149.7 (2020$)	1.8%
Microwave Ovens† 87 FR 52282 (August 24, 2022)	18	10	2026	$46.1 (2021$)	0.7%
Consumer Conventional Cooking Products 88 FR 6818† (February 1, 2023)	34	11	2027	$183.4 (2021$)	1.2%
Residential Clothes Washers† 88 FR 13520 (March 3, 2023)	19	10	2027	$690.8 (2021$)	5.2%
Refrigerators, Freezers, and Refrigerator-Freezers† 88 FR 12452 (February 27, 2023)	49	15	2027	$1,323.6 (2021$)	3.8%
Miscellaneous Refrigeration Products† 88 FR 19382 (April 11, 2023)	38	8	2029	$126.9 (2021$)	3.1%
Room Air Conditioners‡	8	4	2026	$24.8	0.4%

* This column presents the total number of manufacturers identified in the energy conservation standard rule contributing to cumulative regulatory burden.
** This column presents the number of manufacturers producing dishwashers that are also listed as manufacturers in the listed energy conservation standard contributing to cumulative regulatory burden.
*** This column presents industry conversion costs as a percentage of product revenue during the conversion period. Industry conversion costs are the upfront investments manufacturers must make to sell compliant products/equipment. The revenue used for this calculation is the revenue from just the covered product/equipment associated with each row. The conversion period is the time frame over which

conversion costs are made and lasts from the publication year of the final rule to the compliance year of the energy conservation standard. The conversion period typically ranges from 3 to 5 years, depending on the rulemaking.
† These rulemakings are in the proposed rule stage and all values are subject to change until finalized.
‡ At the time of issuance of this dishwasher proposed rule, this rulemaking has been issued and is pending publication in the *Federal Register*. Once published, the room air conditioners final rule will be available at: www.regulations.gov/docket/EERE-2014-BT-STD-0059.

DOE requests information regarding the impact of cumulative regulatory burden on manufacturers of dishwashers associated with multiple DOE standards or product-specific regulatory actions of other Federal agencies.

3. National Impact Analysis

This section presents DOE's estimates of the NES 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.12 and Table V.13 presents 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.12 Cumulative National Energy Savings for Dishwashers; 30 Years of Shipments (2027–2056)

	Trial Standard Level				
	1	2	3	4	5
	quads				
Source energy	0.05	0.07	0.29	0.32	1.18
FFC energy	0.05	0.08	0.31	0.34	1.25

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

	Trial Standard Level				
	1	2	3	4	5
	trillion gallons				
Water Savings	0.09	0.11	0.24	0.26	0.94

OMB Circular A-4[102] requires agencies to present analytical results, including separate schedules of the monetized benefits and costs that show the type and timing of benefits and costs. Circular A-4 also directs agencies to consider the variability of key elements underlying the estimates of benefits and costs. For this proposed rulemaking, DOE undertook a sensitivity analysis using 9 years, rather than 30 years, of product shipments. The choice of a 9-year period is a proxy for the timeline in EPCA for the review of certain energy conservation standards and potential revision of and compliance with such revised standards.[103] The review timeframe established in EPCA is generally not synchronized with the product lifetime, product manufacturing cycles, or

[102] U.S. Office of Management and Budget. *Circular A-4: Regulatory Analysis*. September 17, 2003. *obamawhitehouse.archives.gov/omb/circulars_a004_a-4/* (last accessed November 2, 2021).

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

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.14 and Table V.15. The impacts are counted over the lifetime of dishwashers purchased in 2027–2035.

Table V.14 Cumulative National Energy Savings for Dishwashers; 9 Years of Shipments (2027–2035)

	Trial Standard Level				
	1	2	3	4	5
	quads				
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.15 Cumulative National Water Savings for Dishwashers; 9 Years of Shipments (2027–2035)

	Trial Standard Level				
	1	2	3	4	5
	trillion gallons				
Water Savings	0.02	0.03	0.07	0.07	0.26

The energy savings in the NOPR analyses differ from the energy savings in the January 2022 Preliminary Analysis primarily due to the updated product class market share distribution as presented in the January 2022 Preliminary TSD. For these NOPR analyses, DOE updated market share distribution using historical shipments data from available literature.[104] The market share for Product Class 2 decreased from 5 percent, used in the Preliminary Analyses, to 2 percent, used in the NOPR analyses. Additionally, DOE updated historical shipments using data from AHAM's Major Appliance Annual

[104] Euromonitor International. 2021. *Air treatment products in the U.S.* December. The report covers market shares for a number of products including dishwashers.

Trends 1989–2020 and updated shipment projections using *AEO 2022* instead of *AEO 2020*.

As discussed, DOE updated its analysis, including efficiency levels, based on more current information regarding shipments of dishwashers, resulting in FFC energy savings of around 0.31 quads over thirty years. Further, as also discussed in section III.D of this document, DOE recently eliminated the numerical threshold for determining significance of energy savings, reverting to its earlier approach of doing so on a case-by-case basis. See 86 FR 70892. In this NOPR, DOE proposes to adopt the energy conservation standards for dishwashers at TSL 3 and refers stakeholders to section V.C of this document where costs and benefits of the proposal are weighed.

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,[105] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. Table V.13 shows the consumer NPV results with impacts counted over the lifetime of products purchased in 2027–2056.

[105] U.S. Office of Management and Budget. *Circular A-4: Regulatory Analysis*. September 17, 2003. *obamawhitehouse.archives.gov/omb/circulars_a004_a-4* (last accessed October 28, 2021).

Table V.16 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
	billion 2021$				
3 percent	0.27	0.31	2.77	2.81	(12.60)
7 percent	0.09	0.08	1.11	1.10	(7.50)

The NPV results based on the aforementioned 9-year analytical period are presented in Table V.14. The impacts are counted over the lifetime of products purchased in 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.17 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
	billion 2021$				
3 percent	0.08	0.09	1.00	1.00	(5.37)
7 percent	0.03	0.03	0.54	0.53	(4.10)

c. Indirect Impacts on Employment

It is estimated that that amended energy conservation standards for dishwashers would 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 timeframe (2027–2031), where these uncertainties are reduced.

The results suggest that the proposed standards would be 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 NOPR TSD presents detailed results regarding anticipated indirect employment impacts.

4. Impact on Utility or Performance of Products

As discussed in section III.F.1.d of this document, DOE has tentatively concluded that the standards proposed in this NOPR would not lessen the utility or performance of the dishwashers under consideration in this proposed rulemaking. Manufacturers of these products currently offer units that meet or exceed the proposed standards.

5. Impact of Any Lessening of Competition

DOE considered any lessening of competition that would be likely to result from new or amended standards. As discussed in section III.F.1.e of this document, the Attorney General determines the impact, if any, of any lessening of competition likely to result from a proposed standard, and transmits such determination in writing to the Secretary, together with an analysis of the nature and extent of such impact. To assist the Attorney General in making this determination, DOE has provided DOJ with copies of this NOPR and the accompanying TSD for review. DOE will consider DOJ's comments on the proposed rule in determining whether to proceed to a final rule. DOE will publish

and respond to DOJ's comments in that document. DOE invites comment from the public regarding the competitive impacts that are likely to result from this proposed rule. In addition, stakeholders may also provide comments separately to DOJ regarding these potential impacts. See the **ADDRESSES** section for information to send comments to DOJ.

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 in the NOPR TSD presents the estimated impacts on electricity generating capacity, relative to the no-new-standards case, for the TSLs that DOE considered in this proposed 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.15 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.D of this document. DOE reports annual emissions reductions for each TSL in chapter 13 of the NOPR TSD.

Table V.18 Cumulative Emissions Reduction for Dishwashers Shipped in 2027–2056

Savings	TSL				
	1	2	3	4	5
Power Sector Emissions					
CO_2 *(million metric tons)*	2.3	3.2	11.4	12.3	46.1
CH_4 *(thousand tons)*	0.1	0.1	0.6	0.7	2.4
N_2O *(thousand tons)*	0.0	0.0	0.1	0.1	0.3
NO_X *(thousand tons)*	1.8	2.4	7.6	8.2	30.8
SO_2 *(thousand tons)*	0.3	0.6	3.3	3.6	13.3
Hg *(tons)*	0.0	0.0	0.0	0.0	0.1
Upstream Emissions					
CO_2 *(million metric tons)*	0.3	0.4	1.2	1.2	4.7
CH_4 *(thousand tons)*	27.5	36.6	112.5	121.7	457.9
N_2O *(thousand tons)*	0.0	0.0	0.0	0.0	0.0
NO_X *(thousand tons)*	4.3	5.7	17.6	19.1	71.8
SO_2 *(thousand tons)*	0.0	0.0	0.0	0.1	0.2
Hg *(tons)*	0.0	0.0	0.0	0.0	0.0
Total FFC Emissions					
CO_2 *(million metric tons)*	2.6	3.6	12.6	13.6	50.8
CH_4 *(thousand tons)*	27.5	36.8	113.1	122.3	460.3
N_2O *(thousand tons)*	0.0	0.0	0.1	0.1	0.4
NO_X *(thousand tons)*	6.1	8.1	25.2	27.3	102.5
SO_2 *(thousand tons)*	0.3	0.6	3.4	3.7	13.5
Hg *(tons)*	0.0	0.0	0.0	0.0	0.1

As part of the analysis for this rulemaking, DOE estimated monetary benefits likely to result from the reduced emissions of CO_2 that DOE estimated for each of the considered TSLs for dishwashers. Section IV.L of this document discusses the SC-CO_2 values that DOE used. Table V.16 presents the value of CO_2 emissions reduction at each TSL. The time-series of annual values is presented for the proposed TSL in chapter 14 of the NOPR TSD.

Table V.19 Present Value of CO_2 Emissions Reduction for Dishwashers Shipped in 2027–2056

TSL	SC-CO_2 Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	Million 2021$			
1	21.3	94.4	149.0	286.5
2	29.8	132.1	208.3	400.6
3	105.3	465.4	733.9	1,412.2
4	113.8	503.1	793.2	1,526.3
5	425.9	1,882.7	2,968.5	5,712.1

As discussed in section IV.L.2 of this document, DOE estimated monetary benefits likely to result from the reduced emissions of CH_4 and N_2O that DOE estimated for each of the considered TSLs for dishwashers. Table V.17 presents the value of the CH_4 emissions reduction at each TSL, and Table V.18 presents the value of the N_2O emissions reduction at each TSL.

Table V.20 Present Value of Methane Emissions Reduction for Dishwashers Shipped in 2027–2056

TSL	SC-CH_4 Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	Million 2021$			
1	10.7	32.9	46.3	87.0
2	14.2	43.9	61.8	116.2
3	43.8	135.1	190.0	357.3
4	47.4	146.1	205.5	386.5
5	178.3	549.7	773.2	1,454.4

Table V.21 Present Value of Nitrous Oxide Emissions Reduction for Dishwashers Shipped in 2027–2056

TSL	SC-N_2O Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	Million 2021$			
1	0.0	0.2	0.2	0.4
2	0.1	0.3	0.4	0.7
3	0.3	1.2	1.9	3.2
4	0.3	1.3	2.0	3.5
5	1.2	4.8	7.5	12.8

DOE is well aware that scientific and economic knowledge about the contribution of CO_2 and other GHG emissions to changes in the future global climate and the potential resulting damages to the global and U.S. economy continues to evolve rapidly. Thus, any value placed on reduced GHG emissions in this proposed rulemaking is subject to change. That said, because of omitted damages, DOE agrees with the IWG that these estimates most likely underestimate the climate benefits of greenhouse gas reductions. DOE, together with other Federal agencies, will continue to review methodologies for estimating the monetary value of reductions in CO_2 and other GHG emissions. This ongoing review will consider the comments on this subject that are part of the public record for this and other rulemakings, as well as other methodological assumptions and issues. DOE notes that the proposed 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 SO_2 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.19 presents the present value for SO_2 emissions reduction for each TSL calculated using 7-percent and 3-percent discount rates.

Table V.22 Present Value of SO_2 Emissions Reduction for Dishwashers Shipped in 2027–2056

TSL	7% Discount Rate	3% Discount Rate
	million 2021$	
1	5.3	13.9
2	10.2	26.9
3	62.8	164.8
4	67.8	177.8
5	249.7	654.5

DOE also estimated the monetary value of the economic benefits associated with NO_X 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.19 presents the present value for NO_X emissions reduction for each TSL calculated using 7-percent and 3-percent discount rates.

Table V.23 Present Value of NO_X Emissions Reduction for Dishwashers Shipped in 2027–2056

TSL	7% Discount Rate	3% Discount Rate
	million 2021$	
1	62.3	170.3
2	85.6	233.6
3	287.4	780.1
4	310.7	843.3
5	1,165.1	3,162.7

The benefits of reduced CO_2, CH_4, and N_2O emissions are collectively referred to as climate benefits. The benefits of reduced SO_2 and NO_X emissions are collectively

referred to as health benefits. For the time series of estimated monetary values of reduced emissions, see chapter 14 of the NOPR TSD.

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

7. Other Factors

The Secretary of Energy, in determining whether a standard is economically justified, may consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6295(o)(2)(B)(i)(VII)) No other factors were considered in this analysis.

8. Summary of Economic Impacts

Table V.21 presents the NPV values that result from adding the monetized estimates of the potential economic, climate, and health benefits resulting from reduced GHG, SO_2, and NO_X 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 in 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 in 2027–2056.

Table V.24 Consumer NPV Combined with Climate and Health Benefits (billions 2021$)

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Using 3% discount rate for NPV of Consumer and Health Benefits (billion 2021$)					
5% d.r., Average SC-GHG case	0.5	0.6	3.9	4.0	(8.2)
3% d.r., Average SC-GHG case	0.6	0.7	4.3	4.5	(6.3)
2.5% d.r., Average SC-GHG case	0.7	0.8	4.6	4.8	(5.0)
3% d.r., 95th percentile SC-GHG case	0.8	1.1	5.5	5.7	(1.6)
Using 7% discount rate for NPV of Consumer and Health Benefits (billion 2021$)					
5% d.r., Average SC-GHG case	0.2	0.2	1.6	1.6	(5.5)
3% d.r., Average SC-GHG case	0.3	0.4	2.1	2.1	(3.6)
2.5% d.r., Average SC-GHG case	0.3	0.4	2.4	2.5	(2.3)
3% d.r., 95th percentile SC-GHG case	0.5	0.7	3.2	3.4	1.1

The national operating cost savings 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 in 2027–2056. The benefits associated with reduced GHG emissions achieved as a result of the adopted standards are also calculated based on the lifetime of dishwashers shipped in 2027–2056.

C. Conclusion

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

For this NOPR, 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. DOE refers to this process as the "walk-down" analysis.

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 forgo 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. For consumers opting not to purchase a dishwasher, the energy consumption of hand-washing dishes is accounted for when energy and water savings are quantified in the NIA (see section 10.4.2 in chapter 10 of the NOPR TSD). Second, DOE accounts for energy savings attributable only to products actually used by consumers in the standards case; if a standard decreases the number of products purchased by consumers, this decreases the potential energy savings from an energy conservation standard. DOE provides estimates of shipments and changes in the volume of product purchases in chapter 9 of the NOPR 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.[106]

[106] 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*.

While DOE is not prepared at present to provide a fuller quantifiable framework for estimating the benefits and costs of changes in consumer purchase decisions due to an energy conservation standard, DOE is committed to developing a framework that can support empirical quantitative tools for improved assessment of the consumer welfare impacts of appliance standards. DOE has posted a paper that discusses the issue of consumer welfare impacts of appliance energy conservation standards, and potential enhancements to the methodology by which these impacts are defined and estimated in the regulatory process.[107]

DOE welcomes comments on how to more fully assess the potential impact of energy conservation standards on consumer choice and how to quantify this impact in its regulatory analysis in future rulemakings.

1. Benefits and Burdens of TSLs Considered for Dishwashers Standards

Table V.25 and Table V.26 summarize the quantitative impacts estimated for 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 FFC results. DOE exercises its own judgment in presenting monetized climate benefits as recommended in applicable Executive Orders, and DOE would reach the same conclusion presented in this notice in

[107] Sanstad, A.H. *Notes on the Economics of Household Energy Consumption and Technology Choice*. 2010. Lawrence Berkeley National Laboratory. *www1.eere.energy.gov/buildings/appliance_standards/pdfs/consumer_ee_theory.pdf* (last accessed October 28, 2021).

the absence of the social cost of greenhouse gases, including the February 2021 Interim Estimates presented by the Interagency Working Group on the Social Cost of Greenhouse Gases. The efficiency levels contained in each TSL are described in section V.A of this document.

Table V.25 Summary of Analytical Results for Dishwasher TSLs: National Impacts

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Cumulative FFC National Energy Savings (quads)					
Quads	0.05	0.08	0.31	0.34	1.25
Cumulative FFC Emissions Reduction (Total FFC Emissions)					
CO_2 *(million metric tons)*	2.56	3.58	12.56	13.58	50.81
CH_4 *(thousand tons)*	27.55	36.77	113.10	122.32	460.32
N_2O *(thousand tons)*	0.01	0.02	0.09	0.10	0.36
NO_X *(thousand tons)*	6.09	8.14	25.20	27.25	102.53
SO_2 *(thousand tons)*	0.30	0.57	3.39	3.65	13.46
Hg *(tons)*	0.00	0.00	0.02	0.02	0.08
Present Value of Monetized Benefits and Costs (*3% discount rate, billion 2021$*)					
Consumer Operating Cost Savings	0.42	0.59	2.92	3.09	4.03
Climate Benefits*	0.13	0.18	0.60	0.65	2.44
Health Benefits**	0.18	0.26	0.94	1.02	3.82
Total Benefits†	0.73	1.02	4.47	4.76	10.28
Consumer Incremental Product Costs‡	0.15	0.28	0.15	0.28	16.62
Consumer Net Benefits	0.27	0.31	2.77	2.81	(12.60)
Total Net Benefits	0.58	0.74	4.32	4.48	(6.34)
Present Value of Monetized Benefits and Costs (*7% discount rate, billion 2021$*)					
Consumer Operating Cost Savings	0.17	0.23	1.19	1.26	1.60
Climate Benefits*	0.13	0.18	0.60	0.65	2.44
Health Benefits**	0.07	0.10	0.35	0.38	1.41
Total Benefits†	0.36	0.51	2.14	2.29	5.45
Consumer Incremental Product Costs‡	0.08	0.15	0.08	0.15	9.09
Consumer Net Benefits	0.09	0.08	1.11	1.10	(7.50)
Total Net Benefits	0.28	0.35	2.06	2.13	(3.64)

Note: This table presents the costs and benefits associated with dishwashers shipped in 2027−2056. These results include benefits to consumers which accrue after 2056 from the products shipped in 2027−2056.
* Climate benefits are calculated using four different estimates of the SC-CO_2, SC-CH_4 and SC-N_2O. Together, these represent the global SC-GHG. For presentational purposes of this table, the climate benefits associated with the average SC-GHG at a 3 percent discount rate are shown, but the Department does not have a single central SC-GHG point estimate. 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 Interagency Working Group on the Social Cost of Greenhouse Gases (IWG).
** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for NO_X and SO_2) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health

benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. The health benefits are presented at real discount rates of 3 and 7 percent. See section IV.L of this document for more details.
† Total and net benefits include consumer, climate, and health benefits. For presentation purposes, total and net benefits for both the 3-percent and 7-percent cases are presented using the average SC-GHG with 3-percent discount rate.
‡ Costs include incremental equipment costs as well as installation costs.

Table V.26 Summary of Analytical Results for Dishwasher TSLs: Manufacturer and Consumer Impacts

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Manufacturer Impacts					
Industry NPV (*million* 2021$) (No-new-standards case INPV = $713.6)	664.4 to 707.0	657.7 to 701.1	578.7 to 624.1	572.0 to 618.2	305.8 to 371.1
Industry NPV *(% change)*	(6.9) to (0.9)	(7.8) to (1.8)	(18.9) to (12.5)	(19.8) to (13.4)	(57.1) to (48.0)
Consumer Average LCC Savings (2021$)					
PC 1: Standard-size dishwashers	$20	$20	$17	$17	($96)
PC 2: Compact-size dishwashers	$30	$6	$30	$6	$6
Shipment-Weighted Average*	$20	$20	$18	$17	($94)
Consumer Simple PBP (years)					
PC 1: Standard-size dishwashers	3.0	3.0	2.4	2.4	12.4
PC 2: Compact-size dishwashers	0.0	5.7	0.0	5.7	5.7
Shipment-Weighted Average*	3.0	3.1	2.3	2.5	12.2
Percent of Consumers that Experience a Net Cost					
PC 1: Standard-size dishwashers	3%	3%	3%	3%	94%
PC 2: Compact-size dishwashers	0%	49%	0%	49%	49%
Shipment-Weighted Average*	3%	4%	3%	4%	93%

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 includes additional design options such as the use of stainless steel tub, in-sump integrated heater, condensation drying, and 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 permanent magnet motor, improved filters, hydraulic system optimization, heater incorporated into base of tub, and reduced sump volume. TSL 5 would save an estimated 1.25 quads of energy and 0.94 trillion gallons of water, an amount DOE considers significant.[108] Under TSL 5, the NPV of consumer benefit would be -$7.5 billion using a discount rate of 7 percent, and -$12.6 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 5 are 50.81 Mt of CO_2, 13.46 thousand tons of SO_2, 102.53 thousand tons of NO_X, 0.08 tons of Hg, 460.32 thousand tons of CH_4, and 0.36 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions (associated with the average SC-GHG at a 3-percent discount rate) at TSL 5 is $2.44 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 5 is $1.41 billion using a 7-percent discount rate and $3.82 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, health benefits from reduced SO_2 and NO_X emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 5 is -$7.50 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 5 is -$12.60 billion. The estimated total NPV is provided for additional

[108] Please see section III.E.2 of this document for a discussion of factors that DOE considers in determining whether energy savings are significant.

information, however DOE primarily relies upon the NPV of consumer benefits when determining whether a proposed standard level is economically justified.

At TSL 5, the average LCC impact is a savings of -$96 for standard-size dishwashers and $6 for compact-size dishwashers. The simple payback period is 12.4 years for standard-size dishwashers and 5.7 years for compact-size dishwashers. The fraction of consumers experiencing a net LCC cost is 94 percent for standard-size dishwashers and 49 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 $135.

For the low-income consumer group, the average LCC impact is a savings of -$28 for standard-size dishwashers and $50 for compact-size dishwashers. The simple payback period is 5.5 years for standard-size dishwashers and 2.6 years for compact-size dishwashers. The fraction of low-income consumers experiencing a net LCC cost is 59 percent for standard-size dishwashers and 28 percent for compact-size dishwashers. For the senior-only households consumer group, the average LCC impact is a savings of -$108 for standard-size dishwashers and -$10 for compact-size dishwashers. The simple payback period is 14.9 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 96 percent for standard-size dishwashers and 56 percent for compact-size dishwashers.

At TSL 5, the projected change in INPV ranges from a decrease of $407.8 million to a decrease of $342.4 million, which correspond to decreases of 57.1 percent and 48.0

percent, respectively. Industry conversion costs could reach $663.7 million at this TSL, as manufacturers work to redesign their portfolio 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 4 percent of basic models in 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 it 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 21 percent of shipments currently meet the required efficiencies. Of the five compact-size dishwasher OEMs, three OEMs currently offer compact-size products that meet max-tech. At TSL 5, compact-size countertop dishwashers with 4 or more place settings and in-sink dishwashers with less than 4 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 them to meet the max-tech efficiencies.

Based on the above considerations, the Secretary tentatively 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 dishwashers (94 percent) would experience a net cost and the average LCC savings would be negative (-$96) 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 tentatively 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 Most Efficient level and the current 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 permanent magnet motor, improved filters, hydraulic system optimization, heater incorporated into base of tub, and reduced sump volume. TSL 4 would save an estimated 0.34 quads of energy and 0.26 trillion gallons of water, an amount DOE considers significant.[109] Under TSL 4, the NPV of consumer benefit would be $1.10 billion using a discount rate of 7 percent, and $2.81 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 4 are 13.58 Mt of CO_2, 3.65 thousand tons of SO_2, 27.25 thousand tons of NO_X, 0.02 tons of Hg, 122.32 thousand tons of CH_4, and 0.10 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions (associated with the average SC-GHG at a 3-percent discount rate) at TSL 4 is $0.65 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 4 is $0.38 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 SO_2 and NO_X emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 4 is $2.13 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL

[109] Please see section III.E.2 of this document for a discussion of factors that DOE considers in determining whether energy savings are significant.

4 is $4.48 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 $6 for compact-size dishwashers. The simple payback period is 2.4 years for standard-size dishwashers and 5.7 years for compact-size dishwashers. The fraction of consumers experiencing a net LCC cost is 3 percent for standard-size dishwashers and 49 percent for compact-size dishwashers.

For the low-income consumer group, the average LCC impact is a savings of $20 for standard-size dishwashers and $50 for compact-size dishwashers. The simple payback period is 1.0 years for standard-size dishwashers and 2.6 years for compact-size dishwashers. The fraction of low-income consumers experiencing a net LCC cost is 2 percent for standard-size dishwashers and 28 percent for compact-size dishwashers. For the senior-only households consumer group, the average LCC impact is a savings of $14 for standard-size dishwashers and -$10 for compact-size dishwashers. The simple payback period is 2.9 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 56 percent for compact-size dishwashers.

At TSL 4, the projected change in INPV ranges from a decrease of $141.6 million to a decrease of $95.4 million, which correspond to decreases of 19.8 percent and 13.4 percent, respectively. Industry conversion costs could reach $135.6 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 21 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. Of the 19 OEMs offering standard-size products, 11 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 4, compact-size countertop dishwashers with 4 or more place settings and in-sink dishwashers with less than 4 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 relative to the size of the compact-size dishwasher market for them to meet the max-tech efficiencies.

Based upon the above considerations, the Secretary tentatively 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 tentatively concluded that TSL 4 is not economically justified.

DOE requests comment on whether there is any information or data on costs and benefits for all households, and/or the sub-groups of low-income and senior-only households that would affect the determination that TSL 4 is not economically justified. DOE also requests information on the income distribution of senior-only households with compact dishwashers, as such households drive many of the differences in outcomes between TSL 4 and other TSLs.

DOE then considered TSL 3, which comprises the gap-fill efficiency level between the ENERGY STAR Most Efficient level and the current ENERGY STAR V. 6.0 level (EL 2) for standard-size dishwashers and the current 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. TSL 3 would save an estimated 0.31 quads of energy and 0.24 trillion gallons of water, an amount DOE considers significant. [110] Under TSL 3, the NPV of

[110] Please see section III.E.2 of this document for a discussion of factors that DOE considers in determining whether energy savings are significant.

consumer benefit would be $1.11 billion using a discount rate of 7 percent, and $2.77 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 3 are 12.56 Mt of CO_2, 3.39 thousand tons of SO_2, 25.20 thousand tons of NO_X, 0.02 tons of Hg, 113.10 thousand tons of CH_4, and 0.09 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions (associated with the average SC-GHG at a 3-percent discount rate) at TSL 3 is $0.60 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 3 is $0.35 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 SO_2 and NO_X emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 3 is $2.06 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 3 is $4.32 billion. The estimated total NPV is provided for additional information, however DOE primarily relies upon the NPV of consumer benefits when determining whether a proposed standard level is economically justified.

At TSL 3, the average LCC impact is a savings of $17 for standard-size dishwashers and $30 for compact-size dishwashers. The simple payback period is 2.4 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 $20 for standard-size dishwashers and $33 for compact-size dishwashers. The simple payback period is 1.0 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 $14 for standard-size dishwashers and $24 for compact-size dishwashers. The simple payback period is 2.9 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.

At TSL 3, the projected change in INPV ranges from a decrease of $134.9 million to a decrease of $89.5 million, which correspond to decreases of 18.9 percent and 12.5 percent, respectively. Industry conversion costs could reach $125.6 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 TSL 3 efficiencies, of which approximately 9 percent of standard-size dishwasher shipments and 87 percent of compact-size 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 of the compact-size dishwasher OEMs currently offer products that meet TSL 3. 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 tentatively concluded that a standard set at TSL 3 for dishwashers would be economically justified. At this TSL, the weighted-average LCC savings for both product classes is $18. The weighted-average share of consumers with a net LCC cost for both product classes is 3 percent. For both 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 $2.77 billion and $1.11 billion using both a 3-percent and 7-percent discount rate respectively. Notably, the benefits to consumers vastly outweigh the cost to manufacturers. At TSL 3, the NPV of consumer benefits, even measured at the more conservative discount rate of 7 percent, is over seven times higher than the maximum estimated manufacturers' loss in INPV. The standard levels at TSL 3 are economically justified even without weighing the estimated monetary value of emissions reductions. When those emissions reductions are included—representing $0.60 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 $0.35 billion (using a 7-percent discount rate) in health benefits—the rationale becomes stronger still.

The proposed standards are applicable to the regulated cycle type (*i.e.*, normal cycle); manufacturers can continue to provide currently available 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, which often 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 that would suggest that any aspect of this proposed 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 that cycle time is not substantively correlated with energy and water consumption of the normal cycle.[111] Based on these results, DOE assumes that this proposed 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 TSL 3, 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.

Although DOE considered proposed amended standard levels for dishwashers by grouping the efficiency levels for each product class into TSLs, DOE evaluates all analyzed efficiency levels in its LCC analysis and all efficiency levels with positive LCC savings for the NIA and MIA analysis. For both standard-size and compact-size dishwashers, the proposed standard level represents the maximum energy savings that

[111] See section 5.5.1 of the January 2022 Preliminary TSD available here: https://www.energy.gov/sites/default/files/2022-01/dw-tsd.pdf

does not result in a large percentage of consumers experiencing a net LCC cost. The efficiency levels at the proposed 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 tentatively concluded they are economically justified, as discussed for TSL 3 in the preceding paragraphs.

Therefore, based on the above considerations, DOE proposes to adopt the energy conservation standards for dishwashers at TSL 3. The proposed 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.27.

Table V.27 Proposed 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 Proposed Standards

The benefits and costs of the proposed standards can also be expressed in terms of annualized values. The annualized net benefit is (1) the annualized national economic value (expressed in 2021$) of the benefits from operating products that meet the proposed standards (consisting primarily of operating cost savings from using less

energy, minus increases in product purchase costs, and (2) the annualized monetary value of the climate and health benefits from emission reductions.

Using a 7-percent discount rate for consumer benefits and costs and NOx and SO_2 reduction benefits, and a 3-percent discount rate case for GHG social costs, the estimated cost of the proposed standards for dishwashers is $8.6 million per year in increased equipment costs, while the estimated annual benefits are $125.8 million from reduced equipment operating costs, $34.6 million from GHG reductions, and $37.0 million from reduced NO_X and SO_2 emissions. In this case, the net benefit amounts to $188.8 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the proposed standards for dishwashers is $8.5 million per year in increased equipment costs, while the estimated annual benefits are $167.8 million from reduced equipment operating costs, $34.6 million from GHG reductions, and $54.3 million from reduced NO_X and SO_2 emissions. In this case, the net benefit amounts to $248.1 million per year.

Table V.28 Annualized Monetized Benefits and Costs of Proposed Energy Conservation Standards for Dishwashers (TSL 3)

Category	Million 2021$/year		
	Primary Estimate	Low-Net-Benefits Estimate	High-Net-Benefits Estimate
3% discount rate			
Consumer Operating Cost Savings	167.8	166.8	169.5
Climate Benefits*	34.6	33.8	35.3
Health Benefit**	54.3	53.1	55.4
Total Benefits†	256.6	253.7	260.2
Consumer Incremental Product Costs‡	8.5	9.8	8.2
Net Benefits	248.1	243.8	251.9
7% discount rate			
Consumer Operating Cost Savings	125.8	125.0	127.0
Climate Benefits*	34.6	33.8	35.3
Health Benefit**	37.0	36.3	37.7
Total Benefits†	197.3	195.1	199.9
Consumer Incremental Product Costs‡	8.6	9.7	8.3
Net Benefits	188.8	185.3	191.6

Note: This table presents the costs and benefits associated with dishwashers shipped in 2027−2056. These results include benefits to consumers which 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 AEO2022 Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental equipment costs reflect a medium decline rate in the Primary Estimate, a low decline rate in the Low Net Benefits Estimate, and a high decline rate in the High Net Benefits Estimate. The methods used to derive projected price trends are explained in sections IV.F.1 and IV.H.1 of this document. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

* Climate benefits are calculated using four different estimates of the 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, but the Department does not have a single central SC-GHG point estimate. 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 Interagency Working Group on the Social Cost of Greenhouse Gases (IWG).

** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. 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 benefits for both the 3-percent and 7-percent cases are presented using the average SC-GHG with 3-percent discount rate, but the Department does not have a single central SC-GHG point estimate.

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

VI. Procedural Issues and Regulatory Review

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

Executive Order ("E.O.") 12866, "Regulatory Planning and Review," 58 FR 51735 (Oct. 4, 1993), as supplemented and reaffirmed by E.O. 13563, "Improving Regulation and Regulatory Review, 76 FR 3821 (Jan. 21, 2011) and E.O. 14094, "Modernizing Regulatory Review," 88 FR 21879 (April 11, 2023), requires agencies, to the extent permitted by law, to (1) propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify); (2) tailor regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations; (3) select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity); (4) to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt; and (5) identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public. DOE emphasizes as well that E.O. 13563 requires agencies to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible. In its guidance, the Office of Information and Regulatory Affairs ("OIRA") in the Office of Management and Budget ("OMB") has emphasized that such techniques may include identifying changing future compliance costs that might

result from technological innovation or anticipated behavioral changes. For the reasons stated in the preamble, this proposed 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 proposed regulatory action does constitute a "significant regulatory action within the scope of section 3(f)(1)" of E.O. 12866. Accordingly, pursuant to section 6(a)(3)(C) of E.O. 12866, DOE has provided to OIRA an assessment, including the underlying analysis, of benefits and costs anticipated from the proposed 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 ("IRFA") 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 has not prepared an IRFA for the products that are the subject of this proposed rulemaking.

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

For manufacturers of dishwashers, the SBA has set a size threshold, which defines those entities classified as "small businesses" for the purposes of the statute. DOE used the SBA's small business size standards to determine whether any small entities would be subject to the requirements of the rule. (See 13 CFR part 121.) The size standards are listed by North American Industry Classification System ("NAICS") code and industry description and are available at *www.sba.gov/document/support--table-size-standards*. Manufacturing of dishwashers is classified under NAICS code 335220,[112] "Major Household Appliance Manufacturing." In 13 CFR 121.201, the SBA sets a threshold of 1,500 employees or fewer for an entity to be considered as a small business for this category.

[112] U.S. Small Business Administration. "Table of Small Business Size Standards." (Effective October 1, 2022). Available at: *www.sba.gov/document/support-table-size-standards* (last accessed November 21, 2022).

DOE conducted a focused inquiry into small business manufacturers of the products covered by this rulemaking. DOE reviewed its Compliance Certification Database,[113] California Energy Commission's Modernized Appliance Efficiency Database System,[114] and ENERGY STAR's Product Finder dataset[115] to create a list of companies that import or otherwise manufacture the products covered by this proposal. DOE then consulted publicly available data to identify OEMs selling dishwashers in the U.S. DOE relied on public data and subscription-based market research tools (*e.g.,* Dun & Bradstreet[116]) to determine company location, headcount, and annual revenue. DOE screened out companies that do not offer products covered by this rulemaking, do not meet SBA's definition of a "small business," or are foreign-owned and operated.

DOE identified 21 dishwasher OEMs. DOE did not identify any domestic OEMs that qualify as a "small business." Therefore, DOE did not identify any companies that meet SBA's definition of a "small business."

Based on the initial finding that there are no dishwasher manufacturers who would qualify as small businesses, DOE certifies that the proposed rule, if finalized, would not have a significant economic impact on a substantial number of small entities and has not prepared an IRFA for this rulemaking. DOE will transmit the certification

[113] U.S. Department of Energy Compliance Certification Database, available at *www.regulations.doe.gov/certification-data/products.html#q=Product_Group_s%3A** (last accessed June 2, 2022).
[114] California Energy Commission Modernized Appliance Efficiency Database System, available at *cacertappliances.energy.ca.gov/Pages/Search/AdvancedSearch.aspx* (last accessed June 2, 2022).
[115] ENERGY STAR Product Finder data set, available at *www.energystar.gov/productfinder* (last accessed June 2, 2022).
[116] The Dun & Bradstreet Hoovers subscription login is accessible at *app.dnbhoovers.com* (last accessed November 1, 2022).

and supporting statement of factual basis to the Chief Counsel for Advocacy of the Small Business Administration for review under 5 U.S.C. 605(b).

DOE requests comment on its initial conclusion that there are no small business manufacturers of dishwashers.

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

DOE is analyzing this proposed regulation in accordance with the National Environmental Policy Act of 1969 ("NEPA") and DOE's NEPA implementing regulations (10 CFR part 1021). DOE's regulations include a categorical exclusion for rulemakings that establish energy conservation standards for consumer products or industrial product. 10 CFR part 1021, subpart D, appendix B5.1. DOE anticipates that this rulemaking qualifies for categorical exclusion B5.1 because it is a rulemaking that establishes energy conservation standards for consumer products or industrial product, none of the exceptions identified in categorical exclusion B5.1(b) apply, no extraordinary circumstances exist that require further environmental analysis, and it otherwise meets the requirements for application of a categorical exclusion. See 10 CFR 1021.410. DOE will complete its NEPA review before issuing the final rule.

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 proposed rule and has tentatively 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 proposed 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 Executive Order 12988 requires Executive agencies to review regulations in light of applicable standards in section 3(a) and section 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, this proposed 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, section 201 (codified at 2 U.S.C. 1531). For a proposed 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 proposed "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*.

Although this proposed rule does not contain a Federal intergovernmental mandate, it 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 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 proposed 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 NOPR and the TSD for this proposed rule respond to those requirements.

Under section 205 of UMRA, the Department is obligated to identify and consider a reasonable number of regulatory alternatives before promulgating a rule for which a written statement under section 202 is required. (2 U.S.C. 1535(a)) DOE is required to select from those alternatives the most cost-effective and least burdensome alternative that achieves the objectives of the proposed 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 proposed rule would amend 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 proposed rule.

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

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

I. Review Under Executive Order 12630

Pursuant to E.O. 12630, "Governmental Actions and Interference with Constitutionally Protected Property Rights," 53 FR 8859 (Mar. 15, 1988), DOE has determined that this proposed rule, if finalized as proposed, 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 NOPR 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 proposed 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 proposed 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 tentatively concluded that this regulatory action, which proposes amended energy conservation standards for dishwashers, is not a significant energy action because the proposed 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 proposed 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 has prepared a report describing that peer review.[117] Generation of this report involved a rigorous, formal, and documented evaluation using objective criteria and qualified and independent reviewers to make a judgment as to the technical/scientific/business merit, the actual or anticipated results, and the productivity and management effectiveness of programs and/or projects. Because available data, models, and technological understanding have changed since 2007, DOE has engaged with the National Academy of Sciences to review DOE's analytical methodologies to ascertain whether modifications are needed to improve the Department's analyses. Further evaluation under that process is expected to continue in 2022.

VII. Public Participation

A. Participation in the Webinar

The time and date the webinar meeting are listed in the **DATES** section at the beginning of this document. Webinar registration information, participant instructions, and information about the capabilities available to webinar participants will be published on DOE's website:

https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid

[117] 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 July 19, 2022).

=38&action=viewlive. Participants are responsible for ensuring their systems are compatible with the webinar software.

B. Procedure for Submitting Prepared General Statements for Distribution

Any person who has an interest in the topics addressed in this document, or who is representative of a group or class of persons that has an interest in these issues, may request an opportunity to make an oral presentation at the webinar. Such persons may submit to *ApplianceStandardsQuestions@ee.doe.gov*. Persons who wish to speak should include with their request a computer file in WordPerfect, Microsoft Word, PDF, or text (ASCII) file format that briefly describes the nature of their interest in this rulemaking and the topics they wish to discuss. Such persons should also provide a daytime telephone number where they can be reached.

C. Conduct of the Webinar

DOE will designate a DOE official to preside at the webinar/public meeting and may also use a professional facilitator to aid discussion. The meeting will not be a judicial or evidentiary-type public hearing, but DOE will conduct it in accordance with section 336 of EPCA (42 U.S.C. 6306). A court reporter will be present to record the proceedings and prepare a transcript. DOE reserves the right to schedule the order of presentations and to establish the procedures governing the conduct of the webinar. There shall not be discussion of proprietary information, costs or prices, market share, or other commercial matters regulated by U.S. anti-trust laws. After the webinar and until

the end of the comment period, interested parties may submit further comments on the proceedings and any aspect of the rulemaking.

The webinar will be conducted in an informal, conference style. DOE will a general overview of the topics addressed in this rulemaking, allow time for prepared general statements by participants, and encourage all interested parties to share their views on issues affecting this rulemaking. Each participant will be allowed to make a general statement (within time limits determined by DOE), before the discussion of specific topics. DOE will permit, as time permits, other participants to comment briefly on any general statements.

At the end of all prepared statements on a topic, DOE will permit participants to clarify their statements briefly. Participants should be prepared to answer questions by DOE and by other participants concerning these issues. DOE representatives may also ask questions of participants concerning other matters relevant to this rulemaking. The official conducting the webinar/public meeting will accept additional comments or questions from those attending, as time permits. The presiding official will announce any further procedural rules or modification of the above procedures that may be needed for the proper conduct of the webinar.

A transcript of the webinar will be included in the docket, which can be viewed as described in the *Docket* section at the beginning of this notice. In addition, any person may buy a copy of the transcript from the transcribing reporter.

D. Submission of Comments

DOE will accept comments, data, and information regarding this proposed rule before or after the public meeting, but no later than the date provided in the **DATES** section at the beginning of this proposed rule. Interested parties may submit comments, data, and other information using any of the methods described in the **ADDRESSES** section at the beginning of this document.

Submitting comments via *www.regulations.gov*. The *www.regulations.gov* webpage will require you to provide your name and contact information. Your contact information will be viewable to DOE Building Technologies staff only. Your contact information will not be publicly viewable except for your first and last names, organization name (if any), and submitter representative name (if any). If your comment is not processed properly because of technical difficulties, DOE will use this information to contact you. If DOE cannot read your comment due to technical difficulties and cannot contact you for clarification, DOE may not be able to consider your comment.

However, your contact information will be publicly viewable if you include it in the comment itself or in any documents attached to your comment. Any information that you do not want to be publicly viewable should not be included in your comment, nor in any document attached to your comment. Otherwise, persons viewing comments will see

only first and last names, organization names, correspondence containing comments, and any documents submitted with the comments.

Do not submit to *www.regulations.gov* information for which disclosure is restricted by statute, such as trade secrets and commercial or financial information (hereinafter referred to as Confidential Business Information ("CBI")). Comments submitted through *www.regulations.gov* cannot be claimed as CBI. Comments received through the website will waive any CBI claims for the information submitted. For information on submitting CBI, see the Confidential Business Information section.

DOE processes submissions made through *www.regulations.gov* before posting. Normally, comments will be posted within a few days of being submitted. However, if large volumes of comments are being processed simultaneously, your comment may not be viewable for up to several weeks. Please keep the comment tracking number that *www.regulations.gov* provides after you have successfully uploaded your comment.

Submitting comments via email, hand delivery/courier, or postal mail. Comments and documents submitted via email, hand delivery/courier, or postal mail also will be posted to *www.regulations.gov*. If you do not want your personal contact information to be publicly viewable, do not include it in your comment or any accompanying documents. Instead, provide your contact information in a cover letter. Include your first and last names, email address, telephone number, and optional mailing address. The cover letter will not be publicly viewable as long as it does not include any comments.

Include contact information each time you submit comments, data, documents, and other information to DOE. If you submit via postal mail or hand delivery/courier, please provide all items on a CD, if feasible, in which case it is not necessary to submit printed copies. No telefacsimiles ("faxes") will be accepted.

Comments, data, and other information submitted to DOE electronically should be provided in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format. Provide documents that are not secured, that are written in English, and that are free of any defects or viruses. Documents should not contain special characters or any form of encryption and, if possible, they should carry the electronic signature of the author.

Campaign form letters. Please submit campaign form letters by the originating organization in batches of between 50 to 500 form letters per PDF or as one form letter with a list of supporters' names compiled into one or more PDFs. This reduces comment processing and posting time.

Confidential Business Information. Pursuant to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit via email two well-marked copies: one copy of the document marked "confidential" including all the information believed to be confidential, and one copy of the document marked "non-confidential" with the information believed to be confidential deleted. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

It is DOE's policy that all comments may be included in the public docket, without change and as received, including any personal information provided in the comments (except information deemed to be exempt from public disclosure).

E. Issues on Which DOE Seeks Comment

Although DOE welcomes comments on any aspect of this proposal, DOE is particularly interested in receiving comments and views of interested parties concerning the following issues:

1) DOE requests comment on specific technology options for reducing standby power, including the type of technologies implemented and the estimated improvement in standby power.
2) DOE requests comment on the proposed baseline compact-size dishwasher EAEU of 191 kWh/year for this NOPR.
3) DOE requests feedback on the efficiency levels analyzed for each product class in this proposal.
4) DOE requests comment on the baseline MPCs and incremental MPCs developed for each dishwasher product class.
5) DOE requests comment on the efficiency characteristics used in the consumer water heater rulemaking described here and encourages comment in both rulemakings.
6) DOE requests comment on the amount of water and energy used for pre-rinsing dishes and flatware before their placement into a dishwasher.
7) DOE requests comment and information on dishwasher lifetime.

8) DOE seeks data on the no-new-standards case efficiency distribution for the compact-size product class, and the efficiency distribution projection for both the standard-size and the compact-size product classes during the analysis period (2027-2056).

9) DOE seeks comment on the approach and inputs used to develop no-new-standards case shipments projection,

10) DOE requests comment on whether industry expects a compression of markups due higher standards, as reflected in the tiered scenario for manufacturer markups.

11) DOE requests comment on how to address the climate benefits and other non-monetized effects of the proposal.

12) DOE seeks comments, information, and data on the capital conversion costs and product conversion costs estimated for each TSL.

13) DOE seeks comment on whether manufacturers expect manufacturing capacity constraints would limit product availability to consumers in the timeframe of the amended standard compliance date (2027).

14) DOE requests information regarding the impact of cumulative regulatory burden on manufacturers of dishwashers associated with multiple DOE standards or product-specific regulatory actions of other Federal agencies.

15) 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.

16) DOE requests comment on its initial conclusion that there are no small business manufacturers of dishwashers.

17) DOE welcomes comments on any analytical approaches to modeling distributional impacts on low-income, senior citizen, renters, or other underrepresented groups who may be impacted by the proposed standards.

18) DOE welcomes comments on the assumptions regarding market size, conditions and dynamics. We welcome specific comment on impacts on downstream industries and markets, including prices for microchips, semiconductors, or other products related to the proposed standards.

19) DOE welcomes comment any unaccounted benefits in this analysis such as the benefits of saving time from handwashing dishes, saving money on buying paper/plastic cups/plates/utensils and other benefits from purchasing a dishwasher for households that are not currently in the market related to the proposed standards.

20) DOE welcomes comments on other related EERE rulemakings that intersect with this rulemaking such as Consumer Water Heaters related to the proposed standards.

Additionally, DOE welcomes comments on other issues relevant to the conduct of this rulemaking that may not specifically be identified in this document.

VIII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this notice of proposed rulemaking and request for comment.

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, Small businesses.

Signing Authority

This document of the Department of Energy was signed on May 1, 2023, by Francisco Alejandro Moreno, Acting Assistant Secretary for Energy Efficiency and Renewable Energy, pursuant to delegated authority from the Secretary of Energy. That document with the original signature and date is maintained by DOE. For administrative purposes only, and in compliance with requirements of the Office of the Federal Register, the undersigned DOE Federal Register Liaison Officer has been authorized to sign and submit the document in electronic format for publication, as an official document of the Department of Energy. This administrative process in no way alters the legal effect of this document upon publication in the *Federal Register*.

Signed in Washington, DC, on May 1, 2023.

FRANCISCO MORENO

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Date: 2023.05.01 08:31:14 -04'00'

X

Francisco Alejandro Moreno
Acting Assistant Secretary for Energy Efficiency and Renewable Energy
U.S. Department of Energy

For the reasons set forth in the preamble, DOE proposes to amend 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:

a. Revising the first sentence of paragraph (f)(1); and

b. Revising paragraph (f)(2).

The revisions 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, and before [DATE 3 YEARS AFTER DATE OF PUBLICATION OF THE FINAL RULE IN THE FEDERAL REGISTER], shall meet the following standard –

* * *

(2) All dishwashers manufactured on or after [*DATE 3 YEARS AFTER DATE OF PUBLICATION OF THE FINAL RULE IN THE FEDERAL REGISTER*], shall not exceed the following standard –

Product Class	**Estimated Annual Energy Use** *(kWh/year)*	**Per-Cycle Water Consumption** *(gal/cycle)*
Standard-size (≥8 place settings plus 6 serving pieces)	223	3.3
Compact-size (<8 place settings plus 6 serving pieces)	174	3.1

Where the 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 in subpart B of this part.