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[6450-01-P]

DEPARTMENT OF ENERGY

10 CFR Part 430

[EERE-2017-BT-STD-0014]

RIN 1904-AD98

Energy Conservation Program: Energy Conservation Standards for Residential Clothes Washers

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

ACTION: Notice of proposed rulemaking and announcement of public meeting.

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

DATES: *Meeting*: DOE will hold a public meeting via webinar on Tuesday, March 28, 2023, from 1:00 p.m. to 4:00 p.m. See section VII of this document, "Public Participation," for webinar registration information, participant instructions, and information about the capabilities available to webinar participants.

Comments: DOE will accept comments, data, and information regarding this NOPR no later than [**INSERT DATE 75 DAYS AFTER DATE OF PUBLICATION IN THE *FEDERAL REGISTER***].

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–2017–BT–STD-0014. Follow the instructions for submitting comments. Alternatively, interested persons may submit comments, identified by docket number EERE-2017-BT-STD-0014, by any of the following methods:

Email: ConsumerClothesWasher2017STD0014@ee.doe.gov. Include the docket number EERE-2017-BT-STD-0014 in the subject line of the message.

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.

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/EERE-2017-BT-STD-0014*. 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 proposed rule.

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. Melanie Lampton, U.S. Department of Energy, Office of the General Counsel, GC-33, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. Telephone: (240) 751-5157. Email: *Melanie.Lampton@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 consumer (residential)[3] clothes washers ("RCWs"), the subject of this proposed rulemaking.

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

In accordance with these and other statutory provisions discussed in this document, DOE proposes amended energy conservation standards for RCWs. The proposed standards, which are expressed in terms of energy efficiency ratio ("EER") measured in pounds per kilowatt-hour per cycle ("lb/kWh/cycle") and water efficiency

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[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.
[3] DOE uses the "residential" nomenclature and "RCW" abbreviation for consumer clothes washers in order to distinguish from the "CCW" abbreviation used for commercial clothes washers, which are also regulated equipment under EPCA.

ratio ("WER") measured in pounds per gallon per cycle ("lb/gal/cycle") as measured using the test procedure at title 10 of the Code of Federal Regulations ("CFR"), part 430, subpart B, appendix J ("appendix J"), are shown in Table I.1. These proposed standards, if adopted, would apply to all RCWs listed in Table I.1 manufactured in, or imported into, the United States starting on the date 3 years after the publication in the *Federal Register* of the final rule for this rulemaking. As shown in Table I.1 and discussed further in IV.A.1 of this document, DOE proposes standards for separate RCW product classes that are defined based on axis of loading (*i.e.*, top-loading or front-loading), clothes container capacity (measured in cubic feet ("ft^3")), and whether the product is automatic or semi-automatic.

Table I.1 Proposed Energy Conservation Standards for Residential Clothes Washers

Product Class	Minimum Energy Efficiency Ratio *(lb/kWh/cycle)*	Minimum Water Efficiency Ratio *(lb/gal/cycle)*
Semi-Automatic Clothes Washers	2.12	0.27
Automatic Clothes Washers		
Top-Loading, Ultra-Compact (less than 1.6 ft^3 capacity)	3.79	0.29
Top-Loading, Standard-Size (1.6 ft^3 or greater capacity)	4.78	0.63
Front-Loading, Compact (less than 3.0 ft^3 capacity)	5.02	0.71
Front-Loading, Standard-Size (3.0 ft^3 or greater capacity)	5.73	0.77

A. Benefits and Costs to Consumers

Table I.2 presents DOE's evaluation of the economic impacts of the proposed standards, represented by trial standard level ("TSL") 4, on consumers of RCWs, as measured by the average life-cycle cost ("LCC") savings and the simple payback period

(“PBP”).[4] The average LCC savings are positive for all product classes, and the PBP is less than the average lifetime of RCWs, which is estimated to be 13.7 years (see section IV.F.6 of this document).

Table I.2 Impacts of Proposed Energy Conservation Standards on Consumers of Residential Clothes Washers

Product Class	Average LCC Savings *2021$*	Simple Payback Period *years*
Semi-Automatic Clothes Washers	$329	0.3
Automatic Clothes Washers		
Top-Loading, Ultra-Compact (less than 1.6 ft^3 capacity)*	n.a.	n.a.
Top-Loading, Standard-Size (1.6 ft^3 or greater capacity)	$134	5.9
Front-Loading, Compact (less than 3.0 ft^3 capacity)	$7	9.1
Front-Loading, Standard-Size (3.0 ft^3 or greater capacity)	$19	3.2

*The entry “n.a.” means not applicable because the standard at the proposed TSL is the baseline.

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

The industry net present value (“INPV”) is the sum of the discounted cash flows to the industry from the base year through the end of the analysis period (2022–2056). Using a real discount rate of 9.3 percent, DOE estimates that the INPV for manufacturers of RCWs in the case without amended standards is $1,738.3 million in 2021$. Under the proposed standards, the change in INPV is estimated to range from -30.5 percent to -20.8 percent, which is approximately -$530.2 million to -$361.6 million. In order to bring

[4] 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).

products into compliance with amended standards, it is estimated that the industry would incur total conversion costs of $690.8 million.

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[5]

DOE's analyses indicate that the proposed energy conservation standards for RCWs would save a significant amount of energy and water. Relative to the case without amended standards, the lifetime energy and water savings for RCWs purchased in the 30-year period that begins in the anticipated year of compliance with the standards (2027–2056) amount to 1.45 quadrillion British thermal units ("Btu"), or quads of energy and 2.53 trillion gallons of water, respectively.[6]

The cumulative net present value ("NPV") of total consumer benefits of the proposed standards for RCWs ranges from $5.14 billion (at a 7-percent discount rate) to $14.52 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 and installation costs for RCWs purchased in 2027–2056.

In addition, the proposed standards for RCWs are projected to yield significant environmental benefits. DOE estimates that the proposed standards would result in cumulative emission reductions (over the same period as for energy savings) of 53.21

[5] All monetary values in this document are expressed in 2021 dollars.
[6] The quantity refers to full-fuel-cycle ("FFC") energy savings. FFC energy savings includes the energy consumed in extracting, processing, and transporting primary fuels (*i.e.*, coal, natural gas, petroleum fuels), and, thus, presents a more complete picture of the impacts of energy efficiency standards. For more information on the FFC metric, see section IV.H.1 of this document.

million metric tons ("Mt")[7] of carbon dioxide ("CO_2"), 19.93 thousand tons of sulfur dioxide ("SO_2"), 92.39 thousand tons of nitrogen oxides ("NO_X"), 411.43 thousand tons of methane ("CH_4"), 0.48 thousand tons of nitrous oxide ("N_2O"), and 0.13 tons of mercury ("Hg").[8]

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").[9] DOE used interim SC-GHG values developed by an Interagency Working Group on the Social Cost of Greenhouse Gases ("IWG").[10] 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 $2.71 billion. DOE does not

[7] A metric ton is equivalent to 1.1 short tons. Results for emissions other than CO_2 are presented in short tons.
[8] DOE calculated emissions reductions relative to the no-new-standards case, which reflects key assumptions in the *Annual Energy Outlook 2022* ("*AEO2022*"). *AEO2022* represents current federal and state legislation and final implementation of regulations as of the time of its preparation. See section IV.K of this document for further discussion of *AEO2022* assumptions that effect air pollutant emissions.
[9] On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from "adopting, employing, treating as binding, or relying upon" the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. As reflected in this rule, DOE has reverted to its approach prior to the injunction and presents monetized benefits where appropriate and permissible under law.
[10] *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. *www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf*.

have a single central SC-GHG point estimate and it emphasizes the importance and value of considering the benefits calculated using all four sets of SC-GHG estimates.

DOE 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 $1.91 billion using a 7-percent discount rate, and $4.57 billion using a 3-percent discount rate.[11] 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 economic benefits and costs expected to result from the proposed standards for RCWs. 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.

[11] 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 Economic Benefits and Costs of Proposed Energy Conservation Standards for Residential Clothes Washers (TSL 4)

	Billion 2021$
3% discount rate	
Consumer Operating Cost Savings	27.83
Climate Benefits*	2.71
Health Benefits**	4.57
Total Benefits†	35.11
Consumer Incremental Product Costs‡	13.31
Net Benefits	14.52
7% discount rate	
Consumer Operating Cost Savings	12.73
Climate Benefits* (3% discount rate)	2.71
Health Benefits**	1.91
Total Benefits†	17.35
Consumer Incremental Product Costs‡	7.58
Net Benefits	5.14

Note: This table presents the costs and benefits associated with RCWs 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. On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22-30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana v. Biden*, No. 21-cv-1074-JDC-KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from "adopting, employing, treating as binding, or relying upon" the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. As reflected in this rule, DOE has reverted to its approach prior to the injunction and presents monetized benefits where appropriate and permissible under law.
** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. See section IV.L of this document for more details.
† Total and net benefits include those consumer, climate, and health benefits that can be quantified and monetized. For presentation purposes, total and net benefits for both the 3-percent and 7-percent cases are presented using the average SC-GHG with 3-percent discount rate, but DOE does not have a single central SC-GHG point estimate. DOE emphasizes the importance and value of considering the benefits calculated using all four sets of SC-GHG estimates.
‡ Costs include incremental equipment costs as well as installation costs.

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 benefits of emission reductions, all annualized.[12]

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 RCWs 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 RCWs 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 IV.L 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.

Using a 7-percent discount rate for consumer benefits and costs and health benefits from reduced NOx 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 $800.8 million per year in increased equipment costs, while the estimated annual benefits are $1,344.2 million in reduced equipment operating costs, $155.7 million in climate benefits, and $202.0 million in health benefits. In this case, the net benefit would amount to $901.1 million per year.

[12] To convert the time-series of costs and benefits into annualized values, DOE calculated a present value in 2021, 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 2021. The calculation uses discount rates of 3 and 7 percent for all costs and benefits. 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 3-percent discount rate for all benefits and costs, the estimated cost of the proposed standards is $764.0 million per year in increased equipment costs, while the estimated annual benefits are $1,598.0 million in reduced operating costs, $155.7 million in climate benefits, and $262.2 million in health benefits. In this case, the net benefit would amount to $1,251.8 million per year.

Table I.4 Annualized Monetized Benefits and Costs of Proposed Energy Conservation Standards for Residential Clothes Washers (TSL 4)

	million 2021$/year		
	Primary Estimate	**Low-Net-Benefits Estimate**	**High-Net-Benefits Estimate**
3% discount rate			
Consumer Operating Cost Savings	1,598.0	1,544.5	1,657.8
Climate Benefits*	155.7	151.7	159.7
Health Benefits**	262.2	255.8	268.9
Total Benefits†	2,015.9	1,952.0	2,086.4
Consumer Incremental Product Costs‡	764.0	778.7	695.5
Net Benefits	1,251.8	1,173.4	1,390.9
7% discount rate			
Consumer Operating Cost Savings	1,344.2	1,302.8	1,389.7
Climate Benefits* (3% discount rate)	155.7	151.7	159.7
Health Benefits**	202.0	197.5	206.7
Total Benefits†	1,701.9	1,652.0	1,756.1
Consumer Incremental Product Costs‡	800.8	813.3	737.9
Net Benefits	901.1	838.7	1,018.3

Note: This table presents the costs and benefits associated with RCWs 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.3 of this document. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

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

greenhouse gas emissions. As reflected in this rule, DOE has reverted to its approach prior to the injunction and presents monetized benefits where appropriate and permissible under law.
** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. See section IV.L of this document for more details.
† Total benefits include 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.

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, to a great extent, the burdens of the proposed standards.

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 RCWs is $800.8 million per year in increased product costs, while the estimated annual benefits are $1,344.2 million in reduced product operating costs, $155.7 million in climate benefits and $202.0 million in health benefits. The net benefit amounts to $901.1 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.[13] For example, some covered products and equipment have substantial energy consumption occur during periods of peak energy demand. The impacts of these products on the energy infrastructure can be more pronounced than products with relatively constant demand. Accordingly, DOE evaluates the significance of energy savings on a case-by-case basis.

As previously mentioned, the proposed standards are projected to result in estimated national energy savings of 1.45 quads FFC, the equivalent of the primary annual energy use of 16 million homes. The NPV of consumer benefit for these projected energy savings is $5.14 billion using a discount rate of 7 percent, and $14.52 billion using a discount rate of 3 percent. The cumulative emissions reductions associated with these energy savings are 53.21 Mt of CO_2, 19.93 thousand tons of SO_2, 92.39 thousand tons of NO_X, 0.13 tons of Hg, 411.43 thousand tons of CH_4, and 0.48 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) is $2.71 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions is $1.91 billion using a 7-percent discount rate and $4.57 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).[14] A more detailed discussion of the basis for these tentative

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

conclusions is contained in the remainder of this document and the accompanying technical support document ("TSD").[15]

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 burdens of the more-stringent energy efficiency levels would outweigh the projected benefits.

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 RCWs.

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 RCWs, the subject of this document. (42 U.S.C. 6292(a)(7)) EPCA

[15] The TSD is available in the docket for this proposed rulemaking at *www.regulations.gov/docket/EERE-2017-BT-STD-0014*.

prescribed energy conservation standards for these products (42 U.S.C. 6295(g)(2) and (9)(A)), and directs DOE to conduct future rulemakings to determine whether to amend these standards. (42 U.S.C. 6295(g)(4) and (9)(B)) EPCA further provides that, not later than 6 years after the issuance of any final rule establishing or amending a standard, DOE must publish either a notice of determination that standards for the product do not need to be amended, or a NOPR including new proposed energy conservation standards (proceeding to a final rule, as appropriate). (42 U.S.C. 6295(m)(1))

The energy conservation program under EPCA consists essentially of four parts: (1) testing, (2) labeling, (3) the establishment of Federal energy conservation standards, and (4) certification and enforcement procedures. Relevant provisions of EPCA specifically include definitions (42 U.S.C. 6291), test procedures (42 U.S.C. 6293), labeling provisions (42 U.S.C. 6294), energy conservation 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 RCWs appear at 10 CFR part 430, subpart B, appendix J ("appendix J") and appendix J2 ("appendix J2").

DOE must follow specific statutory criteria for prescribing new or amended standards for covered products, including RCWs. 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 ("Secretary") 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 the manufacturers and on the consumers of the products subject to such standard;

(2) 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 products which are likely to result from the imposition of the standard;

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

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

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

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

(7) Other factors the Secretary 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 RCWs address standby mode and off mode energy use as part of the EER metric. 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

The current energy conservation standards for RCWs were established in a direct final rule published on May 31, 2012. 77 FR 32308 ("May 2012 Final Rule").[16] These standards are consistent with a joint proposal submitted to DOE by interested parties

[16] DOE published a confirmation of effective date and compliance date for the direct final rule on October 1, 2012. 77 FR 59719.

representing manufacturers, energy and environmental advocates, and consumer groups.[17]

The current standards are defined in terms of a minimum allowable integrated modified energy factor ("IMEF"), measured in cubic feet per kilowatt-hour per cycle ("ft^3/kWh/cycle"), and maximum allowable integrated water factor ("IWF"), measured in gallons per cycle per cubic foot ("gal/cycle/ft^3"), as measured according to appendix J2. *Id*. The May 2012 Final Rule established four classes of RCW: top-loading, compact (less than 1.6 ft^3 capacity); top-loading, standard-size (1.6 ft^3 or greater capacity); front-loading, compact (less than 1.6 ft^3 capacity); and front-loading, standard-size (1.6 ft^3 or greater capacity). 77 FR 32308, 32316–32320. The May 2012 Final Rule established a two-phase compliance date – the first phase of amended standards applied to RCWs manufactured on or after March 7, 2015. 77 FR 32308, 32380. The second phase of amended standards, which is currently applicable, applies to RCWs manufactured on or after January 1, 2018. *Id.*

The current energy conservation standards for RCWs are set forth in DOE's regulations at 10 CFR 430.32(g)(4) and are shown in Table II.1.

[17] Available at: *www.regulations.gov/document/EERE-2008-BT-STD-0019-0032.*

Table II.1 Federal Energy Conservation Standards for Residential Clothes Washers

Product Class	Minimum Integrated Modified Energy Factor *(ft^3/kWh/cycle)*	Maximum Integrated Water Factor *(gal/cycle/ft^3)*
Top-Loading, Compact (less than 1.6 ft^3 capacity)	1.15	12.0
Top-Loading, Standard-Size (1.6 ft^3 or greater capacity)	1.57	6.5
Front-Loading, Compact (less than 1.6 ft^3 capacity)	1.13	8.3
Front-Loading, Standard-Size (1.6 ft^3 or greater capacity)	1.84	4.7

2. History of Standards Rulemaking for Residential Clothes Washers

On August 2, 2019, DOE published a request for information ("RFI") to initiate an effort to determine whether to amend the current energy conservation standards for RCWs. 84 FR 37794 ("August 2019 RFI"). Specifically, through the August 2019 RFI, DOE sought data and information that could enable the agency to determine whether DOE should propose a "no new standard" determination because a more stringent standard: (1) would not result in a significant savings of energy; (2) is not technologically feasible; (3) is not economically justified; or (4) any combination of foregoing. *Id*.

On September 29, 2021, DOE published a notification of the availability of a preliminary technical support document for RCWs ("September 2021 Preliminary Analysis"). 86 FR 53886. In that notification, DOE sought comment on the analytical framework, models, and tools that DOE used to evaluate potential standards for RCWs, the results of preliminary analyses performed, and the potential energy conservation standard levels derived from these analyses, which DOE presented in the accompanying Preliminary TSD ("September 2021 Preliminary TSD").[18] *Id*. On October 29, 2021,

[18] September 2021 Residential Clothes Washers Energy Conservation Standards Preliminary Technical Support Document. Available online at *www.regulations.gov/document/EERE-2017-BTSTD-0014-0030*.

DOE extended the comment period for the September 2021 Preliminary Analysis for an additional 45 days. 86 FR 59889.

The September 2021 Preliminary Analysis was conducted based on energy and water use metrics as measured according to proposed amendments to the test procedure as published in a NOPR on September 1, 2021 (“September 2021 TP NOPR”). 86 FR 49140. Part of this analysis included developing translations between the metrics established by the current appendix J2 test procedure (*i.e.*, IMEF and IWF) and the new metrics proposed to be established by the new appendix J test procedure (*i.e.*, EER and WER).

On April 13, 2022, DOE published a notification of data availability (“NODA”) presenting the results of additional testing conducted in furtherance of the development of the translations between the current test procedure and the proposed new test procedure. 87 FR 21816 (“April 2022 NODA”). The April 2022 NODA included a larger sample size of RCWs than the September 2021 Preliminary Analysis (44 units compared to 16 in the September 2021 Preliminary Analysis, and covering all proposed product classes). The April 2022 NODA presented detailed energy and water use measurements for each model as well as a summary of key characteristics pertaining to each model (*e.g.*, product class, capacity, cabinet width, *etc*.). On May 19, 2022, DOE reopened the comment period for the April 2022 NODA and provided additional information in response to stakeholder questions. 87 FR 30433.

DOE received comments in response to the September 2021 Preliminary Analysis and April 2022 NODA from the interested parties listed in Table II.2.

Table II.2 Written Comments Received in Response to the September 2021 Preliminary Analysis and April 2022 NODA

Commenter(s)	Abbreviation	Comment No. in the Docket: In Response to September 2021 Preliminary Analysis	Comment No. in the Docket: In Response to April 2022 NODA	Commenter Type
Ameren Illinois, Commonwealth Edison Company, Northwest Energy Efficiency Alliance, and Northwest Power and Conservation Council Staff	Ameren *et al.*	42	n/a*	Efficiency Organization & Utilities
Appliance Standards Awareness Project, American Council for an Energy-Efficient Economy, Consumer Federation of America, Natural Resources Defense Council	ASAP *et al.*	37	51	Efficiency Organizations
Art Fraas	Fraas	35	n/a	Individual
Association of Home Appliance Manufacturers	AHAM	40	53	Trade Association
Commonwealth Edison Company and Northwest Energy Efficiency Alliance	ComEd and NEEA	n/a	50	Utility & Efficiency Organization
GE Appliances	GEA	38	n/a	Manufacturer
Members of the committee of the National Academies of Sciences, Engineering, and Medicine	NAS Members	34	n/a	National Advisors
New York State Energy Research and Development Authority	NYSERDA	36	n/a	Public Benefit Corporation
Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison; collectively, the California Investor-Owned Utilities	CA IOUs	43	52	Utilities
Samsung	Samsung	41	n/a	Manufacturer
Whirlpool Corporation	Whirlpool	39	n/a	Manufacturer

* "n/a" signifies that the commenter or group of commenters did not provide a comment in response to the particular notification.

A parenthetical reference at the end of a comment quotation or paraphrase provides the location of the item in the public record.[19] To the extent that interested parties have provided written comments that are substantively consistent with any oral comments provided during the November 10, 2021, public meeting, DOE cites the written comments throughout this document. Any oral comments provided during the webinar that are not substantively addressed by written comments are summarized and cited separately throughout this document.

GEA commented in support of AHAM's comments and incorporated AHAM's comments into its own by reference. (GEA, No. 38 at p. 2)

Whirlpool commented that it supports and echo AHAM's positions. (Whirlpool, No. 39 at p. 2) Whirlpool added that its comments expand upon AHAM's comments and provide additional detail or data to reinforce its positions, as well as to comment on areas where AHAM cannot comment. (*Id*.)

NYSERDA commented that it supports the detailed comments provided by ASAP *et al.*, most notably investigating the correlation between clothes washer capacity and measured efficiency. (NYSERDA, No. 36 at p. 2)

[19] The parenthetical reference provides a reference for information located in the docket of DOE's rulemaking to develop energy conservation standards for RCWs. (Docket NO. EERE-2017-BT-STD-0014, which is maintained at *www.regulations.gov*). The references are arranged as follows: (commenter name, comment docket ID number, page of that document).

AHAM specified that its comments in response to the April 2022 NODA do not supplant its previous comments submitted in response to the September 2021 Preliminary Analysis, but instead supplement those comments. (AHAM, No. 53 at p. 2)

III. General Discussion

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

A. General Comments

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

AHAM commented that publishing the September 2021 TP NOPR and the September 2021 Preliminary Analysis concurrently did not allow sufficient time for stakeholders to provide meaningful comments on either publication. (AHAM, No. 40 at pp. 2–4) AHAM commented that although DOE missed the statutory deadlines for both the test procedure and standards rulemakings, it is disingenuous to claim that the only option is to move forward concurrently on these rulemakings. (*Id.*) AHAM suggested that DOE should have published the test procedure earlier, considered implementing fewer changes to the test procedure, or made changes that do not require testing to evaluate or reestablish the baseline energy conservation standards. (*Id.*) AHAM expressed concern that DOE moving forward concurrently with these rulemakings will likely lead to DOE needing to conduct additional analysis based on the finalized test procedure before proposing a new energy conservation standard, and that DOE is missing the opportunity to receive meaningful feedback on the September 2021 Preliminary Analysis. (*Id*.) AHAM added that despite DOE's desire to move quickly to rectify missed statutory deadlines, DOE must ensure it meets other statutory criteria, including that a standard must be technically and economically justified. (*Id*.)

AHAM noted that the comment periods for the September 2021 Preliminary Analysis and the September 2021 TP NOPR overlapped by 34 days. AHAM noted that it requested a 92-day comment period extension for the September 2021 TP NOPR to provide adequate time to evaluate the proposed changes to the test procedure through testing. (AHAM, No. 53 at p. 2) AHAM added that while it appreciated DOE considering that request and extending the comment period by 28 days, that extension was insufficient to complete the robust testing plan developed by AHAM and its members, gather the test data, and analyze the results. (AHAM, No. 40 at pp. 2–4; AHAM, No. 53 at p. 2)

AHAM stated that because of the insufficient time, it was unable to provide detailed comment on the accuracy, repeatability, and testing burden associated with the proposed test procedure and on its potential impact on measured efficiency, or fully comment on the proposed test procedures implications related to the September 2021 Preliminary Analysis. (AHAM, No. 53 at p. 2) AHAM further stated that it was planning its own testing in order to fully understand and evaluate DOE's proposed changes. (AHAM, No. 40 at pp. 2–4)

AHAM commented that it was poor process for DOE to issue a test procedure final rule before receiving comments on the April 2022 NODA, and to do so during a brief comment period extension. (*Id.*) AHAM added that DOE finalizing the test procedure during the brief NODA comment period extension made it nearly impossible for AHAM to review and analyze the final test procedure in addition to the new data and responses to AHAM's questions in order to formulate complete comments on the NODA. (*Id.*)

AHAM further commented that although DOE did not hold a public meeting for the April 2022 NODA, it appreciated that DOE answered its questions and provided more time for comments in order to allow commenters to review the updates. (AHAM, No. 53 at pp. 2–3) AHAM stated, however, that the timing of when DOE provided links to the updated data and responses to questions left very little time for review and analysis of the additional data and information. (*Id.*)

AHAM noted that although the April 2022 NODA is technically part of the energy conservation standards docket, comments on DOE's test data could relate to both the energy conservation standards and test procedure rulemakings. (AHAM, No. 53 at p. 3) AHAM stated that its comments in response to the April 2022 NODA therefore address both the test procedure and the energy conservation standards. (*Id.*) AHAM commented that it was poor process for DOE to issue a test procedure final rule before receiving comments on the April 2022 NODA, and to do so during a brief comment period extension. (*Id.*) AHAM further explained that even though DOE answered or deferred most of AHAM's requests in the test procedure final rule and in the April 2022

NODA, AHAM's comments on the September 2021 Preliminary Analysis indicated that additional information was needed in order to provide full feedback to DOE on the test procedure. (*Id*.) AHAM added that DOE finalizing the test procedure during the brief NODA comment period extension made it nearly impossible for AHAM to review and analyze the final test procedure in addition to the new data and responses to AHAM's questions in order to formulate complete comments on the NODA. (*Id*.)

AHAM requested that DOE allow for 180 days between the publication of the test procedure final rule and the end of the comment period for the energy conservation standards NOPR. (AHAM, No. 40 at pp. 4–6; AHAM, No. 53 at p. 12)

Samsung also commented that, given the scope of changes proposed in appendix J, more data would be needed to establish the baseline and efficiency levels, which could further delay the finalization of the next energy conservation standards. (Samsung, No. 41 at p. 3) Samsung commented that it therefore believes more time and test data are needed to fully adopt appendix J. (*Id*.)

NYSERDA encouraged DOE to quickly proceed in this rulemaking to unlock additional significant savings for New Yorkers. (NYSERDA, No. 36 at p. 3)

In response to AHAM's comments regarding the timing of the September 2021 TP NOPR and the September 2021 Preliminary Analysis, 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 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" or "Process Rule"). The Process Rule inherently recognizes a certain amount of overlap between test procedure and energy conservation standards rulemakings. In particular, the Process Rule 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 the Process Rule 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 published a test procedure final rule on June 1, 2022 ("June 2022 TP Final Rule"). 87 FR 33316. This standards NOPR is publishing more than 180 days after the publication of the June 2022 TP Final Rule, in accordance with the requirements of the Process Rule.

As acknowledged by AHAM, DOE is conducting this rulemaking in fulfillment of its statutory obligations under EPCA. DOE recognizes and appreciates the information and data provided by multiple interested parties in response to the September 2021 TP NOPR, September 2021 Preliminary Analysis, and April 2022 NODA. As discussed throughout this NOPR, DOE has incorporated data and other information received during these prior rulemaking stages into the analyses conducted for this NOPR.

In response to the September 2021 Preliminary TSD, AHAM commented that DOE did not provide sufficient data to support the September 2021 Preliminary TSD, and that DOE's analysis was not transparent. (AHAM, No. 40 at pp. 4−6) AHAM asserted that by providing summary data and conclusions without providing further detail, DOE failed to meet the requirements of the Administrative Procedure Act or the Data Quality Act. (*Id.*) AHAM further commented that the summary information that DOE provided as part of the September 2021 Preliminary TSD was somewhat helpful but did not allow stakeholders to fully assess the data and did not clearly demonstrate that DOE's proposed translation between appendix J2 and proposed appendix J was accurate. (*Id.*) AHAM requested that DOE provide its full test data by model for all models tested to appendix J2 and new appendix J, via a NODA or other appropriate regulatory tool. (*Id.*) AHAM also requested that DOE share the model numbers of the clothes washers it tested since it would help stakeholders, such as AHAM and its members, determine the representativeness of the sample. (*Id.*) Specifically, AHAM requested that all data released contain all variables including, but not limited to: total weighted per-cycle hot water energy consumption ("HE_T"), total weighted per-cycle machine electrical energy consumption ("ME_T"), total per-cycle energy consumption for removal of moisture ("DE_T"), combined per-cycle low power mode energy consumption ("E_{TLP}"), and total weighted per-cycle water consumption ("Q_T"). (*Id.*) AHAM asked that if DOE cannot provide the information AHAM requested, DOE should issue an explanation as to why it cannot produce the data. (*Id.*) AHAM added that it will consider sharing its data confidentially with DOE once its analysis is complete so that DOE can include its analysis on the docket. (*Id.*)

AHAM stated that DOE should not issue an energy conservation standards NOPR until it publishes a NODA that provides updated data from DOE and AHAM members' testing. (AHAM, No. 40 at pp. 4−6)

In response to the April 2022 NODA, AHAM commented that it had tested 26 RCW models that represent a cross-section of the market in terms of capacity and features. (AHAM, No. 53 at pp. 6−7) AHAM tested each model one to three times and averaged the results. (*Id.*) AHAM presented data comparing IMEF versus EER and IWF versus WER for the 26 units tested by AHAM and the 44 units tested by DOE in the April 2022 NODA, by product class. (*Id.*) AHAM concluded that DOE's data presented in the April 2022 NODA appears to be similar to AHAM's data in terms of test results, distribution of models, and variability. (*Id.*) AHAM commented that while it appreciates DOE including equations and other transparent information in the April 2022 NODA, DOE still has not provided model numbers for the units it tested. (*Id.*) AHAM therefore noted that it is impossible for AHAM to know whether DOE and AHAM tested some of the same models. (*Id.*)

The CA IOUs encouraged DOE to disclose clothes washer cycle time, length of spin time for extracting rinse water, and the maximum spin speed for the 62 clothes washers tested by DOE so that interested parties could better ascertain the trade-offs related to cycle time and gain a better understanding of the differences between the remaining moisture content ("RMC")[20] as calculated using appendix J2 versus appendix J. (CA IOUs, No. 43 at p. 4) The CA IOUs commented that in the September 2021 Preliminary TSD, higher spin speeds and longer spin times were both used as design options for efficiency level ("EL") 3 and EL 4, depending on the product class and that based on the publicly available information, they were unable to assess the potential impacts to the overall cycle time or to understand the potential trade-offs for higher spin speeds in lieu of longer cycle times. (*Id.*)

As discussed in section II.B.2 of this document, the April 2022 NODA presented additional test data and detailed information characterizing each tested model. This data included the key energy and water use parameters requested by AHAM (*i.e.*, HE_T, ME_T, DE_T, E_{TLP}, and Q_T) for each of the models tested. DOE also provided a number of key characteristics pertaining to each model (*e.g.*, product class, capacity, cabinet width, *etc.*) that illustrate the types of units on the market that were represented by DOE's test program. DOE appreciates the additional test data subsequently provided by AHAM. As discussed in section IV.C.5 of this document, DOE used AHAM's data in combination with DOE's data to evaluate the appendix J2 to appendix J efficiency metric translation methods under consideration.

Regarding the CA IOUs' comment requesting disclosure of the cycle time measured for each unit in DOE's test sample, although the April 2022 NODA did not

[20] The RMC represents the amount of moisture remaining in the test load at the end of the washer cycle. RMC is used to calculate the drying energy component of IMEF and EER. On most clothes washers, the drying energy component represents the largest portion of energy captured in the IMEF and EER metrics.

indicate the measured cycle time of each unit in DOE's test sample, DOE has characterized the average cycle time associated with each defined efficiency level for each product, as described in chapter 5 of the NOPR TSD.

NAS Members commented generally on DOE's analytical approach to setting efficiency standards and offered findings and recommendations for improving DOE's methodology, and ultimately, the net social benefits of the efficiency standards DOE establishes under EPCA. (NAS Members, No. 34 at pp. 1–7)

AHAM commented that National Academy of Sciences ("NAS") recently released a peer review of methods used by DOE in setting appliance and equipment standards. (AHAM, No. 40 at p. 9) AHAM recommended that DOE determine how it will address the NAS report before engaging in further rulemakings or new amended standards. (*Id*.) AHAM acknowledged that although this may not be feasible given the number of missed deadlines and the need to move forward to mitigate further missed deadlines, AHAM and its members are reviewing the NAS report and may have additional comments on how DOE should revise its methodology for future rulemakings both generally, and with regard to RCWs. (*Id*.)

In response to AHAM, DOE is addressing the contents of the NAS report[21] in a separate rulemaking, in parallel with other ongoing rulemakings including this RCW rulemaking.

B. Scope of Coverage

This NOPR covers those consumer products that meet the definition of "clothes washer." 10 CFR 430.2.

EPCA does not define the term "clothes washer." DOE has defined a "clothes washer" as a consumer product designed to clean clothes, utilizing a water solution of soap and/or detergent and mechanical agitation or other movement, that must be one of the following classes: automatic clothes washers, semi-automatic clothes washers, and other clothes washers. *Id*.

An "automatic clothes washer" is a class of clothes washer that has a control system that is capable of scheduling a preselected combination of operations, such as regulation of water temperature, regulation of the water fill level, and performance of wash, rinse, drain, and spin functions without the need for user intervention subsequent to the initiation of machine operation. Some models may require user intervention to initiate these different segments of the cycle after the machine has begun operation, but

[21] The Consensus Study Report, "Review of Methods Used by the U.S. Department of Energy in Setting Appliance and Equipment Standards," January 7, 2022. Available at *www.nap.edu/catalog/25992/review-of-methods-used-by-the-us-department-of-energy-in-setting-appliance-and-equipment-standards*.

they do not require the user to intervene to regulate the water temperature by adjusting the external water faucet valves. *Id*.

A "semi-automatic clothes washer" is a class of clothes washer that is the same as an automatic clothes washer except that user intervention is required to regulate the water temperature by adjusting the external water faucet valves. *Id*. "Other clothes washer" means a class of clothes washer that is not an automatic or semi-automatic clothes washer. *Id*.

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

Other definitions relevant to RCWs have been established by the Environmental Protection Agency ("EPA") for purposes of the ENERGY STAR program. For example, Version 8.1 of the Program Requirements Product Specification for Clothes Washers ("ENERGY STAR Version 8.1 Specification") [22] defines a "combination all-in-one washer-dryer" as a consumer product that meets the definition of an RCW and an electric clothes dryer or gas clothes dryer, which cleans and dries clothes in a single tumble-type drum; a drying cycle can be performed independently without first performing a wash cycle. During the drying cycle, combination all-in-one washer-dryers use one of two methods to dry the clothing load: either using circulated air (without the use of water) to

[22] ENERGY STAR Version 8.1 Program Requirements Product Specification for Clothes Washers. Available online at *www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Version%208.1%20Clothes%20Washer%20Final%20Specificaiton%20-%20Partner%20Commitments%20and%20Eligibility%20Criteria.pdf.*

cool and condense moisture from the dryer process air (*i.e.*, "combination all-in-one washer-dryers with air-only drying"), or consuming water to cool and condense moisture from the dryer process air (*i.e.*, "combination all-in-one washer-dryers with water-cooled drying"). In the ENERGY STAR Version 8.1 Specification, combination all-in-one washer-dryers with air-only drying are eligible for ENERGY STAR certification, whereas combination all-in-one washer-dryers with water-cooled drying are ineligible for ENERGY STAR certification.

The CA IOUs encouraged DOE to investigate water-cooled combination all-in-one washer-dryers and to take steps to address water usage concerns raised by the ENERGY STAR Version 8.1 Specification published in April 2021. (CA IOUs, No. 43 at pp. 6–7) The CA IOUs noted that combination all-in-one washer-dryers with water-cooled drying are not currently subject to any water use standards or water-usage testing requirements despite the recent changes finalized by the clothes dryer test procedure final rule published on October 8, 2021. (*See* 86 FR 56608; *Id.*) The CA IOUs expressed concern that there is unmeasured and unregulated water use in products that seemingly include a water standard for the washing mode of the same product. (*Id.*) The CA IOUs encouraged DOE to find ways to disclose this information, including requiring public disclosure of any product configurations that use water during the drying cycle as part of the certification requirements and relevant product labeling; making changes to the consumer clothes dryer test procedure to measure water use for combination clothes washer products; and developing a separate test procedure and standard for combination all-in-one washer-dryers and laundry centers that include both the washing and drying functions. (*Id.*)

Evaluating or developing test procedures is outside the scope of this energy conservation standards rulemaking. DOE is not proposing any certification or labeling requirements in this NOPR. Instead, DOE may consider proposals to establish certification requirements and reporting for RCWs under a separate rulemaking regarding appliance and equipment certification.

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 RCWs are expressed in terms of IMEF and IWF as measured using appendix J2. (See 10 CFR 430.32(g)(4).)

1. History of Appendix J

As discussed, the September 2021 TP NOPR proposed a new test procedure at appendix J, which proposed to define new energy efficiency metrics: an energy efficiency ratio (*i.e.*, EER) and a water efficiency ratio (*i.e.*, WER). 86 FR 49140, 49172. EER is defined as the weighted-average load size in pounds ("lbs") divided by the sum of (1) the per-cycle machine energy, (2) the per-cycle water heating energy, (3) the per-cycle drying energy, and (4) the per-cycle standby and off mode energy consumption, in kilowatt-hours ("kWh"). *Id*. WER is defined as the weighted-average load size in lbs divided by the total weighted per-cycle water consumption for all wash cycles in gallons. *Id*. For both EER and WER, a higher value indicates more efficient performance. *Id*.

The September 2021 Preliminary Analysis was performed using the appendix J test procedure as it was proposed in the September 2021 TP NOPR.

As discussed, DOE finalized the new appendix J test procedure in the June 2022 TP Final Rule. 87 FR 33316. DOE used appendix J as finalized in the June 2022 TP Final Rule as the basis for the analysis in this NOPR.

AHAM commented that DOE did not finalize appendix J as proposed in the September 2021 TP NOPR and that the test procedure changes described in the June 2022 TP Final Rule could impact measured energy and water efficiency. (AHAM, No. 53 at p. 12) AHAM asserted that it may be premature to use the April 2022 NODA data or AHAM's additional data to inform the translation from appendix J2 metric to appendix J metrics because appendix J is not identical to the test procedure proposed in the September 2021 TP NOPR. (*Id*. at p. 3)

AHAM commented that it is still reviewing finalized appendix J and noted that even if DOE's and AHAM's samples together represent a significant portion of shipments, it may be necessary to reconsider the September 2021 Preliminary Analysis based on finalized appendix J. (*Id*.)

The appendix J test procedure finalized by the June 2022 TP Final Rule included only one change that affects measured energy consumption. Specifically, the June 2022 TP Final Rule updated the assumed final moisture content ("FMC") assumption in the drying energy formula from 4 percent as proposed in the September 2021 NOPR to 2 percent in finalized appendix J. *Id*. at 87 FR 33354. DOE specifically discussed in the September 2021 NOPR that it would consider updating the FMC from 4 percent to 2 percent. 86 FR 49140, 49176. The updated FMC value affects only the drying energy calculation and can be implemented formulaically on any test data that was acquired using the version of appendix J as proposed in the September 2021 TP NOPR. In the April 2022 NODA, DOE published two sets of translation equations corresponding to an FMC of 4 percent and 2 percent, respectively, providing interested parties with the opportunity to evaluate the data under both approaches. 87 FR 21816, 21817.

2. Metrics

As discussed, under appendix J2, energy efficiency is measured using the IMEF metric, measured in ft^3/kWh/cycle, and water efficiency is measured using the IWF metric, measured in gal/cycle/ft^3. Under appendix J, energy efficiency is measured using the EER metric, measured in lb/kWh/cycle, and water efficiency is measured using the WER metric, measured in lb/gal/cycle.

Samsung commented in support of the efficiency metric changes shifting from capacity-based to load size-based, stating that it would be better understood by consumers. (Samsung, No. 41 at p. 3) Samsung recommended, however, that this be the only change that DOE implements to calculate the new energy and water efficiency metrics EER and WER. (*Id*.) Samsung added that shifting the metrics to EER and WER in this way will only result in a change in the numeric quantity of measured efficiency, given that the capacity and weighted-average load size relationship is linear. (*Id*.) Samsung commented that changing only the metric calculation would ease burden for manufacturers while making it easier for consumers to understand their clothes washer's efficiency. (*Id*.)

EPCA requires that any test procedures prescribed or amended by DOE shall be reasonably designed to produce test results which measure energy efficiency, energy use or estimated annual operating cost of a covered product or equipment during a representative average use cycle or period of use, and shall not be unduly burdensome to conduct. (42 U.S.C. 6293(b)(3)) As presented in the June 2022 TP Final Rule, in general the changes in appendix J in comparison to appendix J2 improve the representativeness of test results and reduce test burden, among other benefits. 87 FR 33316, 33320–33321. In this NOPR, DOE is proposing standards based on the new metrics defined in appendix J as finalized. To aid interested parties in understanding the translation between the current metrics and the new metrics, the engineering analysis is presented using both the current metrics (*i.e.*, IMEF and IWF) and the new metrics (*i.e.*, EER and WER), as discussed in section IV.C of this document.

ASAP *et al*. commented in support of DOE's change to make the efficiency metrics based on load size instead of capacity, which they asserted will help mitigate the current bias toward large-capacity clothes washers. (ASAP *et al*., No. 37 at p. 2) ASAP *et al*. expressed concern, however, that for top-loading standard-size clothes washers, large-capacity clothes washers still achieve higher efficiency ratings. (*Id*.) ASAP *et al*. stated that while the correlation between large capacity and high efficiency is less pronounced for EER than for IMEF, it persists based on the data presented in the September 2021 Preliminary TSD. (*Id*.) ASAP *et al*. therefore encouraged DOE to investigate whether this correlation results from larger clothes washers being inherently more efficient, larger clothes washers employing additional technology options that improve efficiency, or some remaining inherent bias toward larger capacity clothes washers. (*Id*.)

The CA IOUs commented that while they agree that the appendix J test procedure offers improvements to the test procedure to reduce some inherent biases between efficiency metrics and capacity, tub capacity can still contribute to improved efficiency because a larger amount of clothing can be washed using an incremental increase in the quantity of water, and a larger drum diameter can exert a higher g-force on clothing, thereby removing more water during the final spin and reducing the drying energy. (CA IOUs, No. 43 at pp. 2−3)

Whirlpool commented that based on its initial testing, it does not agree with DOE's conclusion that there is no benefit to larger capacities using the EER metric. Whirlpool commented that since capacity is still factored into the load sizes used for testing, and those load sizes remain a part of the EER calculation, capacity will still affect efficiency ratings. (Whirlpool, No. 39 at p. 19)

In the June 2022 TP Final Rule, DOE noted that under the current metrics in appendix J2, energy use (*i.e.*, the denominator of the IMEF equation) scales with weighted-average load size, whereas capacity (*i.e.*, the numerator of the IMEF equation) scales with maximum load size. 87 FR 33316, 33349. This provides an inherent numerical advantage to large-capacity clothes washers that is disproportionate to the efficiency advantage that can be achieved through “economies of scale” associated with washing larger loads. *Id*. This advantage means that a larger-capacity clothes washer consumes more energy to wash a pound of clothes than a smaller-capacity clothes washer with the same IMEF rating. *Id*. This relationship applies similarly to water efficiency through the IWF equation. *Id*. This disproportionate benefit increases as average clothes washer capacity increases over time. *Id*. To avoid providing bias for large-capacity clothes washers, DOE changed the energy and water efficiency metrics in new appendix J by replacing the capacity term with the weighted-average load size. *Id*. Under appendix J, energy and water use scale proportionally with weighted-average load size, thus eliminating the efficiency “bias” currently provided to large-capacity clothes washers. *Id*.

To the extent that larger clothes washers continue to achieve higher ratings than smaller clothes washers under the new metrics, such higher performance reflects inherent design option advantages applicable to larger-capacity clothes washers. For example, as noted by the CA IOUs, large-capacity clothes washers typically have wider drum diameters, which can exert higher g-forces on the load during the spin cycle for a given spin speed, effectively yielding a lower RMC measurement (*i.e.*, reduced drying energy) compared to an otherwise identical smaller clothes washer with a narrower drum diameter. Having removed the numerical “bias” inherent within the current IMEF and IWF metrics, any remaining performance advantage provided to larger-capacity clothes washers under the new metrics is an accurate and representative reflection of differences in efficiency between smaller- and larger-capacity clothes washers on a per-pound of clothing basis.

AHAM commented that it appreciates that the appendix J test procedure results in a reduction of test burden and that DOE could even further reduce test burden by eliminating the requirement to measure and calculate standby energy. (AHAM, No. 53 at p. 13) AHAM further commented that in most cases, the standby energy is so low that it is not offset by a benefit to the environment or consumers under EPCA. (*Id*.) AHAM added that because standby energy use is so low, it is unlikely that manufacturers will reduce it further in order to meet future energy conservation standards; and because manufactures are not likely to increase standby energy use since they have already invested in reducing it, standby energy use will not be a differentiator between products. (*Id*.) AHAM therefore recommended eliminating the standby measurement requirement because it will not have a material effect on overall energy savings or individual energy testing results. (*Id*.)

As discussed, EPCA requires that any test procedure for RCWs prescribed in a final rule after June 30, 2009 must include standby mode and off mode energy consumption, taking into consideration the most current versions of Standards 62301 and 62087 of the International Electrotechnical Commission, with such energy consumption integrated into the overall energy efficiency, energy consumption, or other energy descriptor for each covered product, unless the Secretary determines that either the current test procedures already fully account for and incorporate the standby mode and off mode energy consumption of the covered product; or such an integrated test procedure is technically infeasible for a particular covered product, in which case EPCA requires the Secretary to prescribe a separate standby mode and off mode energy use test procedure for the covered product, if technically feasible. (42 U.S.C. 6295(gg)(2)(A)–(B))

3. Test Cloth

Both appendix J2 and appendix J require the use of specialized test cloth that conforms to the specifications outlined in 10 CFR part 430, subpart B, appendix J3 (“appendix J3”). As discussed in the June 2022 TP Final Rule, the specifications for the energy test cloth were developed to be representative of the range of fabrics comprising consumer wash loads: a 50-percent cotton/50-percent polyester blended material was specified to approximate the typical mix of cotton, cotton/polyester blend, and synthetic articles that are machine-washed by consumers. 87 FR 33316, 33366. In developing the test cloth specifications, DOE also considered:

- Manufacturability: A 50/50 cotton-polyester momie weave was specified because at the time, such cloth was produced in high volume, had been produced to a consistent specification for many years, and was expected to be produced on this basis for the foreseeable future. 66 FR 3314, 3331.

- Consistency in test cloth production: The cloth material properties were specified in detail, including fiber content, thread count, and fabric weight; as well as requirements to verify that water repellent finishes are not applied to the cloth. *Id*.

- Consistency of the RMC measurement among different lots: A procedure was developed to generate correction factors for each new "lot" (*i.e.*, batch) of test cloth to normalize test results and ensure consistent RMC measurements regardless of which lot is used for testing. *Id*.

Test cloth is manufactured in batches called "lots," which are quantities of test cloth that have been manufactured with the same batches of cotton and polyester during one continuous process. Due to differences between batches of cotton and polyester used to manufacture the test cloth, each lot has slightly different absorption properties. To account for these differences in absorption during the RMC measurement, appendix J3 specifies a procedure to determine correction factors for each lot that correlate the measured RMC values of the new test cloth lot with a set of standard RMC values established as the historical reference point. These correction factors are applied to the RMC test results in appendix J and appendix J2 to ensure the repeatability and reproducibility of test results performed using different lots of test cloth. In particular, the measured RMC of each clothes washer is used to calculate the drying energy, which has a significant impact on the final IMEF or EER value. Application of these correction factors significantly reduces lot-to-lot variation in RMC, from over 10 percentage points uncorrected to around 3 percentage points corrected. 87 FR 33316, 33369.

AHAM commented that it recently notified DOE of an issue concerning Lot 24 of the test cloth used in clothes washer testing, stating that AHAM's initial investigations have revealed serious issues with variation in Lot 24 that are impacting certification, verification, and regulatory testing efforts. (AHAM, No. 53 at pp. 4–5) AHAM specified that the correction factor for Lot 24 is not accurate across the entire lot. (*Id.*) AHAM further explained that this has resulted in an increased difficulty in meeting the applicable standard because the inaccurate correction factor is negatively impacting efficiency. (*Id.*) AHAM also specified that it is more difficult to certify products correctly or with certainty because the variation in results and enforcement are major concerns. (*Id.*) AHAM also expressed concern that testing related to appendix J may be questionable given the Lot 24 correction factor variation since both DOE and AHAM used Lot 24 for over half the units in their test samples. (*Id.*) AHAM therefore concluded that the results of DOE's and AHAM's testing should not be used to reestablish a baseline, as they likely do not accurately represent measured energy or water efficiency. (*Id.*) AHAM further commented that it convened its test cloth task force to address the correction factor variation issue with the goal of providing recommendations for DOE, and has sought guidance and an enforcement policy from DOE to address the Lot 24 issues in the short-term. (*Id.*) AHAM noted that since the test cloth Lot 24 variation will likely impact the accuracy of DOE and AHAM's testing, AHAM will conduct further review of its data and may need to submit revised data and/or comments once the impact of this variation on the test data is better understood. (*Id.*) AHAM recommended that DOE work to understand the impact of this variation on the accuracy of its test data and standards analysis. (*Id.*) For example, AHAM noted that if it has been more difficult to meet current standards due to the uncertainty in Lot 24's correction factor, DOE will need to understand whether current products have been tuned to be more efficient just because of the test cloth. (*Id.*) AHAM added that this could impact DOE's analysis of more stringent standards, as some technology options may already be in use due to the correction factor issue. (*Id*.) AHAM also recommended that DOE conduct its own analysis of AHAM's data, as well as the combined AHAM and DOE dataset, which should include an evaluation of the Lot 24 variation. (AHAM, No. 53 at p. 12)

AHAM also commented that for some time, several manufacturers and, likely other testing laboratories, have experienced delays in obtaining test cloth. (AHAM, No. 53 at p. 5) AHAM further explained that delays in obtaining test cloth mean that some companies need to ration testing and may not be able to do testing other than certification and/or audit testing until test cloth is received. (*Id*.) AHAM added that it will therefore take more time for AHAM and its members to provide test results to support DOE's rulemaking efforts related to clothes washers and clothes dryers. (*Id*.) AHAM requested that DOE ensure it does not move so quickly that its analysis (and manufacturers' comments) are unable to account for these test cloth challenges. (*Id*.)

DOE is acutely aware of the issues regarding variation in Lot 24 and is participating in the AHAM test cloth task force to help determine the root causes of the observed variation and to develop solutions to mitigate these concerns for Lot 24 as well as for future test cloth lots. Subsequent to the submission of AHAM's comment, the AHAM test cloth task force determined to divide Lot 24 into four distinct "sub-lots," each with its own correction factors developed using the process specified by appendix J3. DOE has added these sub-lot correction factors to the RCW test report template published on the DOE website.[23] Establishing these separate sub-lots, each with separate correction factors, has mitigated much of the concern regarding variability throughout Lot 24. DOE is aware that the task force continues to investigate the extent to which any variability that remains within each sub-lot can be further mitigated, and DOE continues to participate in those efforts.

With regard to delays in obtaining test cloth, DOE is aware that the causes of delay have largely been addressed and that the test cloth supplier is currently working to fulfill the backlog of test cloth orders.

4. Other Test Procedure-Related Comments

In response to the September 2021 Preliminary Analysis and the April 2022 NODA, a number of stakeholders made comments pertaining to the clothes washer test procedure, many of which DOE subsequently addressed in the June 2022 TP Final Rule. Comments regarding certain test procedure issues that were not discussed in the June 2022 TP Final Rule are summarized in the paragraphs that follow. Addressing test procedure concerns is outside the scope of this energy conservation standards rulemaking; however, DOE encourages stakeholders to resubmit these comments during the next clothes washer test procedure rulemaking.

AHAM commented in opposition to DOE's decision to change the FMC assumption from 4 percent in appendix J2 to 2 percent in appendix J. (AHAM, No. 53 at

[23] DOE's test report templates are available at *energy.gov/eere/buildings/standardized-templates-reporting-test-results*.

p. 12) AHAM stated that the change in FMC assumption from 4 to 2 percent will overstate the impact of drying energy and will likely drive many clothes washer designs to increase spin speeds and spin times beyond an acceptable level. (*Id.*) AHAM expressed concern that this could change a clothes washer's core functionality into a water extractor, and in effect, remove the consumer functionality of washing the clothes. (*Id.*) AHAM commented that the test procedure should not drive design changes of this magnitude, and added that this change will limit the opportunity in the energy conservation standards rulemaking for technologically feasible and cost efficient improvements because there are limits on how much spin speeds can increase before the chassis needs to be redesigned or before safety and consumer utility are impacted. (*Id.*)

AHAM commented that if DOE moves forward with changing FMC from 4 to 2 percent, it must address the impact of the apparent mismatch between clothes washer drying energy and total per-cycle electric dryer energy consumption defined in the clothes dryer test procedures at 10 CFR part 430, subpart B, appendix D2 ("appendix D2") or 10 CFR part 430, subpart B, appendix D1 ("appendix D1"). (AHAM, No. 53 at p. 13) AHAM further explained that currently, the drying impact of a clothes washer is significantly over-credited as a result of the mismatch in clothes loads between the clothes washer and clothes dryer test procedures. (*Id.*) For example, AHAM noted that the average weight of the load in appendix J can be nearly 50 percent greater than the weight of a load in the clothes dryer test procedure. (*Id.*) AHAM stated that according to the clothes washer test procedure, the annual weight to dry for a 6 ft^3 clothes washer is 2,917 pounds per year, whereas the annual weight to dry according to the clothes dryer test procedure is 1,994 pounds per year, despite the units being a matching pair. (*Id.*)

AHAM commented that it acknowledges that this difference makes sense because consumers do not dry in the clothes dryer all the clothes they wash in the clothes washer. (*Id.*) However, AHAM emphasized that lowering the FMC to 2 percent for clothes washer exacerbates this mismatch in energy contribution. (*Id.*)

ASAP *et al.* commented that both DOE's recent analysis for clothes dryers and real-world data suggest that drying energy usage in the clothes washers analysis is being underestimated and encouraged DOE to update its drying energy use calculations in the test procedure to better align with DOE's clothes dryers analysis and real-world energy usage. (ASAP *et al.*, No. 37 at pp. 3−4) ASAP *et al.* noted that in the September 2021 Preliminary TSD, DOE stated that drying energy use represents 75 to 83 percent of total energy usage. (*Id.*) ASAP *et al.* therefore commented that changes in drying energy estimates can have a significant impact on overall energy savings and economic analysis. (*Id.*) ASAP *et al.* emphasized that, based on DOE's April 2021 Clothes Dryers Preliminary TSD,[24] the active-mode energy use of a clothes dryer is between 67 and 93 percent greater than the estimated drying energy usage presented in the September 2021 Preliminary TSD for top-loading standard-size and front-loading clothes washers, respectively.[25] (*Id.*) ASAP *et al.* further commented that the clothes dryer analysis more closely agrees with real-world clothes dryer energy use estimates from data from the Energy Information Administration's ("EIA's") 2015 Residential Energy Consumption

[24] Available online at *www.regulations.gov/document/EERE-2014-BT-STD-0058-0016*.
[25] ASAP *et al.* based this estimate on energy use of 700 kWh/year for clothes dryers, 419 kWh/year for top-loading clothes washers and 362 kWh/year for front-loading clothes washers.

Survey ("RECS 2015"),[26] which estimates 776 kWh per year, and NEEA's Dryer Field Study published in 2014 ("NEEA's Dryer Field Study"),[27] which estimates 915 kWh per year. (*Id.*) ASAP *et al.* therefore commented that higher, more realistic drying energy usage estimates should further improve the cost-effectiveness of higher efficiency clothes washers that reduce drying energy use. (*Id.*)

Ameren *et al.* encouraged DOE to mathematically adjust RMC to account for the drying energy of 100 percent cotton textiles using the relationship established in the 2020 NEEA report[28] that analyzed the RMC of two types of test loads across a broad range of RCW efficiency levels and technology types: the 100-percent cotton load specified in AHAM's HLW-1-2013 test procedure and the 50/50 cotton-polyester momie weave test cloth specified in appendix J2 and appendix J. (Ameren *et al.*, No. 42 at pp. 12−13) The NEEA report also developed a linear mathematical relationship between the two types of load. (*Id.*) Ameren *et al.* found that this relationship has an R-squared value close to 1 and determined that it could be used to adjust the measured RMC of an appendix J2 test load to the expected RMC when using an AHAM load. (*Id.*) Ameren *et al.* stated that adjusting the RMC of an appendix J2 test load to an RMC typical of 100 percent cotton textiles would more realistically account for RCW impacts on drying energy use. (*Id.*) Ameren *et al.* further commented that most typical laundry loads have a much higher

[26] U.S. Department of Energy - Energy Information Administration, Residential Energy Consumption Survey: 2015 Public Use Data Files, 2015. Available at *www.eia.doe.gov/emeu/recs/recspubuse15/pubuse15.html*.
[27] Dryer Field Study, 2014. Northwest Energy Efficiency Alliance. Available online at *neea.org/resources/rbsa-laundry-study*.
[28] Foster Porter, Suzanne; Denkenberger, Dave. 2020. *Coming Clean: Revealing Real-World Efficiency of Clothes Washers*. Portland, OR. Northwest Energy Efficiency Alliance. Available online at: *neea.org/resources/coming-cleanrevealing-real-world-efficiency-of-clothes-washers*.

cotton content, which they asserted means that mathematically adjusting the RMC before calculating drying energy would better account for typical energy use. (*Id.*) Ameren *et al.* also commented that adjusting the RMC of appendix J2 textiles to an RMC typical of 100 percent cotton textiles would increase the alignment between the September 2021 Preliminary TSD's clothes washer drying energy use calculation and the measured appendix D2 clothes dryer energy use. (*Id.*) Ameren *et al.* added that while other constants such as DEF[29] in appendix J2 and appendix J are relatively consistent with most appendix D1 and D2 dryer measurements, the typical drying energy calculated in the existing appendix J2 clothes washer test procedure is much lower than the energy consumed by a conventional clothes dryer tested by appendix D1 or D2. (*Id.*) Ameren *et al.* further explained that the clothes dryer test procedures use an initial moisture content of 57.5 percent for the clothes dryer test load, and using NEEA's mathematical adjustment to increase RMC before calculating drying energy would make the drying energy calculated in appendix J2 and J more similar to the drying energy calculated in appendix D1 and D2. (*Id.*)

ASAP *et al.* commented that one potential partial explanation for the apparent underestimation of drying energy usage in the clothes washer analysis is the estimate for DEF. (ASAP *et al.*, No. 37 at p. 4) ASAP *et al.* noted that while DOE assumes a DEF of 0.5 kWh per pound of moisture removed from clothes, ASAP *et al.* estimated a higher nominal DEF of about 0.6 kWh per pound of moisture removed using weighted-average clothes dryer efficiency ratings and parameters from the clothes dryers test procedure.

[29] "DEF" is defined in section 4.3 of appendix J2 and section 4.4 of appendix J as the nominal energy required for a clothes dryer to remove moisture from clothes and is set equal to 0.5 kWh/lb.

(*Id.*) ASAP *et al.* also commented that a 2022 NEEA study[30] suggests that even the clothes dryer test procedure can underestimate drying energy usage, particularly when a non-ENERGY STAR-rated top-loading clothes washer is paired with a non-ENERGY STAR electric dryer. (*Id.*) ASAP *et al.* further noted that the Northwest Regional Technical Forum's most recent estimate for DEF is 0.65 kWh per pounds of moisture removed.[31] (*Id.*)

As discussed, DOE is not addressing test procedure changes in this energy conservation standards rulemaking. DOE notes that FMC and the drying energy calculations were specifically addressed in section III.G.2 of the June 2022 TP Final Rule. 87 FR 33316, 33353–33354.

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 equipment that are the subject of the rulemaking. As the first step in such an analysis, DOE develops a list of technology options for consideration in consultation with manufacturers, design engineers, and other interested parties. DOE then determines which of those means for improving efficiency are technologically feasible. DOE considers technologies

[30] *Perfect Pairings? Testing the Energy Efficiency of Matched Washer-Dryer Sets*, 2022. Northwest Energy Efficiency Alliance. Available online at *neea.org/resources/perfect-pairings-testing-the-energy-efficiency-of-matched-washer-dryer-sets*.
[31] Regional Technical Forum, Residential Clothes Washers, 2021. "Residential Clothes Washers v7.1." Available online at *rtf.nwcouncil.org/measure/clothes-washers-0*.

incorporated in commercially-available products or in working prototypes to be technologically feasible. Sections 6(b)(3)(i) and 7(b)(1) of the Process Rule.

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 the Process Rule. Section IV.B of this document discusses the results of the screening analysis for RCWs, 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 RCWs, 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 proposed rule and in chapter 5 of the NOPR TSD.

E. Energy Savings

1. Determination of Savings

For each trial standard level (*i.e.*, TSL), DOE projected energy savings from application of the TSL to RCWs purchased in the 30-year period that begins in the year of compliance with the proposed standards (2027–2056).[32] The savings are measured over the entire lifetime of RCWs purchased in the previous 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 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 RCWs. The NIA spreadsheet model (described in section IV.H of this document) calculates energy savings in terms of site energy, which is the energy directly consumed by products at the locations where they are used. For electricity, DOE reports national energy savings in terms of primary energy savings, which is the savings in the energy that is used to generate and transmit the site electricity. For natural gas, the primary energy savings are considered to be equal to the site energy savings. DOE also calculates NES in terms of FFC energy savings. The FFC metric

[32] 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.

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.[33] DOE's approach is based on the calculation of an FFC multiplier for each of the energy types used by covered products or equipment. For more information on FFC energy savings, see section IV.H.2 of this document.

2. Significance of Savings

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

The significance of energy savings offered by a new or amended energy conservation standard cannot be determined without knowledge of the specific circumstances surrounding a given rulemaking.[34] 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,

[33] 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).
[34] The numeric threshold for determining the significance of energy savings established in a final rule published on February 14, 2020 (85 FR 8626, 8670), was subsequently eliminated in a final rule published on December 13, 2021 (86 FR 70892).

among other factors. As discussed in section V.C.1 of this document, DOE is proposing to adopt TSL 4, which would save an estimated 1.45 quads of energy (FFC) over 30 years. 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 proposed rulemaking.

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 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.E of this document, DOE uses the NIA spreadsheet models to project national energy savings.

d. Lessening of Utility or Performance of Products

In establishing product classes and in evaluating design options and the impact of potential standard levels, DOE evaluates potential standards that would not lessen the utility or performance of the considered products. (42 U.S.C. 6295(o)(2)(B)(i)(IV)) Based on data available to DOE, the standards proposed in this document would not reduce the utility or performance of the products under consideration in this proposed 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 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 greenhouse gases associated with energy production and use. DOE conducts an emissions analysis to estimate how potential standards may affect these emissions, as discussed in section IV.K of this document; the estimated emissions impacts are reported in section V.B.6 of this document. DOE also estimates the economic value of climate and health benefits from certain emissions reductions resulting from the considered TSLs, as discussed in section IV.L of this document.

g. Other Factors

In determining whether an energy conservation standard is economically justified, DOE may consider any other factors that the Secretary deems to be relevant. (42 U.S.C.

6295(o)(2)(B)(i)(VII)) To the extent DOE identifies any relevant information regarding economic justification that does not fit into the other categories described previously, DOE could consider such information under "other factors."

2. Rebuttable Presumption

As set forth in 42 U.S.C. 6295(o)(2)(B)(iii), EPCA creates a rebuttable presumption that an energy conservation standard is economically justified if the additional cost to the consumer of a product that meets the standard is less than three times the value of the first year's energy savings resulting from the standard, as calculated under the applicable DOE test procedure. DOE's LCC and PBP analyses generate values used to calculate the effects that proposed energy conservation standards would have on the payback period for consumers. These analyses include, but are not limited to, the 3-year payback period contemplated under the rebuttable-presumption test. In addition, DOE routinely conducts an economic analysis that considers the full range of impacts to consumers, manufacturers, the Nation, and the environment, as required under 42 U.S.C. 6295(o)(2)(B)(i). The results of this analysis serve as the basis for DOE's evaluation of the economic justification for a potential standard level (thereby supporting or rebutting the results of any preliminary determination of economic justification). The rebuttable presumption payback calculation is discussed in section IV.F.9 of this proposed rule.

IV. Methodology and Discussion of Related Comments

This section addresses the analyses DOE has performed for this rulemaking with regard to RCWs. 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 and calculates national energy savings and net present value of total consumer costs and savings expected to result from potential energy conservation standards. DOE uses the third spreadsheet tool, the Government Regulatory Impact Model ("GRIM"), to assess manufacturer impacts of potential standards. These three spreadsheet tools are available on the DOE website for this rulemaking: *www.regulations.gov/docket/EERE-2017-BT-STD-0014*. Additionally, DOE used output from the latest version of the 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 RCWs. 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 factors such 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 four RCW product classes (10 CFR 430.32(g)(4)):

- Top-loading, compact (less than 1.6 ft^3 capacity)
- Top-loading, standard-size (1.6 ft^3 or greater capacity)
- Front-loading, compact (less than 1.6 ft^3 capacity)

- Front-loading, standard-size (1.6 ft^3 or greater capacity)

In the September 2021 Preliminary Analysis, DOE analyzed four potential product classes for RCWs using a threshold of 3.0 ft^3 to differentiate between compact and standard-size front-loading RCWs, in contrast to the existing threshold of 1.6 ft^3, resulting in the following product classes being analyzed:

- Top-loading, compact (less than 1.6 ft^3 capacity)
- Top-loading, standard-size (1.6 ft^3 capacity or greater)
- Front-loading, compact (less than 3.0 ft^3 capacity)
- Front-loading, standard-size (3.0 ft^3 capacity or greater)

As noted in chapter 2 of the September 2021 Preliminary TSD, there are no front-loading RCWs with a capacity less than 1.6 ft^3 certified to DOE, indicating that the current threshold of 1.6 ft^3 may no longer be a relevant differentiator of capacity within the front-loading RCW market. Based on front-loading RCW models certified in DOE's Compliance Certification Database ("CCD")[35], DOE identified a gap in front-loading capacity between 2.8 ft^3 and 3.4 ft^3 (*i.e.*, no products are available on the market within this range). The capacity gap is directly related to cabinet size—capacities less than 2.8 ft^3 correspond to a 24-inch cabinet width, and capacities larger than 3.4 ft^3 correspond to a 27-inch cabinet width. In the September 2021 Preliminary Analysis, DOE evaluated an

[35] DOE's Compliance Certification Database is available at *www.regulations.doe.gov/certification-data*.

updated capacity threshold of 3.0 ft^3 between compact-size and standard-size to align more closely with product differentiation in the market.

In the September 2021 Preliminary Analysis, DOE requested comment on whether it should revise the definitions of the front-loading product classes by increasing the capacity threshold of the front-loading compact product class to 3.0 ft^3. DOE also requested comment on whether any other changes to product class definitions are warranted.

Prior to the May 2012 Final Rule, DOE also defined a separate RCW product class for top-loading semi-automatic clothes washers. Semi-automatic clothes washers are designed to be intermittently attached to a kitchen or bathroom faucet and require user intervention to regulate the water temperature by adjusting the external water faucet valves. Top-loading semi-automatic clothes washers were subject to a design standard requiring an unheated rinse water option, as established by the National Appliance Energy Conservation Act of 1987, Public Law 100-12 ("NAECA"). NAECA amended EPCA to require that all rinse cycles of RCWs shall include an unheated water option, but may have a heated water rinse option, for products manufactured on or after January 1, 1988.

In the May 2012 Final Rule, DOE eliminated the top-loading semi-automatic product class distinction, having determined based on its market research and comments submitted by AHAM and three manufacturers that such products were no longer available on the market. 77 FR 32308, 32317. The top-loading standard-size levels that were established in the May 2012 Final Rule were based on consideration of only top-loading automatic clothes washers.

In chapter 2 of the September 2021 Preliminary TSD, DOE discussed that it is now aware of multiple top-loading semi-automatic clothes washers on the market, from multiple manufacturers. DOE stated that it was considering whether it should reinstate an RCW product class definition for top-loading semi-automatic clothes washers, and whether it should consider a performance-based standard rather than the design standard established by EPCA as amended. DOE noted, however, that because the user of a semi-automatic clothes washer controls the water temperature by adjusting the external water faucet valves, semi-automatic clothes washers inherently provide the option for an unheated rinse. Therefore, DOE believes that a design standard that requires an unheated rinse option may be superfluous for semi-automatic clothes washers.

In the September 2021 Preliminary Analysis, DOE requested comment on whether it should reinstate a product class definition for top-loading semi-automatic clothes washers. DOE requested comment on its preliminary conclusion that that a design standard that requires an unheated rinse option may be superfluous for semi-automatic clothes washers.

AHAM presented data indicating the shipment weighted average capacity for clothes washers from 1981–2020. (AHAM, No. 40 at pp. 13−14) Based on this data, AHAM commented that a reassessment of the "compact" definition would be justified since clothes washer capacities in general have increased from an average of 2.63 ft^3 in 1990 to 4.25 ft^3 in 2020. (*Id.*)

AHAM recommended that DOE change the definition of the compact product class in order to retain consumer utility of smaller-capacity and smaller-width products for consumers. (AHAM, No. 40 at pp. 13−15) AHAM recommended that DOE add an upper width limit of 24 inches in the proposed compact product class definition, such that a top-loading or front-loading compact product would either have a capacity less than 1.6 ft^3, or a width less than or equal to 24 inches. (*Id.*) AHAM also commented that typically, based on a review of retailer websites, products advertised as “compact” or “portable” today appear to be under 1.6 ft^3 or 24 inches in width or less. (*Id.*) AHAM commented that it agrees with DOE’s assessment that products with smaller widths and capacities provide a utility to consumers since they can be used in smaller spaces, can be moved more easily from place-to-place, or can be used together with a standard-size clothes washer. (*Id.*) AHAM also agrees with DOE’s acknowledgement that these products, due to their smaller size, cannot achieve the same levels of efficiency as larger products due to technological limitations such as drum diameter and capacity, or due to being geared toward niche consumer usage such as portability or an add-on to a standard-size clothes washer. (*Id.*)

Whirlpool commented that it agrees with DOE’s proposal to change the threshold for the front-loading compact product class and suggested that DOE make further product class changes. (Whirlpool, No. 39 at p. 19) Whirlpool specifically suggested that DOE change the definition of compact clothes washers to be based on product width, corresponding to how they are marketed to consumers as compact or standard size. (*Id*.) Whirlpool added that clothes washers with 24-inch widths and smaller are overwhelmingly marketed as “compact,” regardless of their capacity. (*Id*.)

Whirlpool also recommended that for standard-size clothes washers, DOE separate the standard-size product class into three product classes: standard, small ($\leq$ 4.0 ft^3); standard, medium ($>$ 4.0 ft^3 to $\leq$ 5.0 ft^3); and standard, large ($>$ 5.0 ft^3 and above). (Whirlpool, No. 39 at p. 19) Whirlpool commented that there are numerous performance, technology, efficiency, and consumer-relevant differences between clothes washers in Whirlpool’s suggested product classes. (*Id*.) Whirlpool further explained that entry-level price point clothes washers generally have capacities less than or equal to 4 ft^3 and that the smaller diameter wash baskets of these units create challenges in driving water extraction. (*Id*.) Whirlpool added that these clothes washers also have shorter cycle times and more basic feature sets and controls. (*Id*.)

Whirlpool added that even with a removal of the capacity benefit in the EER and WER efficiency metrics, there are still other technological challenges for clothes washers with smaller cabinet widths since spatial limitations prevent adding technologies that increase efficiency, including larger motors and larger wash baskets to increase spin speed. (Whirlpool, No. 39 at p. 19)

The CA IOUs commented that adjustments to increase the size of the front-loading compact product class are not warranted, and added that they are instead supportive of an equation-based metric that can account for the efficiency differences related to capacity. (CA IOUs, No. 43 at pp. 3–4) The CA IOUs added that they believe the definition of standard-size versus compact product classes artificially segments the data, and that performance is correlated with capacity without a clear delineation. (*Id.*) The CA IOUs expressed three primary concerns related to the changes to the product class definitions. (*Id.*) First, the CA IOUs commented that the proposed changes to capacity definitions would create a different definition of "compact" for top- and front-loading RCWs, which the CA IOUs asserted would add confusion to the market. (*Id.*) Second, the CA IOUs commented that there likely remains an inherent relationship between capacity and performance in the test procedure, which is insufficiently represented by the two large discrete product class groupings of compact size and standard size. (*Id.*) The CA IOUs noted that there was significant interest from stakeholders in response to the August 2019 RFI for DOE to consider narrower capacity ranges to facilitate a separate analysis for larger clothes washers. (*Id.*) The CA IOUs commented that, while they believe this may result in some statistical improvement in the original analysis, they would prefer an equation-based standard that can correct for the continuum of product capacities. (*Id.*) The CA IOUs also specified that creating more narrow capacity ranges may have unintended consequences of incentivizing manufacturers to produce products in one capacity size over another due to less stringent efficiency standards in neighboring classes. (*Id.*) Third, the CA IOUs commented that while DOE can use capacity or another "performance related" feature to justify a higher or lower standard under EPCA, the CA IOUs expressed concern regarding the arbitrary nature of the capacity definitions, particularly for front-loading clothes washers. (*Id.*) The CA IOUs added that under the appendix J2 efficiency metrics, product efficiencies strongly varied with capacity and may continue to do so under the appendix J efficiency metrics. (*Id.*) The CA IOUs commented that a more appropriate approach would be to use an equation-based standard with a capacity, similar to what is used under the consumer refrigerators/refrigerator-freezers/freezers standard. (*Id.*)

Ameren *et al.* commented that while they do not have a specific recommendation for the compact RCW definition, they encourage DOE to ensure that changing the compact product class to incorporate larger capacities does not enable backsliding. (Ameren *et al.*, No. 42 at p. 18) Ameren *et al.* commented that DOE's working definition of less than 1.6 ft^3 for top-loading clothes washers and less than 2.5 ft^3 for front-loading clothes washers would not result in backsliding because there is not a front-loading product less than 1.6 ft^3 on the market. (*Id.*) However, Ameren *et al.* noted that, if defined differently, RCW models presently considered standard-sized (and therefore subject to a higher efficiency standard) could be recategorized as compact (and therefore subject to a lower efficiency standard). (*Id.*)

As discussed, currently, no front-loading products with a capacity less than 1.6 ft^3 are certified to DOE as being available on the market, indicating that the current threshold of 1.6 ft^3 is no longer a relevant differentiator of capacity within the front-loading RCW market. DOE analysis tentatively confirms AHAM and Whirlpool's comments that despite the removal of the capacity "bias" in the EER and WER efficiency metrics, the reduced dimensions of smaller-width products limit the use of certain technologies for increasing efficiency, such as larger wash baskets that can exert a higher g-force on clothing. For this reason, DOE tentatively concludes that a separate product class is warranted for space-constrained front-loading RCWs at a revised threshold that is more relevant to the current market.

DOE recognizes that one of the defining characteristics of front-loading RCWs marketed as "compact" is the width-constrained design (*i.e.*, the ability for the clothes washer to be installed in narrow space that would not accommodate a full-size clothes washer). DOE considered defining the front-loading compact-size product classes on the basis of width. Based on DOE's market research, and supported by comments from AHAM and manufacturers, products marketed as "compact" typically have a nominal cabinet width of 24-inches, whereas full-size products most typically have a nominal cabinet width of 27 inches. DOE has identified a number of practical challenges in basing the product class distinction on a measurement of the width of a clothes washer. The test procedure would need to require measuring the width of the clothes washer and would need to specify how the measurement would be performed. While DOE could consider such amendments to its test procedure, DOE has identified nuances in product design that could create complexities in defining such a measurement. For example, on front-loading clothes washers, DOE has observed that certain aesthetic features, such as the borders of the control panel, may extend beyond the width of the main body of the cabinet. In general, certain measurements of width may not provide an appropriate representation of product width as it relates to product class designation. DOE also notes that although front-loading clothes washers are most often marketed according to their nominal width as a whole number, the actual width may be a fraction of an inch higher or lower than the advertised nominal width. Furthermore, DOE is concerned that by defining the "compact-size" threshold as a width equal to or less than 24 inches, for example, if a manufacturer were to bring to market a 25-inch width product, such a product would be defined as standard-size but would presumably share many of the same inherent efficiency constraints as a 24-inch product (*i.e.*, a 25-inch product may be more appropriately classified as compact-size rather than standard-size).

Having considered these challenges in defining the front-loading compact-size threshold on the basis of product width, DOE further considered defining the threshold based on an updated capacity value that would be more relevant to the current market than the existing threshold of 1.6 ft^3. Based on front-loading RCW models currently certified in DOE's CCD, there is a gap in front-loading capacity between 2.8 ft^3 and 3.4 ft^3 (*i.e.*, no products are available on the market within this range), consistent with DOE's findings presented in the September 2021 Preliminary TSD. DOE evaluated every front-loading model in the CCD and has determined that this capacity gap directly correlates with nominal cabinet size—capacities less than 2.8 ft^3 correspond to a nominal 24-inch cabinet width, and capacities larger than 3.4 ft^3 correspond to a nominal 27-inch cabinet width or greater. Based on this analysis, DOE tentatively concludes that for front-loading RCWs, using a capacity threshold rather than a width threshold would provide a perfectly correlated proxy for differentiating between standard-size products and space-constrained products. DOE therefore proposes to define a threshold of 3.0 ft^3 to differentiate between compact-size and standard-size front-loading RCWs. DOE further notes that given the current gap in capacity between 2.8 ft^3 and 3.4 ft^3 for units currently on the market, defining the threshold at 3.0 ft^3 would provide opportunities for manufacturers to introduce compact-size products with slightly higher capacity, or standard-size products with slightly lower capacity, with such potential products being classified within the appropriate product class. DOE would consider other means for defining the threshold between the compact-size and standard-size front-loading product classes if in the future a capacity threshold were to no longer provides a clear proxy to distinguish between standard-size products and space-constrained products.

Specific to the front-loading standard-size product class, DOE evaluated the merits of separately defining a larger product class (*e.g.*, greater than 5.0 ft^3), as suggested by multiple commenters. Data submitted by AHAM indicates a shipment-weighted average capacity of around 4.2 ft^3 for all RCWs, and the results of the engineering analysis indicate that a capacity of 4.2 ft^3 is representative of the baseline efficiency level for the standard-size front-loading product class. DOE's testing and teardown analysis indicates that all of the evaluated efficiency levels for the standard-size front-loading product class can be achieved by units at 4.2 ft^3 capacity (*i.e.*, an increase in capacity is not required as a means for achieving the higher efficiency levels analyzed). On this basis, DOE tentatively determines that additional capacity-based product classes within the standard-size front-loading product class are not warranted.

For top-loading clothes washers, DOE proposes in this NOPR to maintain the existing "compact" and "standard" product class distinctions (*i.e.*, using a capacity threshold of 1.6 ft^3 to differentiate the two classes); however, DOE continues to consider alternative approaches as discussed further in the paragraphs that follow and in chapter 3 and chapter 5 of the NOPR TSD.

Unlike for front-loading RCWs, top-loading compact-size products are available on the market at capacities less than 1.6 ft^3 (*i.e.*, the current threshold). Considering only automatic top-loading clothes washers,[36] those with capacity less than 1.6 ft^3 are exclusively height-constrained "companion" clothes washers, which are designed to serve as an auxiliary clothes washer for washing a small or delicate load while simultaneously washing a "normal" load in the accompanying standard-size RCW.[37] Among standard-size top-loading clothes washers (*i.e.*, those with capacity equal to or greater than 1.6 ft^3), DOE's CCD indicates a relatively continuous spectrum of capacities available on the market across the entire range (*i.e.*, no large gaps in capacity), with no apparent capacity threshold that closely correlates with product differentiation on the market.

For standard-size top-loading RCWs, DOE's engineering analysis indicates that despite the removal of capacity "bias" from the EER and WER metrics, increases in capacity are required to achieve higher efficiency levels beyond EL 1. (See chapter 5 of the NOPR TSD). DOE continues to consider whether this conclusion justifies separating the standard-size product class into separate product classes, as suggested by Whirlpool. Given this close relationship between efficiency and capacity, DOE also continues to consider whether to specify an equation-based standard for the top-loading standard-size product class, as suggested by the CA IOUs. Chapter 5 of the NOPR TSD provides

[36] As discussed further in section IV.C.2.c of this document, the CCD includes both automatic clothes washer models and semi-automatic clothes washer models certified within the top-loading compact product class.

[37] Companion clothes washers are currently available in two different configurations: (1) Integrated into (*i.e.*, built into) the cabinet above a standard-size front-loading RCW, and (2) built into a pedestal drawer for installation underneath a standard-size front-loading RCW. Both configurations are constrained in the height dimension.

further details of DOE's consideration of these potential alternate product class definitions for top-loading standard-size RCWs.

DOE recognizes that an equations-based standards approach would be unfamiliar to RCW stakeholders and would significantly alter the structure of the standards analysis. As such, the analysis of potential amended standards, and how such standards would impact the existing market, could be difficult for stakeholders to interpret, particularly given the proposed change in metrics to EER and WER. DOE also recognizes that implementing equation-based standards could potentially increase compliance burden from manufacturers. For example, a simple modification made to the balance ring on a top-loading model or the door shape on a front-loading model for aesthetic purposes could change the model's measured capacity, which would in turn change the standard applicable to that unit and would therefore require corresponding changes to the controls to reduce energy and water use. As manufacturers iterate product designs, any change that would affect a model's measured capacity would result in the model being subject to a different standard.

In addition, defining an equation-based standard for only the top-loading standard-size product class would create complexity that may lead to confusion or added regulatory burden for manufacturers.

At this time, DOE tentatively determines that the increased complexity and potential burdens of an equation-based standard outweigh the benefits. As discussed, in this NOPR, DOE proposes a numerically based standard for the top-loading standard-size product class.

In response to the CA IOUs' concern that having a different definition of the "compact" threshold for top-loading and front-loading RCWs would add confusion to the market, DOE is proposing to rename the product class for top-loading RCWs with capacities less than 1.6 ft^3 as "ultra-compact."

In response to Ameren *et al.*'s comment that changing the compact product class threshold should not enable backsliding, DOE notes that, as discussed, EPCA 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)) As discussed in section IV.C.2.a of this document, DOE used the current DOE standard applicable to front-loading standard-size clothes washers as the baseline efficiency level for the newly created front-loading compact-size product class, which prevents any possibility of backsliding.

Ameren *et al.* provided comments pertaining to portable clothes washers, which the comment equates with semi-automatic clothes washers. (Ameren *et al.*, No. 42 at pp. 6−8). Ameren *et al.* commented that since the last standards rulemaking, portable RCWs are now widely available for sale through national retailers and online direct-to-consumer marketplaces. (*Id.*) Ameren *et al.* referenced NEEA research as verifying that the portable RCWs currently on the market meet or exceed current standards, and that therefore they do not require a separate product class. (*Id*.) Ameren *et al*. also commented that nothing should prevent efficient technologies employed in conventional automatic top-loading RCWs from being leveraged in portable top-loading RCWs, including wash plates and higher spin speeds. (*Id*.)

DOE cautions that portable clothes washers[38] as a whole represent a broader category of clothes washers than semi-automatic clothes washers specifically. Although all semi-automatic clothes washers currently on the market are portable, not all portable clothes washers on the market are semi-automatic—certain portable clothes washers are automatic (*i.e.*, they provide means for internal regulation of water temperature, as opposed to requiring the user to adjust the water temperature externally to the clothes washer).

With regard to Ameren *et al.*'s comment that portable RCWs currently on the market meet or exceed current standards and therefore do not require a separate product class, DOE does not agree that this conclusion can be applied to semi-automatic clothes washers specifically, since many of the data points referenced by Ameren *et al*. correspond to automatic top-loading clothes washers. In addition, appendix J includes significant changes to the testing of semi-automatic clothes washers—which improve the representativeness of the test results while reducing test burden—such that when tested under appendix J, a semi-automatic clothes washer uses significantly more hot water (and therefore has inherently lower EER values) than would a similarly-sized automatic

[38] In this NOPR, DOE uses the term "portable clothes washer" to mean a clothes washer, typically with caster wheels, designed to be easily moved by the consumer.

clothes washer.[39] Section IV.C.2.c of this document provides further discussion of the efficiency level analysis for semi-automatic clothes washers.

Given the reemergence of semi-automatic clothes washers on the market, and improvements to the test procedure to improve the representativeness of test results for semi-automatic clothes washers, DOE is proposing to re-establish a separate product class for semi-automatic clothes washers and to establish performance-based standards for semi-automatic clothes washers.

In summary, for this NOPR, DOE analyzed five product classes for RCWs as follows:

- Semi-automatic clothes washers
- Automatic clothes washers:[40]
    - Top-loading, ultra-compact (less than 1.6 ft^3 capacity)
    - Top-loading, standard-size (1.6 ft^3 or greater capacity)
    - Front-loading, compact (less than 3.0 ft^3 capacity)
    - Front-loading, standard-size (3.0 ft^3 or greater capacity)

[39] For example, most automatic clothes washers offer only a cold rinse, whereas appendix J requires semi-automatic clothes washers to be tested on both Hot Wash / Hot Rinse, and Warm Wash / Warm Rinse cycles, based on the assumption that the user would not adjust the water temperature during the cycle. 87 FR 33316. Significantly more hot water is used in these cycles than on the equivalent cycles (Hot Wash / Cold Rinse and Warm Wash / Cold Rinse) on an automatic clothes washer.
[40] For simplicity, many of the tables in the following sections of this document omit the designation that these four product classes pertain to automatic clothes washers.

DOE seeks comment on the product class structure analyzed in this NOPR.

2. Technology Options

In the preliminary market analysis and technology assessment, DOE identified a comprehensive list of technology options that would be expected to improve the efficiency of RCWs, as measured by the DOE test procedures.[41] Initially, these technologies encompass all those that DOE believes are technologically feasible.

In the September 2021 Preliminary Analysis, DOE requested information on any technology options not identified in the September 2021 Preliminary TSD that manufacturers may use to attain higher efficiency levels of RCWs.

Ameren *et al*. commented in support of DOE's inclusion of all relevant technologies, including those to reduce drying energy. (Ameren *et al*., No. 42 at p. 19) Ameren *et al*. also commented that they appreciate DOE's consideration of technologies that have been found in working prototypes in addition to those available in current models. (*Id*.)

[41] See section 3.15.2 of the September 2021 Preliminary TSD. Available online at *www.regulations.gov/document/EERE-2017-BTSTD-0014-0030*.

In this NOPR, DOE considered the technology options listed in Table IV.1. In addition to the technology options DOE considered for the September 2021 Preliminary Analysis, DOE added capacity increase as a technology option for this NOPR.[42]

Table IV.1 Technology Options for Residential Clothes Washers

Methods for Decreasing Water Use*
Adaptive water fill controls
Hardware features enabling lower water levels
Spray rinse
Polymer bead cleaning
Methods for Decreasing Machine Energy
More efficient motor
Direct drive motor
Methods for Decreasing Water Heating Energy
Wash temperature decrease
Ozonated laundering
Methods for Decreasing Drying Energy
Hardware features enabling spin speed increase
Spin time increase
Methods for Decreasing Standby Energy
Lower standby power components
Methods for Increasing Overall Efficiency
Capacity increase

*Most of the methods for decreasing water use are also methods for decreasing water heating energy, since less hot water is used.

Chapter 3 of the NOPR TSD includes the detailed descriptions of each technology option.

DOE seeks comment on the technology options not identified in this NOPR that manufacturers may use to attain higher efficiency levels of RCWs.

[42] In this NOPR, DOE considers capacity increase only as a technology option of "last resort." In defining a representative "path" that manufacturers would be expected to use to achieve higher efficiency levels, DOE included capacity increase only for those efficiency levels that cannot be reasonably achieved without an increase in capacity. See chapter 5 of the NOPR TSD for more details.

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 proprietary technology has proprietary protection and represents a unique pathway to achieving a given efficiency level, it will not be considered further due to the potential for monopolistic concerns.

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

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

The subsequent sections include comments from interested parties pertinent to the screening criteria, 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

In chapter 4 of the September 2021 Preliminary Analysis, DOE screened out electrolytic disassociation of water, ozonated laundering, and polymer bead cleaning on the basis of their practicability to install, manufacture and service. DOE also noted that electrolytic disassociation of water could have impacts on product utility or availability and that polymer bead cleaning was a unique-pathway proprietary technology.

In the September 2021 Preliminary Analysis, DOE sought comment on whether any additional technology options should be screened out on the basis of any of the screening criteria.

AHAM commented that decreasing water temperature, particularly on the warmest warm wash temperature, could decrease cleaning and rinsing performance by making it harder to remove fatty soils, which are soluble around 85 degrees Fahrenheit ("°F"). (AHAM, No. 40 at pp. 9–10) AHAM added that despite the existence of some detergents designed for lower temperatures, detergents alone cannot solve this issue. (*Id.*) AHAM commented that decreased water temperature could also have negative impacts on fabric care resulting from reduced detergent removal, biofilm accumulation, reduced particulate removal, and increased white residues on clothing. (*Id.*) AHAM also noted that if wash time is increased to compensate for a decrease in cleaning performance at lower wash temperatures, the cycle time will consequently increase. (*Id.*)

Whirlpool suggested that lowering wash temperatures from current levels should not be a technology option considered by DOE. (Whirlpool, No. 39 at pp. 6–8) Whirlpool added that it strongly believes that wash temperatures are already low enough, and that lowering temperatures further will effectively create a disconnect between consumer perceptions of acceptable wash water temperatures and what Whirlpool could actually offer. (*Id.*) Whirlpool commented that this impact is compounded by the proposed appendix J test procedure, which proposes to test the hottest and coldest Warm Wash/Cold Rinse settings for all clothes washers instead of using the 25/50/75 test.[43] (*Id.*) Whirlpool commented that changing the test procedure at the same time as the energy conservation standards may impede Whirlpool's ability to offer warm wash temperatures that consumers find acceptable and could affect clothes washers' ability to consistently clean laundry to the consumers' satisfaction, since higher temperatures are needed to effectively remove fatty soils, white residue, and particulates from laundry. (*Id.*) Whirlpool further commented that DOE's standards should not drive wash water temperatures below levels that are acceptable based on consumer perceptions of these temperatures. (*Id.*) Whirlpool recommended that instead, DOE's standards should protect the ability of clothes washers to offer adequate wash temperatures that align with consumer expectations and can deliver on the core purpose of owning and using a clothes washer, which is to remove soils and clean clothes. (*Id.*) Whirlpool noted that the overall impact of lowering wash temperature on improving efficiency is minimal in comparison to other technology options like improving spin speed, but it is still something manufacturers must consider when making tradeoffs between cost and efficiency when designing a clothes washer to meet new standards. (*Id.*)

Whirlpool further commented that detergents become less effective at lower wash temperatures, and that consumers will see this reduction immediately or within several

[43] The "25/50/75" test refers to the provision in section 3.5 of appendix J2 that allows a clothes washer that has four or more Warm Wash/Cold Rinse temperature selections to be tested at the 25-percent, 50-percent, and 75-percent positions of the temperature selection device between the hottest hot (≤135 °F (57.2 °C)) wash and the coldest cold wash. If a selection is not available at the 25-, 50- or 75-percent position, in place of each such unavailable selection, the next warmer temperature selection shall be used.

loads, depending on the soil type on the clothing. (Whirlpool, No. 39 at p. 11) Whirlpool added that even detergents formulated specifically for cold water washing may not be validated for temperatures below 70 °F. (*Id.*) Whirlpool noted that in northern states such as Michigan, yearly ground water temperatures are in the 42–49 °F range, and that Whirlpool is not aware of any detergent that was formulated and validated for performance at temperatures that low. (*Id.*) Whirlpool stated that many clothes washers on the market today have tap cold options, and some have a variety of cold and cool temperatures that mix in some amount of hot water. (*Id.*) Whirlpool commented that some clothes washers offer these temperatures in the 55 °F range. (*Id.*) Whirlpool expressed concern that, due to any amendments to the standards that necessitate a reduction in wash temperatures, the temperature range of these tap cold, cold, and cool settings may be driven down well below the validated temperatures for good performance for even the best detergent formulations on the market. (*Id.*) Whirlpool added that this problem would be even more pronounced for the cheaper and less effective detergents, which may be popular with low-income consumers. (*Id.*) Whirlpool concluded that detergents would need to be reformulated to reflect this broad-scale lowering of wash temperatures in clothes washers, and Whirlpool is not sure if it would be possible to validate a detergent for good performance at these lower temperatures. (*Id.*)

Unlike certain other discrete technology options evaluated by DOE (*e.g.*, direct drive motor), wash temperature decrease can be implemented to varying extents. For example, some manufacturers may implement it to small extent (*e.g.*, a decrease by 0.5 °F), whereas other manufacturers may implement it to a significantly larger extent (*e.g.*, a decrease of 5 °F or more). In addition, DOE observes through testing that manufacturers employ a wide variety of "paths" to achieve higher efficiency levels – some manufacturers may opt to reduce wash temperatures as a means for achieving a particular efficiency level, whereas other manufacturers may prioritize maintaining wash temperatures and instead reducing motor energy use or drying energy. Indeed, through its testing, as discussed in a test report accompanying this NOPR (hereafter, the "performance characteristics test report"), which is available in the docket for this rulemaking, DOE has observed a wide range of wash temperatures available on the market among products with identical efficiency ratings. Because of this variation in implementation from manufacturer to manufacturer, and because DOE observes that some manufacturers choose a "path" to higher efficiency that includes reduced wash temperatures, DOE has not screened out decreased wash temperatures as a design option for improving efficiency.

In chapter 5 of the NOPR TSD, section 5.5.3 describes the design option paths most typically associated with each analyzed efficiency level within each product class, based on DOE's testing and teardowns of a representative sample of units on the market. For the top-loading standard-size product class, the design option path considered by DOE for the analysis incorporates a slight reduction in hot wash water temperatures at EL 3 and a more substantive reduction in hot wash water temperatures at EL 4, reflecting the most prevalent design option path used by units currently on the market at these ELs. Although the most typical design option path includes reduced wash temperatures, DOE's analysis described in the performance characteristics test report suggests that the proposed efficiency level (in particular, EL 3 for the top-loading standard-size product class) can be achieved through a variety of design option paths, including paths that do not require a substantive reduction in wash temperatures compared to the range of wash temperatures provided by lower-efficiency units. Such design option paths could incorporate more efficient motors or higher spin speeds, for example, in lieu of any reductions in wash water temperatures. Such alternate design option paths would have higher manufacturing costs than a path that uses reduction in wash water temperatures.

Additionally, for this NOPR analysis, DOE partially screened out capacity increase as a technology option. Specifically, DOE screened out any capacity increase that would require a corresponding increase in cabinet width larger than 27 inches, on the basis of the practicability to install and service RCWs with cabinet widths larger than 27 inches. DOE recognizes that products with a width greater than 27 inches may not be able to fit through many standards-size interior doorways.

For the reasons discussed in chapter 4 of the NOPR TSD, for this NOPR analysis DOE screened out ozonated laundering, and polymer bead cleaning on the basis of their practicability to install, manufacture and service.

DOE seeks comment on whether any additional technology options should be screened out on the basis of any of the screening criteria in this NOPR.

2. Remaining Technologies

Through a review of each technology, DOE retained (*i.e.*, did not screen out) the technology options listed in Table IV.2 and tentatively concludes that each of these technologies meets all five screening criteria to be examined further as design options.

Table IV.2 Retained Design Options for Residential Clothes Washers

Methods for Decreasing Water Use*
Adaptive water fill controls
Hardware features enabling lower water levels
Spray Rinse
Methods for Decreasing Machine Energy
More efficient motor
Direct drive motor
Methods for Decreasing Water Heating Energy
Wash temperature decrease
Methods for Decreasing Drying Energy
Hardware features enabling spin speed increase
Spin time increase
Methods for Decreasing Standby Energy
Lower Standby power components
Methods for Increasing Overall Efficiency
Capacity increase (without requiring a cabinet width increase)

*Most of the methods for decreasing water use are also methods for decreasing water heating energy, since less hot water is used.

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.*, practicable to manufacture, install, and service; do not result in adverse impacts on product utility or product availability; do not result in adverse impacts on health or safety; and do not represent 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 RCWs. There are two elements to consider in the engineering analysis; the selection of efficiency levels to analyze (*i.e.*, the "efficiency analysis") and the determination of product cost at each efficiency level (*i.e.*, the "cost analysis"). In determining the performance of higher-efficiency products, DOE considers technologies and design option combinations not eliminated by the screening analysis. For each 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).

In this section, DOE discusses comments received in response to the prediction tool developed in support of the September 2021 Preliminary Analysis. In the sections that follow, DOE details the efficiency levels analyzed for each product class; the approach used to develop cost estimates for each efficiency level and the resulting cost-efficiency relationship; the equations used to translate IMEF and IWF into EER and WER; and the approach used to develop the manufacturer markup.

In response to the September 2021 Preliminary Analysis, ASAP *et al.* commented generally in support of DOE's approach to select efficiency levels based on the proposed new efficiency metrics, EER and WER. (ASAP *et al.*, No. 37 at p. 1)

1. Preliminary Analysis Prediction Tool

In support of the September 2021 Preliminary Analysis, DOE tested a sample of RCWs under both appendix J2 and appendix J as proposed in the September 2021 TP NOPR. As described in chapter 5 of the September 2021 Preliminary TSD, DOE supplemented its tested dataset with "predicted" EER and WER values for a larger sample of units. The EER and WER predictions which were estimated based on each model's measured performance under appendix J2 and on the model's physical and operational characteristics. DOE also published an explanation of how the predictive tool was developed, including a table listing the impacts to each underlying variable that were assumed as part of the predictive analysis. DOE explained that it planned to continue testing additional units to appendix J to increase the number of tested, rather than predicted, EER and WER values in future stages of the rulemaking.

AHAM commented that DOE did not provide sufficient explanation for the "prediction tool" that DOE used to predict a clothes washer's EER and WER values based on appendix J2 test results. (AHAM, No. 40 at pp. 4−6) AHAM further explained that its data, which include models representing approximately half of total 2020 shipments, contradicted the data presented in the September 2021 Preliminary TSD. (*Id.*) AHAM expressed concern that DOE did not provide any statistical outcomes to justify the accuracy of the prediction tool it used to predict a clothes washers EER and WER values based on appendix J2 test results. (AHAM, No. 40 at pp. 15−17) AHAM commented that without data on statistical outcomes, AHAM cannot assess the accuracy of the prediction tool. (*Id.*) AHAM also commented that based on the analysis that transposes efficiency levels, DOE's prediction tool appears to be inaccurate and that under the best-fit line method for front-loading clothes washers, the R-squared values show the prediction tool is insufficient. (*Id.*) AHAM therefore recommended that DOE update its analysis based on tested data instead of predicted data, especially for top-loading standard clothes washers with capacities less than 3.0 ft^3, and for front-loading compact clothes washers. (*Id.*) AHAM also requested that DOE provide appendix J2 and appendix J test data; the statistical data demonstrating correlation of the prediction tool; the data supporting the development of the tool, including the equations the prediction tool used; and DOE's comparison between predicted and tested EER where applicable. (*Id.*) AHAM noted that, unlike DOE, its data was all based on actual testing instead of using a model or prediction tool. (*Id.*)

AHAM presented a table showing the variation in tested HE_T, ME_T, DE_T, E_{TLP}, Q_T, and corrected RMC between appendix J2 and appendix J for the AHAM data, DOE data, and the combined AHAM and DOE dataset. (AHAM, No. 53 at pp. 7−8) AHAM measured variation by measuring the percent difference in each metric between appendix J2 and appendix J for all units, and presented an overall variation in each metric by calculating the average percent differences for each metric, the standard deviation of the percent differences for each metric, and the range of percent differences for each metric. (*Id.*) AHAM noted that on average, values for HE_T, ME_T, DE_T, E_{TLP}, Q_T, and corrected RMC were higher under appendix J than under appendix J2. (*Id.*) AHAM also noted that the level of variation was particularly high for DE_T and E_{TLP}. (*Id.*) AHAM commented that, while the overall impact of standby energy in the final calculation for energy efficiency is quite small, the impact of dryer energy on the final calculated efficiency is significant. (*Id.*) Based on its analysis, AHAM concluded that this variation shows that a direct translation between the appendix J2 and appendix J test procedures is not possible. (*Id.*) AHAM specifically pointed out that the total dryer energy consumption showed an average increase of 22.5 percent, but that the range of differences with the tested models is quite wide, indicating that it is impossible to predict the impact of appendix J on dryer energy consumption. (*Id.*) AHAM added that the appendix J2 to appendix J translation has a similar effect on corrected RMC, and is most apparent with respect to E_{TLP}, where measured values varied by as much as 221 percent. (*Id*.) AHAM further explained that the relatively high standard deviations of percent differences underscore the wide ranges in the measured value differences between appendix J2 and appendix J. (*Id*.)

Samsung commented that the prediction tool used in the September 2021 Preliminary TSD does not have a high correlation between EER and IMEF. (Samsung, No. 41 at p. 3)

ASAP *et al*. commented that they support DOE's approach to use its predictive tool and that they support conducting additional testing using the new proposed appendix J test procedure to refine this approach. (ASAP *et al*., No. 37 at p. 1)

Ameren *et al*. expressed support for DOE's approach to predict EER and WER values from tested IMEF and IWF value and commented that they support future testing with appendix J to collect more results with the proposed new appendix J test procedure. (Ameren *et al*., No. 42 at pp. 19–20). Ameren *et al*. added that DOE's RMC and Warm Wash temperature results are consistent with findings in the 2020 NEEA report. (*Id*.) Ameren *et al*. added that the non-linear nature of the relationship between IMEF and IWF values and EER and WER values is similar to the non-linearity that NEEA identified in a translation of appendix J2 tests to real-world energy use. (*Id*.)

As noted, DOE stated in the September 2021 Preliminary TSD that it planned to continue testing additional units to appendix J to increase the number of tested, rather than predicted, EER and WER values for future stages of this proposed rulemaking.

As described in the April 2022 NODA, DOE has tested additional 28 additional RCW models to both appendix J2 and appendix J in order to provide additional data points for the translation equations and to eliminate the need to rely on "predicted" EER and WER values in the translation analysis. 87 FR 21816, 21817. DOE's total test sample includes 44 units across all five product classes analyzed for this NOPR. DOE made available detailed appendix J and appendix J2 test data for its full set of tested units as part of the April 2022 NODA. As discussed in section IV.C.5 of this document, for this NOPR DOE relied exclusively on tested data for developing translation equations for each automatic clothes washer product class and did not continue the usage of its prediction tool as part of its analysis. The discontinuation of the prediction tool addresses many of the concerns expressed by AHAM and Samsung. As detailed in section IV.C.5 of this document, the comprehensive dataset has enabled DOE to develop robust translations between the appendix J2 and appendix J metrics.

2. 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 NOPR, DOE used an efficiency-level approach, supplemented with the design-option approach for certain "gap fill" efficiency levels. The efficiency-level approach is appropriate for RCWs, given the availability of certification data to determine the market distribution of existing products and to identify efficiency level "clusters" that already exist on the market.

In conducting the efficiency analysis for the automatic clothes washer product classes, DOE first identified efficiency levels in terms of the current IMEF and IWF metrics defined in appendix J2 that are the most familiar to interested parties. DOE also initially determined the cost-efficiency relationships based on these metrics. Following that, DOE translated each efficiency level into its corresponding EER and WER values using the translation equations developed for each product class, as discussed further in section IV.C.5 of this document.

For the semi-automatic product class, for which reliable certification data is unavailable, DOE tested a representative sample of units to appendix J and used that set of data points to determine the baseline and higher efficiency levels, as described further in section IV.C.2.c of this document.

The efficiency levels that DOE considered in the engineering analysis are attainable using technologies currently available on the market in RCWs. DOE used the results of the testing and teardown analyses to determine a representative set of technologies and design strategies that manufacturers use to achieve each higher efficiency level. This information provides interested parties with additional transparency of assumptions and results, and the ability to perform independent analyses for verification. Chapter 5 of the NOPR TSD describes the methodology and results of the analysis used to derive the cost-efficiency relationships.

a. Baseline Efficiency Levels

For each 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.

In the September 2021 Preliminary Analysis, DOE presented an initial set of baseline levels for each product class, as shown in Table IV.3.

Table IV.3 Preliminary Baseline Efficiency Levels Presented in the September 2021 Preliminary Analysis

Product Class	**Source**	**Minimum IMEF** *(ft^3/kWh/cycle)*	**Maximum IWF** *(gal/cycle/ft^3)*
Top-Loading, Compact (< 1.6 ft^3) *	Current DOE standard	1.15	12.0
Top-Loading, Standard-Size (≥ 1.6 ft^3)	Current DOE standard	1.57	6.5
Front-Loading, Compact (< 3.0 ft^3)	Current DOE standard for front-loading, standard-size (≥ 1.6 ft^3) **	1.84	4.7
Front-Loading, Standard-Size (≥ 3.0 ft^3)	ENERGY STAR v. 7.0 ***	2.38	3.7

* As discussed in section IV.A.1 of this document, DOE is proposing in this NOPR to rename the top-loading compact product class analyzed in the September 2021 Preliminary Analysis to top-loading "ultra-compact."
** Although the current DOE standard for front-loading, compact (< 1.6 ft^3) is 1.13 IMEF/8.3 IWF, no front-loading units are currently on the market with a capacity < 1.6 ft^3. The proposed baseline efficiency level reflects the currently applicable standard for front-loading RCWs with capacities between 1.6 and 3.0 ft^3.
*** Although the current DOE standard for front-loading standard-size (≥ 1.6 ft^3) is 1.84 IMEF/4.7 IWF, at the time of analysis, the least efficient front-loading standard-size RCW available on the market had an efficiency rating of 2.38 IMEF/3.7 IWF.

Additionally, in the September 2021 Preliminary Analysis, DOE sought comment on whether the baseline efficiency levels identified in its analysis for each product class were appropriate.

The CA IOUs presented data from their analysis of front-loading standard-size products available on DOE's CCD. (CA IOUs, No. 43 at pp. 5–6) The CA IOUs commented that, according to their analysis of the CCD, eight models ranging from 4.3 ft^3 to 5 ft^3 are rated at the current federal minimum standard of 1.84 IMEF and 4.7

IWF, and recommended that DOE update the baseline definition to the current minimum efficiency levels to prevent an undercount of the overall savings potential. (*Id*.) The CA IOUs also identified some models rated at 2.92 IMEF and 4.5 IWF in the CCD, which reflects a worse IWF (although a better IMEF) than the baseline level analyzed in the September 2021 Preliminary Analysis. (*Id*.)

NYSERDA commented that DOE's CCD shows front-loading standard-size clothes washers from 4.3 to 5.0 ft^3 rated at the current minimum standard level of 1.84 IMEF. (NYSERDA, No. 36 at p. 2) NYSERDA recommended that DOE therefore consider the existing standard as the baseline for these products instead of the ENERGY STAR 2015 level of 2.38 IMEF. (*Id*.)

In response to the CA IOUs and NYSERDA's comment that the CCD includes standard-size front-loading clothes washers that are rated at the current standard level of 1.84 IMEF, DOE has determined through testing that these units perform significantly above their rated value at the current standard level. DOE has also confirmed these findings through confidential manufacturer interviews.

In response to the CA IOUs' comment that the CCD also includes a model with a worse IWF rating of 4.5 IWF, DOE notes that this unit's rating appears to be a typographical error. DOE notes that this unit is listed in the ENERGY STAR database with an IWF rating of 2.9 and a capacity of 4.5 ft^3, suggesting that the capacity measurement was inadvertently reported as the IWF value in DOE's CCD.

For these reasons, DOE tentatively concludes that for the standard-size front-loading product class, the lowest available efficiency on the market is 2.38 IMEF and 3.7 IWF, and this level is an appropriate representation of baseline efficiency.

Accordingly, in this NOPR, DOE analyzed the baseline efficiency levels shown in Table IV.4 for each automatic product class.[44]

Table IV.4 Baseline Efficiency Levels Analyzed in this NOPR

Product Class	Source	Minimum IMEF *(ft^3/kWh/cycle)*	Maximum IWF *(gal/cycle/ft^3)*
Top-Loading, Ultra-Compact (< 1.6 ft^3)	Current DOE standard	1.15	12.0
Top-Loading, Standard-Size (≥ 1.6 ft^3)	Current DOE standard	1.57	6.5
Front-Loading, Compact (< 3.0 ft^3)	Current DOE standard for front-loading, standard-size (≥ 1.6 ft^3) *	1.84	4.7
Front-Loading, Standard-Size (≥ 3.0 ft^3)	ENERGY STAR v. 7.0 **	2.38	3.7

* Although the current DOE standard for front-loading compact (< 1.6 ft^3) is 1.13 IMEF/8.3 IWF, no front-loading units are currently on the market with a capacity < 1.6 ft^3. The proposed baseline efficiency level reflects the currently applicable standard for front-loading RCWs with capacities between 1.6 and 3.0 ft^3.
** Although the current DOE standard for front-loading standard-size (≥ 1.6 ft^3) is 1.84 IMEF/4.7 IWF, at the time of analysis, the least efficient front-loading standard-size RCW available on the has an efficiency rating of 2.38 IMEF/3.7 IWF.

DOE seeks comment on whether the baseline efficiency levels analyzed in this NOPR for each product class are appropriate.

[44] See section IV.C.2.c of this document for a discussion of efficiency levels for the semi-automatic product class.

b. Higher Efficiency Levels

To establish higher efficiency levels for the analysis, DOE reviewed data in DOE's CCD to evaluate the range of efficiencies for RCWs currently available on the market.[45]

As part of DOE's analysis, the "maximum available" efficiency level is the highest efficiency unit currently available on the market. DOE also defines a "max-tech" efficiency level to represent the maximum possible efficiency for a given product in each product class. (42 U.S.C. 6295(p)(1)) DOE typically determines max-tech levels based on technologies that are either commercially available or have been demonstrated as working prototypes. If the max-tech design meets DOE's screening criteria, DOE considers the design in further analysis.

DOE has tentatively determined that the max-tech efficiency level for each RCW product class corresponds to the maximum available level for each product class. In other words, DOE has not defined or analyzed any efficiency levels higher than those currently available on the market.

As noted, EPCA requires that any new or amended energy conservation standard be designed to achieve the maximum improvement in energy efficiency that is technologically feasible. (42 U.S.C. 6295(o)(2)(A)) For RCWs, a determination of technological feasibility must encompass not only an achievable reduction in energy

[45] DOE's Compliance Certification Database is available at *www.regulations.doe.gov/certification-data*. Analysis conducted May 2022.

and/or water consumption, but also the ability of the product to perform its intended function (*i.e.*, wash clothing) at reduced energy or water levels.[46] Attributes that are relevant to consumers encompass multiple aspects of RCW operation such as stain removal, solid particle removal, rinsing effectiveness, fabric gentleness, cycle time, noise, vibration, and others. Each of these attributes may be affected by energy and water efficiency levels, and achieving better performance in one attribute may require a tradeoff with one or more other attributes. DOE does not have the means to be able to determine whether a product that uses less water or energy than the maximum efficiency level available on the market would represent a viable (*i.e.*, technologically feasible) product that would satisfy consumer expectations regarding all the other aspects of RCW performance that are not measured by the DOE test procedure. As far as DOE is aware, the complexity of the interdependence among all these attributes precludes being able to use a computer model or other similar means to predict changes in these product attributes as a result of reduced energy and water levels. Rather, as far as DOE is aware, such determinations are made in an iterative fashion through extensive product testing as part of manufacturers' design processes.

In the September 2021 Preliminary Analysis, for all product classes except top-loading compact, DOE considered efficiency levels higher than baseline levels based on specifications prescribed by ENERGY STAR® and the Consortium for Energy Efficiency ("CEE")'s Super Efficient Home-Appliances Initiative,[47] as well as gap-fill

[46] As an extreme example, DOE could consider a hypothetical RCW that reduces its water consumption to near-zero, but such a product would not be viable for washing clothing, given current technology.
[47] CEE Super-Efficient Home Appliance Initiative available at *cee1.org/content/cee-program-resources*. Accessed July 13, 2022.

levels. At the time of the September 2021 Preliminary Analysis, large clusters of models were available at the ENERGY STAR and CEE Tier levels, as evident in the market distribution plots presented in chapter 3 of the September 2021 Preliminary TSD. At the time of the September 2021 Preliminary Analysis, no automatic top-loading compact RCWs were available on the market that exceeded the baseline level. Accordingly, DOE did not consider any higher efficiency levels for this product class.

In chapter 5 of the September 2021 Preliminary TSD, DOE established the preliminary efficiency levels for each product class as presented in Table IV.5 through Table IV.8.

Table IV.5 Top-Loading, Compact* (< 1.6 ft^3) Preliminary Efficiency Levels, as Presented in the September 2021 Preliminary Analysis

EL	Efficiency Level Description	IMEF *(ft^3/kWh/cycle)*	IWF *(gal/cycle/ft^3)*
Baseline	Current DOE standard	1.15	12.0

* As discussed in section IV.A.1 of this document, DOE is proposing in this NOPR to rename the top-loading compact product class analyzed in the September 2021 Preliminary Analysis to top-loading "ultra-compact."

Table IV.6 Top-Loading, Standard-Size (≥ 1.6 ft^3) Preliminary Efficiency Levels, as Presented in the September 2021 Preliminary Analysis

EL	Efficiency Level Description	IMEF *(ft^3/kWh/cycle)*	IWF *(gal/cycle/ft^3)*
Baseline	Current DOE standard	1.57	6.5
1	Gap fill	1.70	5.0
2	ENERGY STAR (v. 8.1)	2.06	4.3
3	2015–2017 CEE Tier 1	2.38	3.7
4	2015 ENERGY STAR Most Efficient / Maximum available	2.76	3.5

Table IV.7 Front-Loading, Compact (< 3.0 ft^3) Preliminary Efficiency Levels, as Presented in the September 2021 Preliminary Analysis

EL	Efficiency Level Description	IMEF *(ft^3/kWh/cycle)*	IWF *(gal/cycle/ft^3)*
Baseline	Current DOE standard for front-loading, standard-size (≥ 1.6 ft^3)	1.84	4.7
1	ENERGY STAR v. 8.1 level for units ≤ 2.5 ft^3	2.07	4.2
2	2018–2022 ENERGY STAR Most Efficient for units ≤ 2.5 ft^3	2.20	3.7
3	ENERGY STAR v. 7.0 level for units > 2.5 ft^3	2.38	3.7
4	ENERGY STAR v. 8.1 level for units > 2.5 ft^3 / Maximum available	2.76	3.2

Table IV.8 Front-Loading, Standard-Size (≥ 3.0 ft^3) Preliminary Efficiency Levels, as Presented in the September 2021 Preliminary Analysis

EL	Efficiency Level Description	IMEF *(ft^3/kWh/cycle)*	IWF *(gal/cycle/ft^3)*
Baseline	ENERGY STAR v. 7.0	2.38	3.7
1	Gap fill	2.60	3.5
2	ENERGY STAR v. 8.1	2.76	3.2
3	2018–2022 ENERGY STAR Most Efficient	2.92	3.2
4	Maximum available	3.00	2.9

DOE sought comment on whether the preliminary higher efficiency levels identified in the September 2021 Preliminary Analysis for each product class were appropriate.

The CA IOUs, ASAP *et al.*, and NYSERDA recommended that DOE consider revisiting max-tech and higher efficiency levels based on currently available products, for the top-loading compact product class. (CA IOUs, No. 43 at pp. 4−5; ASAP *et al.*, No. 37 at p. 4; NYSERDA, No. 36 at p. 2) These stakeholders expressed concern that DOE did not consider any products above the baseline levels of 1.15 IMEF and 12.0 IWF, since the ratings in DOE's CCD indicates top-loading compact models that exceed these levels. (*Id.*) ASAP *et al.* noted that DOE's CCD includes 8 top-loading compact models with IMEF ratings between 1.24 and 1.36. (ASAP *et al.*, No. 37 at p. 4) Furthermore, ASAP *et al.* commented that the new proposed test procedure could change the relative rankings and range of efficiency ratings for top-loading compact models. (*Id.*)

DOE's CCD currently includes both automatic clothes washer models and semi-automatic clothes washer models certified within the top-loading compact product class. While the certification database does not differentiate between automatic and semi-automatic configurations, DOE conducted an analysis of product literature for each certified model to identify the configuration of each model in the CCD. DOE's analysis indicates that considering only *automatic* top-loading compact clothes washers, models are available only at the baseline efficiency level. All of the other top-loading compact-size models in the CCD at higher efficiency levels are *semi-automatic* top-loading clothes washers with capacities less than 1.6 ft^3. When evaluating only automatic top-loading compact clothes washers in the CCD, only products with baseline efficiency have been certified to DOE. Therefore, because DOE is not aware of any *automatic* top-loading compact RCWs available on the market at the time of this analysis that exceed the baseline level, DOE is not proposing any higher efficiency levels for this product class.

Section IV.C.2.c of this document discusses the efficiency levels that DOE proposes for semi-automatic clothes washers.

The CA IOUs and NYSERDA also recommended that DOE consider revisiting max-tech and higher efficiency levels based on currently available products, for the top-loading standard-size product class. (CA IOUs, No. 43 at p. 5; NYSERDA, No. 36 at p.

2) These stakeholders commented that according to their analysis of the CCD, nine models are certified to lower (more efficient) IWFs than the most efficient considered efficiency level presented in the September 2021 Preliminary TSD. (*Id*.) The CA IOUs therefore recommended that DOE adjust the maximum achievable efficiency level to reflect the market availability of top-loading standard-size products. (CA IOUs, No. 43 at p. 5) NYSERDA recommended that DOE add an EL 5 using the maximum technologically available efficiency ratings rather than the 2015 ENERGY STAR Most Efficient level to better reflect the constantly improving market. (NYSERDA, No. 36 at p. 2)

The CA IOUs and NYSERDA also recommended that DOE consider revisiting max-tech and higher efficiency levels based on currently available products, for the front-loading standard-size product class. (CA IOUs, No. 43 at pp. 5−6; NYSERDA, No. 36 at p. 2) These stakeholders commented that the CCD contains units with higher efficiencies than the max-tech level DOE considered in the September 2021 Preliminary Analysis and recommended that DOE adjust the highest efficiency levels to reflect the availability of these products. (*Id*.) The CA IOUs identified 11 models that surpass the IMEF and IWF maximum available level presented in the September 2021 Preliminary TSD, at 3.1 IMEF and 2.7 and 2.9 IWF. (CA IOUs, No. 43 at pp. 5−6)

In response to changes in availability on the market since the September 2021 Preliminary Analysis, as reflected by the models in DOE's CCD identified by commenters, DOE has updated the max-tech levels for the top-loading standard-size and front-loading standard-size product classes to reflect the maximum efficiency available in the CCD at the time of this NOPR analysis. The updated max-tech level for top-loading standard-size is 2.76 IMEF/3.2 IWF, which DOE notes corresponds to the 2016/2017 ENERGY STAR Most Efficient criteria. The updated max-tech level for front-loading standard-size is 3.10 IMEF/2.9 IWF. Although DOE also identified two RCW models in DOE's CCD that are rated at 3.10 IMEF/2.7 IWF, these units have extra-large capacity drums that necessitate cabinet widths greater than 27 inches. As discussed in section IV.B.1 of this NOPR, DOE excluded from consideration any drum capacities increase that require a cabinet width increase beyond 27 inches.

DOE also updated the definition of the top-loading standard-size gap-fill level (*i.e.*, EL 1) to reflect changes in the market since September 2021 Preliminary Analysis. In the September 2021 Preliminary Analysis, DOE defined EL 1 as 1.70 IMEF/5.0 IWF based on a small cluster of units in DOE's CCD rated at or near that level. Subsequent to the September 2021 Preliminary Analysis, these units have been discontinued from the market and are no longer listed in DOE's CCD; in addition, DOE's market research indicates that the brand associated with these units no longer offers top-loading clothes washers for sale in the U.S. market. In lieu of any product offerings currently on the market between the baseline level (corresponding to the DOE minimum standard) and EL 2 (corresponding to the applicable ENERGY STAR criteria), in this NOPR DOE has defined EL 1 as the numerical midpoint between the baseline and EL 2 levels.

Lastly, DOE updated the definition of EL 3 for the front-loading compact product class to better align with an existing market cluster. In the September 2021 Preliminary Analysis, DOE had defined EL 3 as 2.38 IMEF/3.7 IWF, which represented the

ENERGY STAR v. 7.0 level for units with capacity greater than 2.5 ft^3. This resulted in a relatively large gap in IMEF between EL 3 and EL 4 (2.38 to 2.76 IMEF). For this NOPR, DOE has instead defined EL 3 as 2.50 IMEF/3.5 IWF as a gap fill level representing a market cluster at that point. This also results in EL 3 being closer to the midpoint of EL 2 and EL 4.

In summary, for this NOPR, DOE analyzed the efficiency levels for each product class shown in Table IV.9 through Table IV.12.

Table IV.9 Top-Loading, Ultra-Compact (< 1.6 ft^3) Efficiency Levels Analyzed in this NOPR

EL	Efficiency Level Description	IMEF *(ft^3/kWh/cycle)*	IWF *(gal/cycle/ft^3)*
Baseline	Current DOE standard	1.15	12.0

Table IV.10 Top-Loading, Standard-Size (≥ 1.6 ft^3) Efficiency Levels Analyzed in this NOPR

EL	Efficiency Level Description	IMEF *(ft^3/kWh/cycle)*	IWF *(gal/cycle/ft^3)*
Baseline	Current DOE standard	1.57	6.5
1	Gap fill	1.82	5.4
2	ENERGY STAR v. 8.1	2.06	4.3
3	2015–2017 CEE Tier 1	2.38	3.7
4	Maximum available (2016/2017 ENERGY STAR Most Efficient)	2.76	3.2

Table IV.11 Front-Loading, Compact (< 3.0 ft^3) Efficiency Levels Analyzed in this NOPR

EL	Efficiency Level Description	IMEF *(ft^3/kWh/cycle)*	IWF *(gal/cycle/ft^3)*
Baseline	Current DOE standard for front-loading, standard-size (≥ 1.6 ft^3)	1.84	4.7
1	ENERGY STAR v. 8.1 level for units ≤ 2.5 ft^3	2.07	4.2
2	2023 ENERGY STAR Most Efficient for units ≤ 2.5 ft^3	2.20	3.7
3	Gap fill	2.50	3.5
4	Maximum available (ENERGY STAR v. 8.1 level for units > 2.5 ft^3)	2.76	3.2

Table IV.12 Front-Loading, Standard-Size (≥ 3.0 ft^3) Efficiency Levels Analyzed in this NOPR

EL	Efficiency Level Description	IMEF *(ft^3/kWh/cycle)*	IWF *(gal/cycle/ft^3)*
Baseline	ENERGY STAR v. 7.0	2.38	3.7
1	Gap fill	2.60	3.5
2	ENERGY STAR v. 8.1	2.76	3.2
3	2023 ENERGY STAR Most Efficient	2.92	3.2
4	Maximum available	3.10	2.9

DOE seeks comment on whether the higher efficiency levels analyzed in this NOPR for each product class are appropriate.

c. Semi-Automatic

As discussed, DOE's CCD includes both automatic clothes washer models and semi-automatic clothes washer models certified within the top-loading compact product class. While the certification database does not differentiate between automatic and semi-automatic configurations, DOE conducted an analysis of product literature for each certified model to identify whether each model is automatic or semi-automatic.

In the September 2021 Preliminary TSD and the April 2022 NODA, DOE did not present any data or analysis for semi-automatic clothes washers. As discussed in section

IV.A.1 of this document, in this NOPR, DOE is proposing to re-establish a separate product class for semi-automatic clothes washers and to establish performance-based standards for semi-automatic clothes washers.

As discussed previously, CCD currently includes both automatic clothes washer models and semi-automatic clothes washer models certified within the top-loading compact product class. While the certification database does not differentiate between automatic and semi-automatic configurations, DOE conducted an analysis of product literature for each certified model to identify the semi-automatic models in the CCD.

To define the efficiency levels for analysis for the semi-automatic product class, DOE did not rely on any ratings currently provided in the CCD. As discussed in the September 2021 TP NOPR, DOE identified areas in which the current test procedure does not provide explicit instruction with regard to semi-automatic clothe washers. 86 FR 49140, 49147. As a result, DOE stated that it recognizes that the proposed specifications for testing semi-automatic clothes washers in appendix J may differ from how manufacturers are currently testing semi-automatic clothes washers under appendix J2. *Id.* at 86 FR 49168.

As finalized, appendix J includes significant changes to the testing of semi-automatic clothes washers, which improve the representativeness of the test results while reducing test burden. Given the lack of specificity in appendix J2 regarding semi-automatic clothes washers, and the significant differences in testing between appendix J2 versus appendix J for semi-automatic clothes washers, DOE tentatively determined that it could not develop an accurate correlation between appendix J2 metrics (*i.e.*, IMEF and IWF) and appendix J metrics (*i.e.*, EER and WER) for semi-automatic clothes washers. Therefore, in this NOPR analysis, DOE defined efficiency levels in terms of EER and WER directly rather than first defining efficiency levels in terms of IMEF and IWF and then developing translation equations to translate those levels to EER and WER. DOE defined the proposed efficiency levels for semi-automatic clothes washers by testing a representative sample of models on the market and observing the range of EER and WER results. Table IV.13 shows the proposed efficiency levels for the semi-automatic product class. See chapter 5 of the NOPR TSD for more details.

Table IV.13 Semi-automatic Efficiency Levels Analyzed in this NOPR

EL	Efficiency Level Description	EER *(ft^3/kWh/cycle)*	WER *(gal/cycle/ft^3)*
Baseline	Minimum available	1.60	0.17
1	Gap fill	2.12	0.27
2	Maximum available	2.51	0.36

DOE seeks comment on whether the efficiency levels analyzed in this NOPR for semi-automatic RCWs are appropriate.

3. 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 manufacturer production cost ("MPC") estimates.

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

Ameren *et al.* noted that the vast majority of RCW energy savings documented in the September 2021 Preliminary TSD is driven by the top-loading standard-size product class, and recommended that DOE take a rigorous approach to evaluate the baseline technologies, likely technology pathways, and associated incremental cost for this product class. (Ameren *et al.*, No. 42 at pp. 3−4) As discussed, DOE followed a rigorous approach to developing the cost-efficiency relationship for each product class.

4. Cost-Efficiency Results

In the September 2021 Preliminary Analysis, DOE conducted teardowns on 31 models, which covered the entire range of efficiency levels within each analyzed product class.

The preliminary baseline MPCs presented in the September 2021 Preliminary Analysis for each product class are shown in Table IV.14.

Table IV.14 Preliminary Baseline Manufacturer Production Costs (2020$), as Presented in the September 2021 Preliminary Analysis

Product Class	Manufacturer Production Cost
Top-Loading, Compact (less than 1.6 ft^3 capacity) *	$311.00
Top-Loading, Standard-Size (1.6 ft^3 or greater capacity)	$241.97
Front-Loading, Compact (less than 3.0 ft^3 capacity)	$292.85
Front-Loading, Standard-Size (3.0 ft^3 or greater capacity)	$410.15

* As discussed in section IV.A.1 of this document, DOE is proposing in this NOPR to rename the top-loading compact product class analyzed in the September 2021 Preliminary Analysis to top-loading "ultra-compact."

The incremental MPCs presented in the September 2021 Preliminary Analysis for top-loading standard-size; front-loading compact; and front-loading standard-size product classes are shown in Table IV.15 through Table IV.17, respectively. As described previously, DOE did not analyze any higher efficiency levels for the top-loading compact product class in the September 2021 Preliminary Analysis since no units on the market exceeded the baseline level.

Table IV.15 Preliminary Incremental Manufacturer Production Costs for Top-Loading, Standard-Size (≥ 1.6 ft^3) Product Class (2020$), as Presented in the September 2021 Preliminary Analysis

EL	IMEF	IWF	Incremental Cost
Baseline	1.57	6.5	-
1	1.70	5.0	$39.44
2	2.06	4.3	$69.34
3	2.38	3.7	$112.83
4	2.76	3.5	$115.50

Table IV.16 Preliminary Incremental Manufacturer Production Costs for Front-Loading, Compact (< 3.0 ft^3) Product Class (2020$), as Presented in the September 2021 Preliminary Analysis

EL	IMEF	IWF	Incremental Cost
Baseline	1.84	4.7	-
1	2.07	4.2	$17.97
2	2.20	3.7	$45.58
3	2.38	3.7	$83.81
4	2.76	3.2	$94.53

Table IV.17 Preliminary Incremental Manufacturer Production Costs for Front-Loading, Standard-Size (≥ 3.0 ft^3) Product Class (2020$), as Presented in the September 2021 Preliminary Analysis

EL	IMEF	IWF	Incremental Cost
Baseline	1.57	6.5	-
1	1.70	5.0	$39.44
2	2.06	4.3	$69.34
3	2.38	3.7	$112.83
4	2.76	3.5	$115.50

In the September 2021 Preliminary Analysis, DOE sought comment on the cost efficiency relationships developed for each product class. In particular, DOE sought data and information that could be used to further improve the determination of cost at each efficiency level.

Ameren *et al.* commented that NEEA commissioned a laboratory engineering teardown study ("2019 NEEA Teardown"), comparing appendix J2 testing and teardown results of a top-loading standard-size RCW rated at the ENERGY STAR level with a similar top-loading standard-size RCW rated at the baseline level. (Ameren *et al.*, No. 42 at pp. 13−14) Ameren *et al.* stated that the 2019 NEEA Teardown revealed the key difference between the two RCW models was technology that improved water extraction and therefore reduced drying energy. (*Id.*) Specifically, the ENERGY STAR model had a 0.4 horsepower motor, whereas the baseline model had a 0.33 horsepower motor, and the ENERGY STAR model had a slightly larger diameter pully that enabled a higher spin speed of 800 rpm compared to the 700 rpm of the baseline model. (*Id.*) Ameren *et al.* added that even though these differences resulted in slightly higher machine energy use for the ENERGY STAR model, the overall IMEF was better than the baseline model because the ENERGY STAR model had better water extraction capability. (*Id.*) Based on the data from the 2019 NEEA Teardown, Ameren *et al*. recommended that DOE consider an increased motor size and alternate pully ratio as a lower-cost compliance pathway to enable higher spin speeds and lower drying energy sufficient to meet EL 2 as proposed in the September 2021 Preliminary TSD. (*Id*.) Ameren *et al*. added that this lower-cost technology pathway may be more likely given the higher manufacturing cost of the significant redesign needed to employ a direct drive motor for compliance with EL 2. (*Id*.)

As noted, DOE conducted teardowns on a wide range of top-loading RCWs to inform the cost-efficiency relationships presented in the September 2021 Preliminary Analysis and in this NOPR. DOE's analysis confirms Ameren *et al*.'s finding that reduced drying energy through improved water extraction is a key difference between the baseline level and the ENERGY STAR level (*i.e.*, EL 2) in the top-loading standard-size product class. As noted by Ameren *et al.*, DOE's teardown analysis conducted in support of the September 2021 Preliminary Analysis indicated that to achieve EL 2, manufacturers would likely incorporate a wash plate (sometimes also called an "impeller"); direct-drive motor; spray rinse; and other hardware features to enable a spin speed increase. As described previously, the cost-efficiency relationship developed for each product class reflects DOE's assessment of a market-representative "path" to achieve each higher efficiency level; *i.e.*, it does not necessarily reflect the lowest-cost pathway employed by a particular manufacturer. Through the breadth of models torn down at the baseline level and EL 2, DOE determined that the most typical approach currently being used by manufacturers to achieve EL 2 is through the use of a direct-drive motor. DOE also notes that regardless of whether higher spin speeds are achieved through the use of a conventional motor or direct-drive motor, other hardware-related changes must also be employed to safely enable higher spin speeds. The cost-efficiency relationship reflects the totality of these costs.

The CA IOUs commented that the September 2021 Preliminary TSD does not appear to incorporate lower standby components at any efficiency levels for top-loading clothes washers, despite lower standby power being listed in remaining design options of the screening analysis. (CA IOUs, No. 43 at p. 5) The CA IOUs therefore recommended that DOE consider adding lower standby power components as a design option for top-loading products when incorporating changes to its analysis. (*Id.*)

Through its testing and teardowns conducted in support of the September 2021 Preliminary Analysis as well as this NOPR, DOE has not observed any consistent trend of lower-standby power components being used to achieve higher efficiency levels within the top-loading standard-size product class. As discussed, the cost-efficiency relationship developed for each product class reflects DOE's assessment of a market-representative "path" to achieve each higher efficiency level. DOE notes that given the relatively small contribution of standby power to the total energy measured by the test procedure, reducing standby power has a relatively minor impact on EER compared to other design options.

AHAM commented that based on its test data, it would be challenging for low priced top-loading clothes washers to meet the efficiency levels DOE analyzed in the September 2021 Preliminary Analysis. (AHAM, No. 40 at p. 16) Whirlpool commented that many of the design options DOE suggested in the September 2021 Preliminary Analysis to reach EL 2 would present significant challenges to manufacturers and cautioned DOE against considering some of these design options as viable technology options. (Whirlpool, No. 39 at p. 3)

With regard to top-loading standard-size EL 2 specifically, in the September 2021 Preliminary Analysis, DOE indicated that the following design options are used: wash plate, direct-drive motor, spray rinse, and hardware features enabling spin speed increase. As discussed, DOE's identification of design options reflects DOE's observations through teardowns of those design options that manufacturers are currently employing to achieve each higher efficiency level. DOE's analyses consider the costs required to implement these design options as well as other implications that may be associated with each higher efficiency level.

Ameren *et al*. commented that NEEA's market research identified key characteristics of baseline top-loading standard-size RCWs, including capacity, water fill control, number of programs, number of wash temperatures, price, and wash basket material type, based on a sample of 9 RCWs, representing 6 brands, and comprising 32 percent of total top-loading standard-size RCW sales. (Ameren *et al*., No. 42 at p. 3−6) Ameren *et al*. concluded that NEEA's data matched well with DOE's characterization of the baseline product market with one key exception: NEEA observed a dominance of stainless-steel wash baskets in the baseline market, while DOE characterizes the baseline product as having an enameled steel wash basket. (*Id*.) NEEA found that, among RCWs with a retail price less than $600, 64 percent of top-loading baseline efficiency RCWs had stainless-steel wash baskets, and that among RCWs with a retail price less than $500, 51 percent of RCWs had stainless-steel wash baskets. (*Id.*) Given NEEA's findings, Ameren *et al.* recommended that DOE adjust the engineering analysis to include stainless-steel wash baskets in its characterization of the baseline model by either adopting a representative baseline model with a stainless-steel wash basket to represent the baseline top-loading standard-size RCWs, or developing a sales-weighted average cost of the top-loading RCW baseline model and a sales-weighted average incremental cost for EL 1 and EL 2. (*Id.*)

Whirlpool also commented on the use of stainless-steel wash baskets as a design option. Whirlpool commented that its testing confirmed DOE's statement that drying energy is the largest component of overall efficiency and stated that a faster and longer spin speed is the number one technology option for many clothes washer models to enable increased efficiency as measured using IMEF or EER. (Whirlpool, No. 39 at pp. 4–6) Whirlpool added that for some clothes washers, increasing spin speed or spin time would be the only viable path to meet EL 2. (*Id.*) Whirlpool commented that using stainless-steel wash baskets instead of porcelain ones is a necessary technology upgrade to increase spin speed and spin time because porcelain tends to chip or crack at higher speeds, which exposes the underlying steel, which then rusts. (*Id.*) Whirlpool commented that an increase to amended standards could drive porcelain wash baskets out of the market and force a massive costly shift to stainless-steel wash baskets. (*Id.*) Whirlpool noted that clothes washers with porcelain wash baskets comprise a majority of its opening-price-point top-loading standard-size clothes washers, which are popular with consumers for their traditional look and affordability. (*Id.*) Whirlpool expressed concern that the transition to using stainless-steel wash baskets would lead to increased costs for redesign, retooling, lost sales volume, reduced margins, marketing and reflooring, and potential job losses, all of which may be a cost burden to bear by low-income consumers. (*Id.*)

DOE defines a baseline model for each product class as a reference point against which any changes resulting from energy conservation standards can be measured. The baseline model in each product class represents the characteristics of common or typical products in that class. Typically, a baseline model is one that exactly meets the current minimum energy conservation standards. DOE's cost efficiency curves are intended to represent incremental costs associated with design options that are required in order to achieve higher efficiency levels above the baseline. For top-loading standard-size clothes washers, the faster spin speed at EL 2 requires the use of a stainless-steel wash basket, which has higher strength than the enameled steel material used in baseline models. For top-loading standard-size products at lower efficiency levels (*i.e.*, baseline and EL 1), stainless steel may be used for aesthetic purposes but is not required in order to operate at that efficiency level. DOE teardowns indicate that use of an enameled steel material is representative of a "true" baseline top-loading compact RCW, and DOE maintains this as the basis for its baseline manufacturing cost estimate in this NOPR. However, DOE notes that its industry conversion cost estimates account for the costs associated with transitioning the portion of the market using porcelain wash baskets to stainless-steel wash baskets.

Whirlpool also commented that in addition to using a stainless-steel wash basket, other hardware features would be needed to enable the higher spin speeds required under EL 2 including motor power and powertrain upgrades; more robust product structure such as drive stampings, suspension, and attachments; and components that keep noise and vibration levels consistent with current products. (*Id.*) Whirlpool concluded that, while DOE captured some of the design options needed to increase spin speed and spin time, DOE's analysis may not be comprehensive of the number and scale of changes needed when simultaneously changing the test procedure and standards. (*Id.*)

Whirlpool commented that, while implementing a direct drive motor could use up to 50 percent less motor energy, which corresponds with about 5 percent less total energy, the larger savings would come from the increase to spin speed enabled by these new motors and powertrain systems. (Whirlpool, No. 39 at p. 6) Whirlpool also commented that most ENERGY STAR level clothes washers have a direct drive motor or more advanced brushless permanent magnet ("BPM") motor, while baseline models typically use a permanent split capacitor ("PSC") motor, which is less expensive, but is not capable of reaching higher speeds without tradeoffs. (*Id.*)

AHAM commented that increasing spin speed and spin time will drive motor structure and other product design changes including larger counterweights in front-loading clothes washers. (AHAM, No. 40 at pp. 9–10) AHAM further commented that increasing spin speed and spin time could cause increased vibration and noise, negatively impact fabric care due to tangling and wrinkling, and increase cycle time. (*Id.*)

Whirlpool commented that more efficient spray rinses are a critical piece in the package of technology options needed to meet EL 2 for top-loading standard-size clothes washers. (Whirlpool, No. 39 at p. 6) Whirlpool further explained that while spray rinse is already being used for most models, a further reduction of the amount of water used during spray rinses will be necessary at higher efficiency levels. (*Id*.) Whirlpool commented that changes to make spray rinse technology even more efficient may impact the design of dispensers and hydraulic components to use less water for the removal of detergent from the load. (*Id*.) Whirlpool commented that it is uncertain whether DOE has adequately captured these additional design considerations for spray rinse technology and recommended that DOE ensure that they are captured. (*Id*.)

In response to Whirlpool and AHAM's comments regarding the costs associated with specific design options, DOE notes that it developed its cost-efficiency relationships based on comprehensive teardowns in which DOE physically dismantles commercially available products, component-by-component, to develop a detailed bill of materials for the product. In this regard, any ancillary components or parts that accompany the major design options indicated in chapter 5 of the NOPR TSD would also be accounted for in DOE's cost estimates. In particular, with regard to hardware features needed to enable higher spin speeds, DOE's teardown costs include the cost increases associated with motor structure, bearings, and counterweights. With regard to hardware features needed to enable spray rinse, DOE's teardown costs include the cost increases associated with water dispensers and tubing.

As discussed, DOE conducted additional testing and teardowns following the September 2021 Preliminary Analysis. Table IV.18 shows the updated MPCs for each product class. Table IV.19 through Table IV.22 provide the incremental MPCs for each higher efficiency level for each product class. As discussed, no automatic top-loading compact RCWs are available on the market that exceed the baseline level. Accordingly, DOE did not consider any higher efficiency levels for this product class.

Table IV.18 Baseline Manufacturer Production Costs (2021$)

Product Class	Manufacturer Production Cost
Semi-Automatic	$192.96
Top-Loading, Ultra-Compact (less than 1.6 ft^3 capacity)	$374.62
Top-Loading, Standard-Size (1.6 ft^3 or greater capacity)	$272.42
Front-Loading, Compact (less than 3.0 ft^3 capacity)	$326.18
Front-Loading, Standard-Size (3.0 ft^3 or greater capacity)	$525.52

Table IV.19 Incremental Manufacturer Production Costs for Semi-Automatic Product Class (2021$)

EL	EER	WER	Incremental Cost
Baseline	1.60	0.17	-
1	2.12	0.27	$5.45
2	2.51	0.36	$9.55

Table IV.20 Incremental Manufacturer Production Costs for Top-Loading, Standard-Size ($\geq$ 1.6 ft^3) Product Class (2021$)

EL	IMEF	IWF	Incremental Cost
Baseline	1.57	6.5	-
1	1.82	5.4	$55.49
2	2.06	4.3	$108.76
3	2.38	3.7	$114.95
4	2.76	3.5	$117.90

Table IV.21 Incremental Manufacturer Production Costs for Front-Loading, Compact (< 3.0 ft^3) Product Class (2021$)

EL	IMEF	IWF	Incremental Cost
Baseline	1.84	4.7	-
1	2.07	4.2	$32.21
2	2.20	3.7	$62.07
3	2.50	3.5	$82.10
4	2.76	3.2	$84.04

Table IV.22 Manufacturer Production Costs for Front-Loading, Standard-Size (≥ 3.0 ft^3) Product Class (2021$)

EL	IMEF	IWF	Incremental Cost
Baseline	1.57	6.5	-
1	1.70	5.0	$11.41
2	2.06	4.3	$19.71
3	2.38	3.7	$30.52
4	2.76	3.5	$43.64

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

5. Translations

As discussed in section III.C of this document, the June 2022 TP Final Rule established a new test procedure, appendix J, which established new efficiency metrics: EER and WER. Appendix J also incorporates a number of revisions that affect the per-cycle energy and water use in comparison to results obtained under the current appendix J2 test procedure.

a. Preliminary Analysis Approach

In chapter 5 of the September 2021 Preliminary TSD, DOE performed an initial analysis to translate the appendix J2 efficiency levels into appendix J efficiency levels, expressed in EER and WER. Since appendix J was not yet finalized at the time of publication for the September 2021 Preliminary Analysis, DOE's initial analysis was performed using the version of appendix J proposed in the September 2021 TP NOPR.

In the September 2021 Preliminary Analysis, DOE explored two potential methods for translating the IMEF and IWF efficiency levels into equivalent values of EER and WER: using a best-fit line equation for each product class, and using a more qualitative market-cluster method. The IMEF-EER plots generally had lower R-squared values[48] than the IWF-WER plots, indicating a weaker correlation between EER and IMEF than the relatively stronger correlation between WER and IWF. In particular, the front-loading standard-size product class had an R-squared value of 0.08—indicating a high amount of variance around the line of best fit—such that the linear translation formula would not provide a robust prediction of how individual front-loading standard-size models would be rated under appendix J compared to under appendix J2. Conversely, the top-loading standard-size product class had a higher R-squared value of 0.77 for the IMEF to EER translation, indicating a much higher degree of confidence in the prediction of how individual top-loading standard-size models would be rated under appendix J. Given the lack of strong R-squared value correlation for the front-loading product classes using the best-fit line method, for the September 2021 Preliminary

[48] The R-squared values of each line of best fit represents the variability of the data around the lines of best fit. The closer the R-squared value is to 1.0, the more the equation of best fit is an accurate representation of the conversion between the two metrics.

Analysis, DOE used a market-cluster approach to define the EER and WER levels corresponding to the selected IMEF and IWF efficiency levels.

The translated EER and WER efficiency levels presented in the September 2021 Preliminary Analysis are shown in Table IV.23 through Table IV.26.

Table IV.23 Top-Loading, Compact* (< 1.6 ft^3) Preliminary Efficiency Levels Analyzed in the September 2021 Preliminary Analysis

EL	Efficiency Level Description	IMEF *(ft^3/kWh/cycle)*	IWF *(gal/cycle/ft^3)*	EER *(lb/kWh/cycle)*	WER *(lb/gal/cycle)*
Baseline	Current DOE standard	1.15	12.0	4.26	0.33

* As discussed in section IV.A.1 of this document, DOE is proposing in this NOPR to rename the top-loading compact product class analyzed in the September 2021 Preliminary Analysis to top-loading "ultra-compact."

Table IV.24 Top-Loading, Standard-Size (≥ 1.6 ft^3) Preliminary Efficiency Levels Analyzed in the September 2021 Preliminary Analysis

EL	Efficiency Level Description	IMEF *(ft^3/kWh/cycle)*	IWF *(gal/cycle/ft^3)*	EER *(lb/kWh/cycle)*	WER *(lb/gal/cycle)*
Baseline	Current DOE standard	1.57	6.5	3.73	0.42
1	Gap fill	1.70	5.0	4.05	0.54
2	ENERGY STAR v. 8.1	2.06	4.3	4.37	0.65
3	2015–2017 CEE Tier 1	2.38	3.7	4.96	0.73
4	2015 ENERGY STAR Most Efficient / Maximum available	2.76	3.5	5.30	0.73

Table IV.25 Front-Loading, Compact (< 3.0 ft^3) Preliminary Efficiency Levels Analyzed in the September 2021 Preliminary Analysis

EL	Efficiency Level Description	IMEF *(ft^3/kWh/cycle)*	IWF *(gal/cycle/ft^3)*	EER *(lb/kWh/cycle)*	WER *(lb/gal/cycle)*
Baseline	Current DOE standard for front-loading, standard-size (≥ 1.6 ft^3)	1.84	4.7	4.20	0.61
1	ENERGY STAR v. 8.1 level for units ≤ 2.5 ft^3	2.07	4.2	4.49	0.66
2	2018–2022 ENERGY STAR Most Efficient for units ≤ 2.5 ft^3	2.20	3.7	4.78	0.71
3	ENERGY STAR v. 7.0 level for units > 2.5 ft^3	2.38	3.7	5.10	0.78
4	ENERGY STAR v. 8.1 level for units > 2.5 ft^3 / Maximum available	2.76	3.2	5.60	0.88

Table IV.26 Front-Loading, Standard-Size (≥ 3.0 ft^3) Preliminary Efficiency Levels Analyzed in the September 2021 Preliminary Analysis

EL	Efficiency Level Description	IMEF *(ft^3/kWh/cycle)*	IWF *(gal/cycle/ft^3)*	EER *(lb/kWh/cycle)*	WER *(lb/gal/cycle)*
Baseline	ENERGY STAR v. 7.0	2.38	3.7	4.90	0.81
1	Gap fill	2.60	3.5	5.10	0.85
2	ENERGY STAR v. 8.1	2.76	3.2	5.30	0.90
3	2018–2022 ENERGY STAR Most Efficient	2.92	3.2	5.60	0.90
4	Maximum available	3.00	2.9	6.06	1.10

In the September 2021 Preliminary Analysis, DOE sought comment on the EER and WER levels identified as being equivalent to the IMEF and IWF efficiency levels. DOE further requested data from manufacturers indicating the EER and WER values equivalent to the IMEF and IWF values, respectively, for RCW models currently on the market.

Whirlpool commented that DOE underestimated the impacts of the amended test procedure on RCW efficiency and overestimated the number of models that could meet the EER associated with EL 2 in the September 2021 Preliminary TSD, when tested under appendix J. (Whirlpool, No. 39 at p. 3) Whirlpool also commented that many current ENERGY STAR certified RCWs meet the IMEF and IWF levels associated with preliminary EL 2, but would not meet the EER and WER levels defined for EL 2. (*Id.*) Whirlpool commented that this discrepancy could indicate that the impact of the proposed amended standards could be more severe than DOE analyzed. (*Id.*)

AHAM commented that without a proven translation between appendix J2 and appendix J, DOE has no reliable means to estimate energy savings from its incremental ELs. (AHAM, No. 40 at p. 16) AHAM commented that it attempted to evaluate the accuracy of DOE's translation by comparing tested appendix J2 and appendix J data among clothes washers that AHAM tested. (*Id.*) AHAM presented a table comparing R-squared values for AHAM test data with those presented by DOE in the preliminary analysis. (*Id.*) AHAM commented that its results are consistent with DOE's statement that the best-fit line method is insufficient for front-loading clothes washers. (*Id.*) Additionally, AHAM concluded that DOE's best-fit line equations show low levels of correlation between appendix J2 and appendix J testing, especially for top-loading standard-size and front-loading compact products. (*Id.*) AHAM therefore recommended that DOE update its analysis to improve the accuracy of the best-fit line equations and that DOE further investigate the impact of changing from a capacity-based test procedure to a load size-based test procedure on energy and water use. (*Id.*)

AHAM also presented data that plotted DOE’s proposed efficiency levels as well as EER versus WER data for the clothes washers that AHAM tested. (AHAM, No. 40 at pp. 16–17) Based on the data, AHAM found that 65 percent of the top-loading standard-size RCWs it tested, which represent about half of top-loading standard-size clothes washer shipments, are less efficient than the EER/WER baseline proposed in the September 2021 Preliminary TSD. (*Id.*) AHAM similarly noted that 44.5 percent of DOE’s tested and predicted results are less efficient that the proposed EER/WER baseline. (*Id.*) AHAM therefore recommended that DOE shift the baseline for top-loading standard-size clothes washers so that it appropriately represents the least efficient clothes washers on the market. (*Id.*) AHAM suggested that DOE evaluate a gap-fill level between a baseline level that accounts for the RCWs that fall below DOE’s proposed baseline level and DOE’s proposed EL 1. (AHAM, No. 40 at p. 18) AHAM further commented that the baseline EER/WER level DOE proposed in the September 2021 Preliminary Analysis could serve as a gap-fill level. (*Id.*)

AHAM commented that it is challenging for top-loading standard-size RCWs to reach the EER and WER levels associated with preliminary EL 2. (AHAM, No. 40 at pp. 17–18) Since the IMEF and IWF efficiency levels associated with preliminary EL 2 are the same as the current ENERGY STAR levels, AHAM sought to clarify that DOE should not assume that the current ENERGY STAR penetration values would represent the percentage of models or shipments that can meet EL 2 when tested under appendix J. (*Id.*)

Regarding DOE's method to evaluate average performance among market clusters, AHAM commented that since DOE did not provide critical calculation and evaluation metrics for its results, AHAM cannot properly assess this approach or test the method's accuracy using AHAM's data. (AHAM, No. 40 at p. 16)

AHAM commented that the models it tested represent approximately half of total 2020 shipments, and that its test results bring into question the accuracy to DOE's data. (AHAM, No. 53 at pp. 10−11) AHAM recommended that DOE carefully evaluate AHAM's dataset and integrate it with its own data in order to update its analysis. (*Id.*)

ASAP *et al.* commented that they support DOE's approach to use the market cluster approach outlined in EPCA to develop efficiency levels. (ASAP *et al.*, No. 37 at p. 1)

The CA IOUs expressed concern that for the top-loading compact product class, the IMEF versus EER and IWF versus WER translations indicate opposite trends compared to the other three product classes, showing a negative relationship between IMEF and EER and a positive relationship between IWF and WER. (CA IOUs, No. 43 at p. 3)

Following publication of the September 2021 Preliminary Analysis, DOE published the April 2022 NODA, which presented the results of additional testing conducted in furtherance of the development of the translations between the current test procedure and the proposed new test procedure. 87 FR 21816. The improved translation equations addressed the concerns expressed by commenters regarding the translations presented in the September 2021 Preliminary Analysis. The following section summarizes the translation approach presented in the April 2022 NODA.

b. NODA Approach

In the April 2022 NODA, DOE published updated translation equations that were developed using data points from the 44 units it tested to both appendix J2 and appendix J. In a separate spreadsheet accompanying the April 2022 NODA and available in the rulemaking docket, DOE also published the underlying test results for each RCW model in its test sample. 87 FR 21816, 21817. The April 2022 NODA summarized analyses of RMC and water fill control system ("WFCS") type, which DOE tentatively determined have a significant impact on these translation equations. *Id*.

To account for the impacts of RMC, DOE developed values for "adjusted" EER based on an "adjusted" RMC, which is equivalent to the RMC value measured under appendix J2 plus 4 percentage points. *Id*. To account for the difference in efficiency level correlation between clothes washers with automatic and manual WFCS, DOE presented an alternate set of translation equations that separate top-loading portable RCWs (which use manual WFCS) from top-loading stationary RCWs (which provide either automatic WFCS or both manual and automatic WFCSs). 87 FR 21816, 21820.

The following sections summarize the adjusted RMC approach presented in the April 2022 NODA. As discussed previously, RMC is a significant contributor to both the IMEF and EER metrics. The approach presented in the April 2022 NODA provides the foundation for the approach used for this NOPR, as discussed further in section IV.C.5.c of this document.

i. Adjusted RMC

The following paragraphs explain the difference in RMC measurement methodology between appendix J2 and appendix J. This difference in methodology underlies DOE's careful consideration of RMC in developing the metric translation equations.

As discussed, the RMC is a measure of the amount of water remaining in the clothing load after completion of the clothes washer cycle. The RMC value is used to calculate the total per-cycle energy consumption for removal of moisture from the clothes washer test load in a clothes dryer to an assumed final moisture content, *i.e.*, the "drying energy," which is one of the factors contained within both the IMEF and EER metrics. Lower values of RMC result in less drying energy and thus represent more-efficient performance.

Section 3.8.2 of appendix J2 requires that the RMC be calculated based on a test run with the maximum load size on the Cold Wash/Cold Rinse ("Cold/Cold") temperature selection. Section 3.8.4 of appendix J2 requires that for clothes washers that have multiple spin settings[49] available within the energy test cycle that result in different RMC values, the maximum and minimum extremes of the available spin settings must be

[49] The term "spin settings" refers to spin times or spin speeds. The maximum spin setting results in a lower (better) RMC.

tested with the maximum load size on the Cold/Cold temperature selection.[50] In this case, the final RMC is the weighted average of the maximum and minimum spin settings, with the maximum spin setting weighted at 75 percent and the minimum spin setting weighted at 25 percent.

In contrast, appendix J requires measuring RMC on each of the energy test cycles (*i.e.*, each load size and each wash/rinse temperature combination included for testing) using the default spin setting. On some clothes washers, the default spin setting is not the maximum spin setting. In section 4.3 of appendix J, the final RMC is calculated by weighting the individual RMC measurements using the same temperature and load size weighting factors that apply to the water and energy measurements.

As discussed in the April 2022 NODA, multiple factors can affect the RMC of a particular cycle, including the spin speed and the duration of the spin portion of the wash cycle. 87 FR 21816, 21818. The size of the load can also affect RMC—generally, larger load sizes result in lower (better) RMC values, whereas smaller load sizes result in higher (worse) RMC values. *Id*. These factors result in different measured RMC values for appendix J and appendix J2, specifically because under appendix J, RMC is measured across a wider range of cycles (compared to only the Cold/Cold cycle in appendix J2) and

[50] On clothes washers that provide a Warm Rinse option, appendix J2 requires that RMC be measured on both Cold Rinse and Warm Rinse, with the final RMC calculated as a weighted average using TUFs of 73 percent for Cold Rinse and 27 percent for Warm Rinse. DOE has observed very few RCW models on the market that offer Warm Rinse. For simplicity throughout this discussion, DOE references the testing requirements for clothes washers that offer Cold Rinse only.

because the appendix J load sizes are smaller than the appendix J2 maximum load size (on which the appendix J2 RMC measurement is based). *Id*.

In the interest of improving the translation equations as presented in the September 2021 Preliminary Analysis, DOE conducted an in-depth analysis of the differences in RMC between the appendix J2 and proposed appendix J test procedures. *Id*. For each unit that DOE tested, DOE examined the cycle-by-cycle test results to determine the key driver behind the difference in RMC when testing to appendix J as compared to appendix J2. *Id*. Based on this analysis, DOE identified three categories of spin implementations that result in differences between the appendix J RMC value and the appendix J2 RMC value, described as follows.

- The first type, referred to as "consistent spin" throughout the remainder of this NOPR, is illustrative of units in which the characteristics of the spin cycle (*e.g.*, spin speed, spin time) are consistent across temperature selections. On these units, RMC values measured on Warm/Cold, Hot/Cold, and Extra Hot/Cold cycles are substantially similar to the RMC value measured on the Cold/Cold cycle.[51]

- The second type, referred to as "Cold/Cold optimized spin" throughout the remainder of this NOPR, is illustrative of units in which the spin cycle is

[51] DOE notes that the "consistent spin" designation is not meant to exclude clothes washers that offer multiple spin speed settings on the Normal cycle. Rather, the term "consistent" refers to a particular spin speed setting demonstrating substantially similar performance regardless of which wash/rinse temperature is selected.

optimized on the Cold/Cold setting with maximum load size, corresponding to the one cycle combination for which RMC is measured under appendix J2. On these units, the spin portion of the cycle is significantly faster or longer on either the Cold/Cold setting, when using a maximum load size, or both as compared to the other temperature settings or load sizes that are tested as part of the energy test cycle.

- The third type, referred to as "non-default maximum spin" throughout the remainder of this NOPR, is illustrative of units in which the maximum spin speed setting (which is tested under appendix J2) is not the default spin speed setting on the Normal cycle. On these units, the default spin speed setting tested under appendix J would provide a lower-speed spin or a shorter spin portion of the cycle. *Id*.

For clothes washers with "consistent spin," the only source of difference between the measured RMC values under appendix J and appendix J2 is the use of smaller load sizes for appendix J. *Id*. The observed difference in RMC between the two test procedures is relatively consistent among models from different manufacturers of RCWs with this characteristic, as discussed further in this section. *Id*.

For clothes washers with "Cold/Cold optimized spin" the difference between the measured RMC values under appendix J and appendix J2 is due to a combination of both the smaller load sizes for appendix J and the different spin behavior on the temperature settings other than Cold/Cold. *Id*. The observed difference in RMC between the two test procedures varies significantly among models from different manufacturers of RCWs with "Cold/Cold optimized spin," depending on the degree to which the Cold/Cold RMC differs from the RMC on all other tested cycles. *Id*.

For clothes washers with "non-default maximum spin," the difference between the measured RMC values under appendix J and appendix J2 is due to a combination of both the smaller load sizes for appendix J and the different spin behavior on the maximum and default spin settings. *Id*. Similar to units with "Cold/Cold optimized spin," the observed difference in RMC between the two test procedures varies significantly among models from different manufacturers of RCWs with "non-default maximum spin," depending on the degree to which the maximum spin setting differs from the default spin setting. *Id*.

As discussed, the RMC value is the most significant contributor to both the IMEF metric measured by appendix J2 and the EER metric measured by appendix J. *Id*. Because of the more significant variation in RMC between the two test procedures for "Cold/Cold optimized spin" and "non-default maximum spin" units, the correlation between IMEF and EER for these units is less strong (*i.e.*, lower "R-squared" values for the best-fit line) than for "consistent spin" units. *Id*. at 87 FR 21819.

To investigate strategies for defining translation equations with a stronger correlation between IMEF and EER, DOE developed a second set of EER values based on an "adjusted" RMC value (substituted for the measured RMC value) that assumes a "consistent spin" characteristic for each unit in the test sample. *Id*. Under this approach, only the change in load size would be assumed to impact the RMC values measured under appendix J as compared to appendix J2. *Id*. DOE's test data indicated that the smaller load sizes under appendix J result in an increase in RMC of 4 percentage points compared to the RMC values measured under appendix J2 using the maximum load size. *Id*. Therefore, for this approach, DOE calculated an "adjusted RMC" for each unit as the tested RMC value under appendix J2 plus 4 percentage points. *Id*. DOE substituted this adjusted RMC for the RMC value in the drying energy equation within the EER calculation. *Id*. As demonstrated in the second set of "adjusted" translation plots, this approach produced translation equations with significantly higher R-squared values, indicating a stronger correlation between IMEF and EER. *Id*.

Comments submitted by a manufacturer in response to the September 2021 NOPR suggested that, were DOE to amend standards based on appendix J as proposed, manufacturers that currently use "Cold/Cold optimized spin" or "non-default maximum spin"—which yield lower (*i.e.*, better) RMC values on the Cold/Cold temperature setting compared to RMC values obtained using the other temperature settings for RCWs with "Cold/Cold optimized spin," and on the maximum spin setting for RCWs with "non-default maximum spin"—would likely implement similar strategies to decrease the RMC across all cycles required for testing under appendix J. (EERE-2016-BT-TP-0011, Whirlpool, No. 26 at p. 8–9). Specifically, for "Cold/Cold optimized spin" units, manufacturers would likely increase the spin speeds or spin durations across all temperature settings to match the spin behavior of the Cold/Cold temperature setting. For "non-default maximum spin" units, manufacturers would likely make the maximum spin speed the default spin setting to provide the lowest possible (*i.e.*, best possible) RMC measurement under appendix J.

In response to stakeholder questions, DOE published a supplemental data report providing additional details as to how it calculated an average increase in RMC of 4 percentage points due to the smaller load sizes defined in appendix J.[52] DOE investigated two separate methods for determining the impact of test load size on RMC. Both methods yielded nearly identical results, as described in the following paragraphs.

For Method 1, DOE compared the final corrected RMC values obtained under both test procedures for only those units that DOE designated as having a “consistent spin” spin implementation. As described, units designated as “consistent spin” demonstrate key characteristics of the spin cycle (*e.g.*, spin speed, spin time) that are consistent across temperature selections; as such, DOE expects that for these units, the difference between the two final RMC values is due primarily to the difference in load sizes between the two test procedures. Among all the “consistent spin” units in the test sample, appendix J yielded a final RMC value 3.7 percentage points higher than appendix J2, on average.

For Method 2, DOE measured and compared the cycle-specific corrected RMC values for only the following specific Cold/Cold cycles: the appendix J2 Cold/Cold cycle with a maximum load size and default spin settings; the appendix J Cold/Cold cycle with

[52] Available at *www.regulations.gov/document/EERE-2017-BT-STD-0014-0048*.

a large load size and default spin settings; and the appendix J Cold/Cold cycle with a small load size and default spin settings. These three cycles differ only in load size, such that the differences between the RMC values are due primarily to the difference in load sizes.

DOE first calculated the average RMC value of these two appendix J cycles (consistent with the equivalent load weighting factors for the large and small load sizes defined by appendix J) and compared the resulting value to the RMC value for this appendix J2 cycle. Among all the units in the test sample, this approach indicated that the average of the large and small load sizes under appendix J yielded a final RMC value 3.8 percentage points higher than the maximum load size under appendix J2, on average.

In summary, the results from both Method 1 and Method 2 suggest that the smaller load sizes under appendix J result in an increase in RMC of approximately 4 percentage points, on average, compared to the RMC values measured under appendix J2 using the maximum load size.

In the April 2022 NODA, DOE requested comment on whether, if DOE were to establish amended RCW standards based on appendix J as proposed, manufacturers that currently use the "Cold/Cold optimized spin" strategy for their RCWs would modify the spin behavior across all temperature settings to match the spin behavior of the Cold/Cold temperature setting; and whether manufacturers that currently use the "non-default maximum spin" strategy for their RCWs would design the maximum spin speed to be the default spin setting. DOE further requested comment on the impact of such changes to the energy and water use, other aspects of consumer-relevant performance, and life-cycle cost of RCWs. 87 FR 21816.

The CA IOUs commented that all three of the spin strategies identified by DOE are currently on the market, and that identification of these three types of RMC strategies implemented in products currently on the market shows the value that appendix J will provide, in contrast to products optimized for the appendix J2 test rather than what the CA IOUs characterized as "real-world" operation. (CA IOUs, No. 52 at pp. 1–2)

According to ComEd and NEEA, NEEA's testing of 12 clothes washers representing more than 20 percent of sales from May 2018 to April 2019 confirms DOE's three spin implementation types for stationary RCWs; therefore, ComEd and NEEA encouraged DOE to continue to use these spin profiles. (ComEd and NEEA, No. 50 at p. 3)

ComEd and NEEA commented that they agree with DOE's assumption that manufacturers will likely maintain a similar measured efficiency of RCWs with the transition to appendix J, and they support DOE's assumption that manufacturers will modify RCWs to spin consistently across all cycles tested, enabling a comparable RMC and drying energy under appendix J. (ComEd and NEEA, No. 50 at pp. 2–4) According to ComEd and NEEA, most RCWs have a delicate wash program that consumers can use for textiles that may not be able to withstand higher spin speeds or longer spin durations, such that ComEd and NEEA do not expect changes to RMC as a result of appendix J to impact RCW utility. (*Id.*) For these reasons, ComEd and NEEA supported DOE's approach to developing the adjusted appendix J efficiency values proposed in the April 2022 NODA and encouraged DOE to employ the adjusted appendix J efficiency values to develop future candidate standards levels for RCW. (*Id.*)

ASAP *et al.* expressed support for DOE's April 2022 NODA approach to develop a more robust translation of RCW energy and water usage metrics from the current appendix J2 to the new appendix J test procedure. (ASAP *et al.*, No. 51 at pp. 1−2) Specifically, ASAP *et al.* expressed support for the approach of developing translations and resulting ELs based on adjusted RMC given the significant impact of RMC on overall energy usage and resulting efficiency ratings. (*Id.*) ASAP *et al.* commented that given Whirlpool's comments suggesting that manufacturers with RCWs optimized for the appendix J2 spin settings would likely re-program these units to perform better when tested under new appendix J, ASAP *et al.* find it reasonable to assume that manufacturers would modify RCW spin settings if DOE were to establish amended standards based on the new appendix J. (*Id.*)

AHAM commented in response to the September 2021 Preliminary Analysis that DOE's proposed changes to the load sizes in new appendix J would lead to an increase in RMC. (AHAM, No. 40 at pp. 9−10) AHAM noted that accordingly, manufacturers would need to increase spin speed and spin times to compensate for this change so that they continue to comply with future energy conservation standards. (*Id.*)

In response to the April 2022 NODA, AHAM presented data that examined the corrected RMC of units with "consistent spin," including units that were tested by both

AHAM and DOE. (AHAM, No. 53 at pp. 8–10) AHAM's data presented RMC for each unit as tested to appendix J2 and appendix J, and the difference between those values for each unit. (*Id.*) AHAM noted that when only considering units tested by AHAM, the average difference in RMC is 5.9 percent,[53] as opposed to the 3.7 percent average RMC difference calculated when only using the units in DOE's test sample from the April 2022 NODA. (*Id.*) AHAM also noted that when the AHAM and DOE datasets are combined, the average RMC difference is 4.7 percent. (*Id.*) AHAM commented that the difference in averages show that average RMC difference is subject to changes in sample content and size. (*Id.*) AHAM also commented that the range of RMC differences is wide. (*Id.*) AHAM noted that DOE's sample ranges from -1.6 to 11.3 percent difference, AHAM's sample ranges from -1.0 percent to 16.4 percent difference, and the combined sample has a range of -1.6 to 16.4 percent difference. (*Id.*) AHAM further commented that the models were well-distributed throughout the range and that the end points of this range are not outliers. (*Id.*)

AHAM commented that due to the wide range of differences in RMC between appendix J2 and appendix J testing among units in AHAM's and DOE's test samples, in AHAM's opinion, the average is not representative of the range of differences in the data. (AHAM, No. 53 at p. 10) AHAM also added that the average difference in RMC is highly susceptible to change depending on which and how many units are included in the dataset, which demonstrates that the average is not a reliable value for determining an "adder" to account for design optimization to the new test procedure. (*Id.*) AHAM

[53] DOE uses the term "percent" in this context to refer to RMC percentage points.

commented that without a proven translation between appendix J2 and appendix J, DOE has no reliable means to estimate energy savings from its incremental efficiency levels until it can conduct testing or receive test data to assist in re-establishing the baseline. (*Id*.)

AHAM commented that without a finalized test procedure to consider during the majority of the April 2022 NODA comment period and during the September 2021 Preliminary Analysis comment period, it was impossible to evaluate the percentage that would be appropriate for RMC adjustment, when the test procedure could change from DOE's proposal. (AHAM, No. 53 at p. 12) AHAM commented that even if an RMC adjustment is an appropriate approach for developing a translation between appendix J2 and appendix J, it does not change the overall concerns AHAM has with appendix J. (*Id.*) AHAM recommended that, now that DOE has finalized the test procedure, DOE should collect data to determine whether a translation equation or adjustment factor are possible and, if not, collect data to reestablish the baseline. (*Id*.)

AHAM further commented that without a proven translation between appendix J2 and appendix J, DOE has no reliable means to estimate energy savings from its incremental efficiency levels until it can conduct testing or receive test data to assist in re-establishing the baseline. (AHAM, No. 53 at p. 10) AHAM also commented that DOE needs to further investigate the impact of the change from capacity-based efficiency metrics to load-size based efficiency metrics. (*Id*.)

In response to AHAM's comment regarding the specific value of the "adjusted" RMC adder determined in the April 2022 NODA, DOE has closely reviewed AHAM's RMC data to understand the reason for the larger average difference between the test procedures than was observed in DOE's data. DOE also closely re-examined its own data, as presented in appendix 5A of the NOPR TSD. The following paragraphs summarize DOE's key conclusions from this analysis.

DOE notes that in both datasets, any differences above 10 percent appear to be outliers, as evidenced by a large gap in data points between 6 percent and 11 percent (whereas the data points less than 6 percent are fairly evenly distributed around the mean of 4 percent).

DOE re-evaluated the unit in its test sample with an RMC difference of 11.1 percent. Upon closer examination, DOE determined that this unit was incorrectly characterized in the April 2022 NODA as having a "consistent spin" spin implementation. Upon closer examination of the time series power data for each cycle, this unit exhibits "Cold/Cold optimized spin" behavior and therefore should be excluded from consideration for the purpose of determining an RMC adjustment factor based on load size differences alone. Although DOE does not have access to the time series power data underlying AHAM's data submission, DOE's determination that the outlier unit in DOE's test sample was incorrectly categorized suggests that the outlier units in AHAM's sample may also be incorrectly categorized as having "consistent spin" spin implementation. As discussed, given the large gap in data points between 6 percent and 11 percent, and given DOE's determination that it had incorrectly categorized its unit at

11 percent, DOE tentatively determines that the outlier data points above 11 percent very likely do not represent units with "consistent spin" spin implementation and therefore should be excluded from the analysis to determine an RMC adjustment factor based on load size differences alone.

Excluding such data points, DOE notes that the revised mean of DOE's dataset would be 3.4 percent. Excluding the values 12.1, 15.8, and 16.3 from AHAM's dataset, the revised mean would be 3.7 percent. Considering both datasets together, the revised mean of the joint dataset would be 3.5 percent.

Based on this analysis, DOE tentatively determines that a 4-percentage-point adder (rounded to the nearest whole number) provides a representative estimate of the change in RMC between the two test procedures due to only the change in load size. In this NOPR, DOE maintains use of the 4-percentage-point adder to calculate "adjusted RMC" for the purposes of developing translation equations.

ii. NODA Translation Equations

In the April 2022 NODA, DOE presented several versions of the translation equations that DOE could consider using to define potential higher efficiency levels based on the new EER and WER metrics. In particular, for the top-loading standard-size product class, DOE presented potential translations based on data points for all configurations as well as separate translations specific to stationary units with automatic WFCS and portable units with manual WFCS.

In response to the April 2022 NODA, AHAM presented data showing the R-squared values for the translation equations developed using DOE's data from the April 2022 NODA and using AHAM's data. (AHAM, No. 53 at p. 11) AHAM commented that the R-squared value for "top-loading, standard, all configurations" is very low, and that there is not a meaningful improvement using the adjusted RMC approach using DOE's data alone, or the combined AHAM and DOE dataset. (*Id.*)

AHAM commented that it understands that DOE's 4-percent adjustment in RMC was developed only to account for changes in tested spin speeds between appendix J2 and appendix J. (AHAM, No. 53 at p. 11) However, AHAM noted that there could be other design changes manufacturers would employ to account for the new test procedure. (*Id.*) AHAM added that DOE indicated that it did not consider other potential design changes. (*Id.*) AHAM added that it is inappropriate for a test procedure to drive design changes in and of itself. (*Id.*)

AHAM commented that it does not believe at this time that the translation equation can adequately address all models or changes in the test procedure to serve as a replacement for reestablishing the baseline through test data. (*Id.*) AHAM recommended that should DOE pursue a translation equation despite AHAM's comments that doing so is not supported by available data, DOE should consider design changes other than spin speed because spin speeds are not the only thing manufacturers will need to change in product design due to the new test procedure. (*Id.*)

DOE acknowledged in the April 2022 NODA that for the top-loading standard-size product class, each of the separate translation equations has a stronger correlation (*i.e.,* higher R-squared value) than the single translation equation in which top-loading portable and top-loading stationary products are combined. 87 FR 21816, 21820. DOE notes that the combined dataset for the top-loading standard-size sample contained 12 stationary units (representing 71 percent of the sample) and 5 portable units (representing 29 percent of the sample). Shipment data submitted by AHAM indicates that top-loading portable clothes washers represent approximately 1 percent of the top-loading market. This indicates that the portable configuration was significantly over-sampled within the combined dataset.

For this NOPR, DOE proposes to use datapoints representing only stationary units to develop the translation equations for the top-loading standard-size product class, on the basis that these units' characteristics are significantly more representative of the market than the portable configuration. Appendix 5A of the NOPR TSD provides further details and discussion of the development of the translation equations for this NOPR.

c. NOPR Approach

For this NOPR, DOE used the "adjusted EER" approach presented in the April 2022 NODA to define the translation between the appendix J2 and appendix J metrics for this NOPR. Additionally, as discussed further in appendix 5A of the NOPR TSD, DOE used AHAM's dataset to confirm the accuracy and appropriateness of these translation equations. Table IV.27 through Table IV.30 show the efficiency level translations considered in this NOPR based on the updated efficiency metric translations presented in chapter 5 of the NOPR TSD.

Table IV.27 Top-Loading, Ultra-Compact (< 1.6 ft^3) Efficiency Level Translations

EL	Efficiency Level Description	IMEF *(ft^3/kWh/cycle)*	IWF *(gal/cycle/ft^3)*	EER *(lb/kWh/cycle)*	WER *(lb/gal/cycle)*
Baseline	Current DOE standard	1.15	12.0	3.79	0.29

Table IV.28 Top-Loading, Standard-Size (≥ 1.6 ft^3) Efficiency Level Translations

EL	Efficiency Level Description	IMEF *(ft^3/kWh/cycle)*	IWF *(gal/cycle/ft^3)*	EER *(lb/kWh/cycle)*	WER *(lb/gal/cycle)*
Baseline	Current DOE standard	1.57	6.5	3.50	0.38
1	Gap fill	1.82	5.4	3.89	0.47
2	ENERGY STAR v. 8.1	2.06	4.3	4.27	0.57
3	2015–2017 CEE Tier 1	2.38	3.7	4.78	0.63
4	Maximum available (2016/2017 ENERGY STAR Most Efficient)	2.76	3.2	5.37	0.67

Table IV.29 Front-Loading, Compact (< 3.0 ft^3) Efficiency Level Translations

EL	Efficiency Level Description	IMEF *(ft^3/kWh/cycle)*	IWF *(gal/cycle/ft^3)*	EER *(lb/kWh/cycle)*	WER *(lb/gal/cycle)*
Baseline	Current DOE standard for front-loading, standard-size (≥ 1.6 ft^3)	1.84	4.7	4.41	0.53
1	ENERGY STAR v. 8.1 level for units ≤ 2.5 ft^3	2.07	4.2	4.80	0.62
2	2023 ENERGY STAR Most Efficient for units ≤ 2.5 ft^3	2.20	3.7	5.02	0.71
3	Gap fill	2.50	3.5	5.53	0.75
4	Maximum available (ENERGY STAR v. 8.1 level for units > 2.5 ft^3)	2.76	3.2	5.97	0.80

Table IV.30 Front-Loading, Standard-Size (≥ 3.0 ft^3) Efficiency Level Translations

EL	Efficiency Level Description	IMEF (*ft^3/kWh/cycle*)	IWF (*gal/cycle/ft^3*)	EER (*lb/kWh/cycle*)	WER (*lb/gal/cycle*)
Baseline	ENERGY STAR v. 7.0	2.38	3.7	5.02	0.64
1	Gap fill	2.60	3.5	5.31	0.69
2	ENERGY STAR v. 8.1	2.76	3.2	5.52	0.77
3	2023 ENERGY STAR Most Efficient	2.92	3.2	5.73	0.77
4	Maximum available	3.10	2.9	5.97	0.85

d. Alternative Approaches

For this NOPR, DOE analyzed the efficiency levels determined by the dataset, translation equations, and baseline definition approach previously presented in section IV.C.5.c. However, DOE is also considering alternate approaches for each of these components (*i.e.*, the dataset to use, the method of defining translation equations, and the method for defining baseline) as well as any combination thereof, as described in the following sections.

i. Joint DOE-AHAM Dataset

As discussed, AHAM has shared RCW test data with DOE, which DOE used to confirm the accuracy and appropriateness of the NOPR translation equations. As discussed in appendix 5A of the NOPR TSD, DOE considered developing alternate translation equations using the joint dataset containing both DOE and AHAM test data. However, neither the DOE dataset nor the AHAM dataset identifies the individual model numbers of each unit in the sample; therefore, DOE cannot ascertain whether the joint dataset double-counts any individual models. For this reason, DOE has tentatively determined to not use translation equations based on the joint dataset in this NOPR. Rather, DOE has overlayed the AHAM data onto the translation equations developed using DOE’s dataset in order to confirm that the AHAM and DOE datasets exhibit consistent trends, as discussed further in appendix 5A of the NOPR TSD.

DOE seeks comment on its tentative determination to use the DOE dataset as the basis for the translation equations rather than use the joint DOE-AHAM dataset.

ii. Merging Compact and Standard-Size Translation Equations

The CA IOUs suggested that DOE eliminate the standard-size and compact product classes when developing both the “best-fit line method” and the “average performance and market cluster method”. (CA IOUs, No. 43 at pp. 2–3) The CA IOUs stated that segmenting product classes into standard-size and compact arbitrarily separates products at a discrete product capacity and assumes that the relationship of IMEF to EER and IWF to WER is impacted by assignment to compact and standard-size categories. (*Id.*) The CA IOUs commented that while product classes can be useful for categorization, this categorization should not be confused for statistically justifiable clusters when conducting a translation analysis. (*Id.*) The CA IOUs commented that, although it may be appropriate to segment the data by product classes or a subset of unique performance attributes (such as top-loading versus front-loading), these performance attributes should be demonstrated with supporting analysis. (*Id.*) The CA IOUs suggested that a statistical clustering analysis such as k-means clustering could be used to show that the relationship between appendix J2 and appendix J metrics has fundamental differences that impact performance. (*Id.*) The CA IOUs commented that the separate categorization between compact and standard-size clothes washers assumes performance is impacted by product class alone, and that a k-means clustering would confirm if these four categories were statistically justified. (*Id.*) The CA IOUs stated that the relationship between appendix J2 and appendix J metrics could instead operate on a continuum based on capacity. (*Id.*) The CA IOUs commented that they believe that product performance is impacted by capacity, which exists along a continuum in alignment with the product performance relationship to capacity. (*Id.*) The CA IOUs also commented that they believe the relationship between the appendix J2 and appendix J metrics should be controlled along that same continuum of capacity, and requested that DOE provide the measured EERs and WERs of products tested to appendix J so that this hypothesis can be tested. (*Id.*) The CA IOUs commented that combining data between compact and standard-size product classes will improve model fits to be better than the models presented in the September 2021 Preliminary TSD. (*Id.*) The CA IOUS also commented that combining data will address the lack of tested appendix J data in the top-loading compact product class. (*Id.*)

DOE evaluated the CA IOUs' suggestion to develop only two sets of translation equations (*i.e.*, one per axis of loading) rather than four (*i.e.*, one per product class). Appendix 5A of the NOPR TSD presents the detailed results of this analysis.

DOE notes that automatic top-loading ultra-compact and automatic top-loading standard-size clothes washers have significantly different operational characteristics (beyond just a difference in capacity), such that DOE does not expect that there should be a consistent correlation between appendix J2 and appendix J performance across the two product classes. For example, DOE has observed that the top-loading ultra-compact units on the market offer only two wash temperatures (warm and cold), and as such, hot water heating energy makes up a significantly lower fraction of total energy compared to top-loading standard-size units.[54] Furthermore, although AHAM did not provide shipment data for the top-loading ultra-compact product class, DOE expects that because these represent niche products, this product class likely represents less than 1 percent of total sales. If DOE were to combine the 2 top-loading ultra-compact points with the 12 data points for top-loading standard-size units, the ultra-compact class would be significantly oversampled (*e.g.*, 14 percent of the data versus less than 1 percent of sales). For these reasons, DOE is not proposing to use translation equations for top-loading product classes based on a single dataset that combines top-loading ultra-compact units with top-loading standard-size units.

Similarly, for the front-loading product classes, if DOE were to combine its 13 front-loading compact points with its 12 front-loading standard-size points, the compact class would be significantly oversampled (*e.g.*, 52 percent of the data versus 6 percent of shipments, based on AHAM data). For this reason, DOE is not proposing to use translation equations for front-loading product classes based on a single dataset that combines front-loading compact-size units with front-loading standard-size units.

[54] As shown in the energy breakdown tables in chapter 7 of the NOPR TSD, hot water heating energy represents 5 percent of the total energy for the top-loading ultra-compact product class. Whereas, for the baseline efficiency level in the top-loading standard-size product class, hot water heating energy represents 16 percent of total energy use.

DOE seeks comment on its tentative determination not to merge the compact and standard-size translations, but to instead develop separate translations for each product class.

iii. "Unadjusted" Baseline Approach

The CA IOUs commented that DOE should base its translation analysis on currently available cycle settings and performance and not employ the proposed 4-percentage-point adjustment. (CA IOUs, No. 52 at pp. 1−2) The CA IOUs added that using the performance of currently available products more accurately reflects real-world energy and water efficiencies. (*Id.*) The CA IOUs commented that based on manufacturer input identified by DOE, the CA IOUs understand DOE's consideration that manufacturers may simply implement strategies similar to Cold/Cold optimized spin and non-default maximum spin to decrease RMC. (*Id.*) The CA IOUs stated that while some manufacturers may take this approach, this presumption should not be used as part of the baseline translation for all products. (*Id.*) The CA IOUs further commented that improving the RMC of different cycle settings (*e.g.*, operating small loads at higher spin speeds or software adjustments to optimize RMC for different wash/rinse temperatures) should be treated as a low-cost technology option for efficiency level development, and that DOE's proposal of applying a 4-percentage point adjustment to the tested RMC of appendix J2 (the RMC of appendix J plus the difference in RMC for the smaller loads tested under appendix J2) only accounts for the natural difference in load size centrifugal force using the same spin speed and duration, effectively removes small load RMC improvements as a technology option. (*Id.*) The CA IOUs noted that this adjustment does improve the R-squared, the coefficient of determination for the translation correlation, but at the expense of accurately representing the differences between appendix J and appendix J2, which is what appendix J is partly designed to capture. (*Id.*) The CA IOUs added that while a higher R-squared translation correlation is preferable, the CA IOUs stated it should not be achieved at the expense of removing product-to-product variation that represents the real-world operation of available products. (*Id.*)

ComEd and NEEA supported DOE's efforts to develop a more robust translation from appendix J2 to appendix J and DOE's general approach and methodology. (ComEd and NEEA, No. 50 at p. 2) However, ComEd and NEEA commented that NEEA estimates there will be 0.3 quads of newly realized real-world site energy savings achieved with this test procedure update that were counted earlier (by assuming a lower RMC across all cycles even though RMC was only tested on one cycle setting) but uncaptured in practice, and that this substantial energy savings is twice the site energy savings DOE calculated for EL 1 in the September 2021 Preliminary TSD. (*Id.*) ComEd and NEEA stated that this discrepancy validates DOE's continued efforts to move forward with the translation analysis using appendix J. (*Id.*)

ComEd and NEEA recommended that DOE not justify costs associated with the translation of spin implementations from appendix J2 to appendix J for three key reasons. (ComEd and NEEA, No. 50 at p. 4) First, for the most common RCW spin implementation ("consistent spin"), there is zero incremental cost to obtain the adjusted appendix J EER value because no design changes are needed to retain spin performance. (*Id.*) Second, for RCWs with "cold-cold optimized" spin and "non-default maximum" spin implementations, the incremental cost to achieve the adjusted appendix J EER value is nearly zero. (*Id.*) Third, these costs were already accounted for in the May 2012 Final Rule in the case of RCWs with increased spin time over the appliance lifetime whose manufacturers choose to upgrade to more durable components. (*Id.*)

In response to the CA IOUs' comments, DOE is also considering an alternate approach to the translation of IMEF to EER in which DOE would define the baseline efficiency level based on a translation between appendix J2 and appendix J metrics without consideration of any changes to spin implementations as a result of adopting the appendix J test procedure. EL 1, in contrast, would be represented by the baseline level presented in this NOPR (*i.e.*, reflecting the 4 percent "adjusted RMC" approach). As suggested by the CA IOUs, this approach would allow for a more explicit consideration of savings that are likely to occur solely as a result of the switching from appendix J2 to appendix J, as opposed to those savings already being reflected at baseline level. Appendix 5A of the NOPR TSD details the specific efficiency levels that could be defined for each front-loading product class using this approach.

In response to ComEd and NEEA's comment that DOE should not include the costs associated with changes to spin implementation as a result of the change in test procedure, DOE notes that all costs incurred by manufacturers in response to this NOPR have been included in this NOPR analysis. While there may be zero incremental manufacturing cost to changing spin implementation, such changes would incur product conversion costs, as discussed further in section IV.J.2.c of this document. With regard to the assertion that these costs were already accounted for in the May 2012 Final Rule, the standards enacted by the May 2012 Final Rule were based on a different test procedure (*i.e.*, appendix J2) than the test procedure proposed as a basis for the amended standards in this NOPR (*i.e.*, appendix J). To the extent that appendix J requires manufacturers to change designs of products as they currently exist in the market, such changes are justifiable in considering in this analysis, irrespective of the costs that may have been incurred previously by manufacturers as a result of product investments required to comply with the standards enacted by the May 2012 Final Rule.

DOE seeks comment on whether it should consider defining an "unadjusted" baseline efficiency level based on a translation between appendix J2 and appendix J metrics without consideration of any changes to spin implementations as a result of adopting the appendix J test procedure.

D. Markups Analysis

The markups analysis develops appropriate markups (*e.g.*, manufacturer markup, retailer markups, distributor markups, contractor markups) in the distribution chain and sales taxes to convert the MPC 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.

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 RCWs.[55] See chapter 12 of the NOPR TSD for additional detail on the manufacturer markup.

For RCWs, the main parties in the post-manufacturer distribution chain are retailers/distributors and consumers. DOE developed baseline and incremental markups for each of these. 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 costs before and after amended standards.[56] DOE relied on economic data from the U.S. Census Bureau to estimate average baseline and incremental markups.[57]

Chapter 6 of the NOPR TSD provides details on DOE's development of markups for RCWs.

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[55] U.S. Securities and Exchange Commission, *Electronic Data Gathering, Analysis, and Retrieval (EDGAR) system*. Available at *www.sec.gov/edgar/search/* (last accessed July 1, 2022).
[56] 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.
[57] US Census Bureau, *Annual Wholesale Trade Survey*. 2017. Available at *www.census.gov/awts* (last accessed May 2, 2022).

E. Energy and Water Use Analysis

The purpose of the energy and water use analysis is to determine the annual energy and water consumption of RCWs 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 RCW efficiency. The energy and water use analysis estimates the range of energy and water use of RCWs 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.

To establish a reasonable range of energy and water consumption in the field for RCWs, DOE primarily used data from 2015 RECS.[58] RECS is a national sample survey of housing units that collects statistical information on the consumption of and expenditures for energy in housing units along with data on energy-related characteristics of the housing units and occupants. The 2015 RECS collected data on 5,686 housing units and was constructed by EIA to be a national representation of the household population in the United States.[59] DOE's assumptions for establishing an RCW sample included the following considerations:

- The household had a clothes washer.

[58] U.S. Department of Energy - Energy Information Administration, Residential Energy Consumption Survey: 2015 Public Use Data Files, 2015. Available at *www.eia.doe.gov/emeu/recs/recspubuse15/pubuse15.html* (last accessed May 12, 2022).
[59] RECS 2015 is the most recent edition of RECS available at the time of this NOPR analysis. For the final rule analysis, DOE plans to use the microdata of the 2020 RECS.

- Clothes washer use was greater than zero.

DOE divided the sample of households into five sub-samples to characterize the product category being analyzed: standard-size or compact or semi-automatic, top-loading or front-loading RCWs. For compact and semi-automatic clothes washers, DOE developed a sub-sample consisting of households from multifamily buildings, manufactured homes, and single-family homes with less than 1,000 square feet and no garage or basement, since DOE reasoned that such products are most likely to be found in these housing types.

The energy and water use analysis requires DOE to establish a range of total annual usage or annual number of cycles in order to estimate annual energy and water consumption by a clothes washer unit. DOE estimated the number of clothes washer cycles per year for each sample household using data given by RECS 2015 on the number of laundry loads washed (clothes washer cycles) per week.

For each sample household, DOE estimated the field-based annual energy and water use of the clothes washer by multiplying the annual number of clothes washer cycles for each household by the per-cycle energy and water use values established by the engineering analysis (using the DOE test procedure) for each considered efficiency level. Per-cycle clothes washer energy use is calculated in the test procedure as the sum of per-cycle machine energy use associated with the clothes washer (including the energy used to heat water and remove moisture from clothing),[60] and combined low-power mode energy use.

1. Number of Annual Cycles

The average annual energy and water consumption reflects an average annual weighted usage of 238 cycles per year (233 for top-loading clothes washers and 254 for front-loading clothes washers). This average usage is obtained from 2015 RECS.[61]

Ameren *et al*. recommended that DOE not use the number of annual clothes washer cycles predicted by the RECS methodology because it relies on participant recollection and is therefore subject to recall bias. They stated that a single RECS respondent may not accurately count cycles of other household members, leading to underestimates. (Ameren *et al*., No. 42 at pp. 16–17)

RECS asks "In a typical week, about how many times is your clothes washer used?" A response does not require recollection of behavior in the distant past. DOE acknowledges that recall bias is in general an issue in surveys where consumers are asked

[60] The per-cycle energy consumption associated with a given clothes washer has three components: energy used for heating water, operating the machine, and drying the clothes.

[61] DOE acknowledges that the value of 238 average annual cycles used in the Energy and Water Use Analysis differs from the value of 234 annual cycles used in appendix J. As discussed above, the value of 238 was determined while excluding RECS households that do not use their clothes washer (*i.e.*, households with clothes washer use equal to 0 cycles per week) because these households' clothes washers would not contribute to the nation's total energy and water use. By comparison, the value of 234 used in appendix J did not exclude such households, because the test procedure is designed to represent the average household energy and water usage.

about their past behavior, but DOE does not believe that RECS households would significantly underestimate the number of washer cycles.

Ameren *et al.* encouraged DOE to increase the annual number of clothes washer cycles in its analysis and/or conduct its own field study to determine more accurately the average annual number of clothes washer cycles given that the RECS estimate is significantly lower than the annual number of cycles calculated in NEEA's RBSA Laundry study published in 2014 ("2014 Laundry Study").[62] (Ameren *et al.*, No. 42 at pp. 17−18)

DOE reviewed the 2014 Laundry Study. Because the Study collected field metering data from 45 homes across three States, with more than 70 percent of selected homes located in Washington State, it is not a representative sample of all U.S. households that use a clothes washer. The 2015 RECS is a nationally representative sample of U.S. households with more than 5,600 households with a clothes washer. For the final rule analysis, DOE plans to use the microdata of the 2020 RECS, which was released in July 2022 and contains a nationally representative sample of 18,500 occupied U.S. households.

2. Rebound Effect

In calculating energy consumption of RCWs, DOE considered whether it would be appropriate to include a rebound effect (also called a take-back effect), which

[62] Hannas, B. and Gilman, L. 2014. *RBSA Laundry Study* (Report # E14-287). Portland, OR: Northwest Energy Efficiency Alliance. p. 38. 20 November. Retrieved from *neea.org/resources/rbsa-laundry-study*.

represents the increased energy consumption that can result from increases in energy efficiency and the associated reduction in operating costs. The rebound effect assumes that consumers will increase their overall annual usage of a more efficient product, thereby decreasing their overall annual savings.

Ameren *et al*. commented in support of DOE's determination that there is no rebound effect associated with more efficient clothes washers and agreed with DOE that consumers will not use their clothes washers more if the efficiency increases. (Ameren *et al*., No. 42 at p. 20)

DOE requests comment and information on the specific efficiency levels at which any potential rebound effects may happen, as well as the magnitude of the effect.

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

3. Water Heating Energy Use

Per-cycle water heating energy consumption is one of the four energy components in the EER metric. Appendix J includes water-heating energy equations that estimate the energy required by the household water heater to heat the hot water used by the clothes washer. In section 4.1.2 of appendix J, the water heating energy consumption is calculated by multiplying the measured volume of hot water by a constant fixed temperature rise of 65 °F and by the specific heat of water. No efficiency or loss factor is included in this calculation, which implies an electric water heater efficiency of 100 percent.

Ameren *et al.* presented data from 3 studies that contradict DOE's assertion that 78 percent efficiency is typical for gas water heaters. Based on these 3 studies, Ameren *et al.* concluded that both market and field data analysis reveal that typical gas water heater efficiency ranges from 62 to 70 percent. (Ameren *et al.*, No. 42 at pp. 14–16) ASAP *et al.* commented that they believe DOE's assumption of 100 percent efficiency for electric water heaters and 78 percent efficiency for gas water heaters is likely significantly overstating the efficiencies of water heaters in the field. ASAP *et al.* commented that based on shipment data from the last water heater rulemaking and current models in DOE's CCD, the shipment-weighted efficiencies for new water heaters are about 92 percent for electric water heaters and 64 percent for gas water heaters. (ASAP *et al.*, No. 37 at pp. 2–3)

In the 2019 preliminary analysis for consumer water heaters, DOE calculated the energy use of water heaters using a simplified energy equation, the water heater analysis model (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 September 2021 Preliminary TSD states that DOE used a recovery efficiency of 78 percent for gas water heaters, not 0.78 Energy Factor 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.[63]

ASAP *et al*. recommended that DOE clarify the hot water temperature rise estimate used in the hot water energy usage calculations and suggested that believe a value lower than 75 °F (*e.g.*, 67.5 °F) would more accurately reflect hot water energy usage. (ASAP *et al.*, No. 37 at p. 5)

For this NOPR analysis, DOE revised hot water temperature rise from 75 °F to 65 °F based on the updates in the RCW test procedure. 87 FR 33316, 33326-33327.

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 RCWs. The effect of new or amended energy conservation standards on individual consumers usually involves a reduction in operating cost and an increase in purchase cost. DOE used the following two metrics to measure consumer impacts:

- The LCC is the total consumer expense of an appliance or product over the life of that product, consisting of total installed cost (manufacturer selling price, distribution chain markups, sales tax, and installation costs) plus

[63] 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).

operating costs (expenses for energy and water use, maintenance, and repair). To compute the operating costs, DOE discounts future operating costs to the time of purchase and sums them over the lifetime of the product.

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

For any given efficiency level, DOE measures the change in LCC relative to the LCC in the no-new-standards case, which reflects the estimated efficiency distribution of RCWs in the absence of 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 residential housing units. As stated previously, DOE developed household samples from the 2015 RECS. For each sample household, DOE determined the energy and water consumption for the RCWs and the appropriate energy and water prices. By developing a representative sample of households, the analysis captured the variability in energy and water consumption and energy and water prices associated with the use of RCWs.

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

The computer model DOE uses to calculate the LCC relies on a Monte Carlo simulation to incorporate uncertainty and variability into the analysis. The Monte Carlo simulations randomly sample input values from the probability distributions and RCW user samples. For this rulemaking, the Monte Carlo approach is implemented in MS Excel together with the Crystal Ball™ add-on.[64] The model calculated the LCC for products at each efficiency level for 10,000 housing units per simulation run. The analytical results include a distribution of 10,000 data points showing the range of LCC savings for a given efficiency level relative to the no-new-standards case efficiency distribution. In performing an iteration of the Monte Carlo simulation for a given consumer, product efficiency is chosen based on its probability. If the chosen product efficiency is greater than or equal to the efficiency of the standard level under consideration, the LCC calculation reveals that a consumer is not impacted by the standard level. By accounting for consumers who already purchase more-efficient

[64] 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 July 6, 2022).

products, DOE avoids overstating the potential benefits from increasing product efficiency.

DOE calculated the LCC and PBP for consumers of RCWs as if each were to purchase a new product in the expected year of required compliance with amended standards. Amended standards would apply to RCWs manufactured 3 years after the date on which any amended standard is published. (42 U.S.C. 6295(m)(4)(A)(i)) At this time, DOE estimates publication of a final rule in 2023. Therefore, for purposes of its analysis, DOE used 2027 as the first year of compliance with any amended standards for RCWs.

Table IV.31 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.31 Summary of Inputs and Methods for the LCC and PBP Analysis*

Inputs	Source/Method
Product Cost	Derived by multiplying MPCs by manufacturer and retailer markups and sales tax, as appropriate. Used historical data to derive a price scaling index to project product costs.
Installation Costs	Baseline installation cost determined with data from RS Means Residential Cost Data 2021. Assumed no change with efficiency level.
Annual Energy and Water Use	Per cycle energy and water use multiplied by the cycles per year. Average number of cycles based on field data. Variability: Based on the 2015 RECS
Energy and Water Prices	Electricity: Based on EIA's Form 861 data for 2021. Variability: Regional energy prices determined for 9 Census Divisions. Water: Based on 2020 AWWA/ Raftelis Survey Variability: Regional water prices determined for 4 Census Regions.
Energy and water Price Trends	Energy: Forecasted using *AEO* 2022 price forecasts. Water: Forecasted using BLS historic water price index information.
Repair and Maintenance Costs	Repair costs vary by product class and vary between ENERGY STAR and non-ENERGY STAR washers.
Product Lifetime	Average: 13.7 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.

Ameren *et al.* encouraged DOE to calculate and consider the return on investment for each efficiency level in its analysis to add additional insight for stakeholders and decision-makers. Ameren *et al.* commented that efficiency improvements to an appliance can be considered capital investments, with "returns" being the money saved from utility bill reductions. (Ameren *et al.*, No. 42 at pp. 18–19)

DOE acknowledges that return on investment 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 "Net Cost" for impacted households is incomplete and misleading. AHAM suggested that the "Net Cost" should be calculated only among the affected households. (AHAM, No. 40 at p. 21)

DOE maintains that showing the share of all consumers who would experience a net LCC cost is useful information, as EPCA requires DOE to consider the impact of standards on "consumers," not only those who would be affected by a standard.

1. Consumer Product Cost

To calculate consumer product costs, DOE multiplied the MPCs developed in the engineering analysis by the markups described in section IV.C.6 of this document (along with sales taxes). DOE used different markups for baseline products and higher-efficiency products, because DOE applies an incremental markup to the increase in MSP associated with higher-efficiency products.

Economic literature and historical data suggest that the real costs of many products may trend downward over time according to "learning" or "experience" curves. Experience curve analysis implicitly includes factors such as efficiencies in labor, capital investment, automation, materials prices, distribution, and economies of scale at an industry-wide level.[65] To derive the learning rate parameter for RCWs, DOE obtained historical Producer Price Index ("PPI") data for "household laundry equipment" between 1948 and 2016 and "major household appliance: primary products" between 2016 and 2019 from the Bureau of Labor Statistics' ("BLS") to form a time series price index representing household laundry equipment from 1948 to 2021.[66] These two PPI series are the most current and disaggregated price index that includes RCWs, and DOE assumes that the price trend estimated from the household laundry equipment PPI is representative of that for RCWs. 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. The estimated learning rate (defined as the fractional reduction in price expected from each doubling of cumulative production) is 14.4 ± 1.7 percent. See chapter 8 of the NOPR TSD for further details on this topic.

Ameren *et al*. encouraged DOE to continue to apply a learning rate for product prices in its lifecycle cost and payback period analyses and encourages DOE to model as if RCW sales occurred before 1947, as this could produce a better fit to the model used and be more representative of the learning rate for the RCW industry. (Ameren *et al*., No. 42 at p. 19)

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[65] Taylor, M. and Fujita, K.S. Accounting for Technological Change in Regulatory Impact Analyses: *The Learning Curve Technique*. LBNL-6195E. Lawrence Berkeley National Laboratory, Berkeley, CA. April 2013. Available at *escholarship.org/uc/item/3c8709p4#page-1*.

[66] Household laundry equipment PPI (PCU3352203352204) is available till May 2016, and major household appliance: primary products (PCU335220335220P) is available starting from 2016. See more information at: *www.bls.gov/ppi/*.

The fit started in 1948 because that is the start year of the household laundry product PPI. In order to derive the corresponding cumulative productions, DOE performed a trend analysis to extrapolate shipments prior to AHAM historical data and determined the shipments were at a very low level and thus started the cumulative production accounting in 1948. DOE will explore alternative approaches for shipment extrapolation in the final rule analysis to better account for shipments prior to 1948 and improve the model fit.

AHAM commented that equipment prices at EL 1 and EL 2 in the September 2021 Preliminary Analysis were underestimated and suggested that DOE use actual retail price differences between a baseline and higher efficiency level instead of taking the traditional approach of converting manufacturer production costs to consumer retail prices. (AHAM, No. 40 at p. 21)

The actual retail price differences between a baseline and higher efficiency level may include the price for other features in addition to engineering designs relating to efficiency, and also reflects economies of scale in production, as well as marketing strategies and profit margins of manufacturers and retailers. DOE maintains that its traditional approach, which has been subject to peer review, is better able to identify the incremental costs that are only connected to higher efficiency. Furthermore, for this NOPR analysis, DOE revised the engineering costs of top-loading standard-size clothes washers, and the estimated equipment price difference between the baseline level and the ENERGY STAR level is now $163.50, before sales tax, which closely aligns with the retail price difference (*i.e.*, $160 before sales tax) presented by AHAM.

2. Installation Cost

Installation cost includes labor, overhead, and any miscellaneous materials and parts needed to install the product. DOE used data from 2021 *RSMeans Residential Cost Data* to estimate the baseline installation cost for RCWs.[67] DOE found no evidence that installation costs would be impacted with increased efficiency levels.

3. Annual Energy and Water Consumption

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

4. Energy and Water Prices

a. Energy Prices

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

[67] RS Means Company Inc., RS Means Residential Cost Data (2021). Available at *https://rsmeans.com/*.

DOE derived electricity prices in 2021 using data from EEI Typical Bills and Average Rates reports for summer and winter 2021.[68] Based upon comprehensive, industry-wide surveys, this semi-annual report presents typical monthly electric bills and average kilowatt-hour costs to the customer as charged by investor-owned utilities. For the residential sector, DOE calculated electricity prices using the methodology described in Coughlin and Beraki (2018).[69]

DOE obtained data for calculating regional prices of natural gas from the EIA publication, *Natural Gas Navigator*.[70] This publication presents monthly volumes of natural gas deliveries and average prices by state for residential, commercial, and industrial customers. DOE used the complete annual data for 2020 to calculate an average annual price for each census division. Residential natural gas prices were adjusted by applying seasonal marginal price factors to reflect a change in a consumer's bill associated with a change in energy consumed.

EIA provides historical monthly natural gas consumption and expenditures by state. This data was used to determine 10-year average marginal price factors for the RECS 2015 census divisions, which are then used to convert average monthly natural gas prices into marginal monthly natural gas prices. DOE interpreted the slope of the

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[68] Edison Electric Institute. Typical Bills and Average Rates Report. Winter 2021, Summer 2021. Available at: *www.eei.org/resourcesandmedia/products/Pages/Products.aspx*.
[69] Coughlin, K. and B. Beraki.2018. Residential Electricity Prices: A Review of Data Sources and Estimation Methods. Lawrence Berkeley National Lab. Berkeley, CA. Report No. LBNL-2001169. Available at *ees.lbl.gov/publications/residential-electricity-prices-review*.
[70] U.S. Department of Energy–Energy Infomation Administration. *Natural Gas Navigator* 2020. Available at *www.eia.gov/naturalgas/data.php*.

regression line (consumption vs. expenditures) for each State as the marginal natural gas price factor for that State.

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

To estimate energy prices in future years, DOE multiplied the average and marginal regional energy prices by the projection of annual average price changes for each of the nine census divisions from the Reference case in *AEO2022*, which has an end year of 2050.[71] To estimate price trends after 2050, the 2046–2050 average was used for all years.

b. Water and Wastewater Prices

DOE obtained residential water and wastewater price data from the Water and Wastewater Rate Survey conducted by Raftelis Financial Consultants and the American Water Works Association.[72] The survey covers approximately 194 water utilities and

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[71] EIA. *Annual Energy Outlook 2022 with Projections to 2050*. Washington, DC. Available at *www.eia.gov/forecasts/aeo/* (last accessed June 14, 2022).
[72] Raftelis Financial Consultants, Inc. 2020 RFC/AWWA Water and Wastewater Rate Survey. 2021. Charlotte, NC, Kansas City, MO, and Pasadena, CA.

140 wastewater utilities analyzing each industry (water and wastewater) separately. For each water or wastewater utility, DOE calculated the average price per unit volume by dividing the total volumetric cost by the volume delivered. DOE also calculated the marginal price by dividing the incremental cost by the increased volume charged at each consumption level.

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

For this NOPR analysis, DOE also developed water prices for consumers who rely on private well water systems for their water needs rather than relying on the public supply system. DOE considered several factors when developing consumer prices for water supplied by private wells. Initial costs to install a well include well siting; well drilling; pump purchase and installation; water testing; and sometimes a water treatment system. Ongoing costs include pump maintenance; pump fuel to lift water to the surface and to the point of use or storage; plus, any required maintenance of the treatment system (water-softening chemicals, filters, *etc.*). To determine the current percentage of the U.S. population served by private wells, DOE used historical American Housing Survey ("AHS") data from 1970 to 2019 to develop a projection for 2027, the effective year of potential new standards for RCWs.[73] DOE then weighted public utility water and

[73] The U.S. Census Bureau. The American Housing Survey. Years 1970-2019. Available at *www.census.gov/programs-surveys/ahs.html* (last accessed May 12, 2022).

wastewater prices and private well prices for each census region and derived weighted-average regional and national water price for residential consumers.

To estimate the future trend for water and wastewater prices, DOE used data on the historic trend in the national water price index (U.S. city average) from 1988 through 2021 provided by the Labor Department's BLS.[74] DOE extrapolated the future trend based on the linear growth from 1988 to 2021. DOE used the extrapolated trend to forecast prices through 2050. To estimate price trend after 2050, DOE used a constant value derived from the average values from 2046 through 2050.

AHAM commented that DOE's water prices should include rural well and septic tank users. (AHAM, No. 40 at pp. 29-31)

As described above, for this NOPR analysis, DOE developed water prices for rural well and septic tank users. DOE then weighted public utility water and wastewater prices and private well prices for each census region and derived weighted-average regional and national water price for residential consumers.

Chapter 8 and Appendix 8E of the NOPR TSD provides further details on the methodology and sources DOE used to develop consumer water prices.

[74] U.S. Department of Labor-Bureau of Labor Statistics, Consumer Price Indexes, Item: Water and sewerage maintenance, Series Id: CUSR0000SEHG01, U.S. city average, 2021. Washington, DC. Available at *www.bls.gov/cpi/home.htm#data*.

5. Repair and Maintenance Costs

Repair costs are associated with repairing or replacing product components that have failed in an appliance; maintenance costs are associated with maintaining the operation of the product.

For RCWs, DOE determined repair cost associated with loading type and clothes washer capacity commonly found on an appliance repair web site.[75] DOE estimated the average repair cost for an RCW is about $225, ranging from $115 to $275. For maintenance cost, DOE conducted literature review of maintenance cost available from a variety of sources, including online resources. DOE estimated the annual maintenance cost for an RCW is approximately $25, including costs of clothes washer cleaners and of running clothes washer cleaning cycles.

Typically, small incremental increases in product efficiency produce no, or only minor, changes in repair and maintenance costs compared to baseline efficiency products. For this NOPR analysis, DOE estimated that for repair costs, there is a cost difference between an ENERGY STAR and non-ENERGY STAR clothes washer of approximately $44 for a front-loading and $32 for a top-loading clothes washer, based on information aggregated from confidential manufacturer interviews. For maintenance costs, DOE assumed that there is no change with efficiency level for RCWs.

[75] Fixr, *How Much Does It Cost to Repair a Washing Machine?* Available at *www.fixr.com/costs/washing-machine-repair#washing-machine-repair-cost-by-type-of-repair.*

DOE requests comment and information on frequency of cleaning cycles run per number of cycles used to clean clothes and associated data as compared to the recommendations in the manufacturer's use and care manuals.

6. Product Lifetime

Product lifetime is the age at which an appliance is retired from service. *Appliance* magazine, a trade publication, provides estimates of the low, high, and average years of an appliance's lifetime.[76] The estimates, which are based on first-owner use of the product, represent the judgment of *Appliance* staff based on input obtained from various sources. The average lifetime estimate from *Appliance* magazine is 11 years.

To determine estimates for RCW lifetime, DOE conducted an analysis of standard-capacity RCW lifetime in the field based on a combination of shipments data and data on the ages of the clothes washer products reported in the household stock from RECS conducted in 2001, 2005, 2009, and 2015 data.[77] DOE also used the U.S. Census's biennial AHS from 1974–2019, which surveys all housing, noting the presence of a range of appliances.[78] As described in chapter 8 of the NOPR TSD, the analysis yielded an estimate of mean age for standard-capacity RCWs of approximately 13.7 years. It also yielded a survival function that DOE incorporated as a probability

[76] Appliance Magazine. *A Portrait of the U.S. Appliance Industry: Market Share, Life Expectancy & Replacement Market, and Saturation Levels.* 2014.
[77] U.S. Department of Energy - Energy Information Administration, Residential Energy Consumption Survey ("RECS"), Multiple Years (1990, 1993, 1997, 2001, 2005, 2009, and 2015). Available at *www.eia.gov/consumption/residential/*.
[78] U.S. Census Bureau: Housing and Household Economic Statistics Division, *American Housing Survey,* Multiple Years (1974, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1983, 1985, 1987, 1989, 1991, 1993, 1995, 1997, 1999, 2001, 2003, 2005, 2007, 2009, 2011, 2013, 2015, 2017, and 2019). Available at *www.census.gov/programs-surveys/ahs/*.

distribution in its LCC analysis. Because the RECS data does not indicate whether the clothes washer has a top-loading or front-loading configuration, DOE was not able to derive separate lifetime estimates for these two loading types. DOE did not receive any data or analysis to support separate lifetime for the different product classes.

DOE requests comment and information on RCW lifetime.

See chapter 8 of the NOPR TSD for further details on the method and sources DOE used to develop product lifetime.

7. Discount Rates

In the calculation of LCC, DOE applies discount rates appropriate to RCWs to estimate the present value of future operating cost savings. DOE estimated a distribution of discount rates for RCWs 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.[79] The LCC analysis estimates net present value over the lifetime of the product, so the appropriate discount rate will reflect the general opportunity cost of household funds, taking this time scale into account. Given the long time horizon modeled in the LCC analysis, the application of a

[79] 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.

marginal interest rate associated with an initial source of funds is inaccurate. Regardless of the method of purchase, consumers are expected to continue to rebalance their debt and asset holdings over the LCC analysis period, based on the restrictions consumers face in their debt payment requirements and the relative size of the interest rates available on debts and assets. DOE estimates the aggregate impact of this rebalancing using the historical distribution of debts and assets.

To establish residential discount rates for the LCC analysis, DOE identified all relevant household debt or asset classes in order to approximate a consumer's opportunity cost of funds related to appliance energy cost savings. It estimated the average percentage shares of the various types of debt and equity by household income group using data from the Federal Reserve Board's triennial Survey of Consumer Finances ("SCF") starting in 1995 and ending in 2019.[80] 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.

[80] The Federal Reserve Board, *Survey of Consumer Finances* (1995, 1998, 2001, 2004, 2007, 2010, 2013, 2016, and 2019). Available at: *www.federalreserve.gov/econres/scfindex.htm.*

AHAM and GEA suggested that DOE develop a more reasonable interest rate distribution for the low-income group that is closer to a credit card rate for this group. (AHAM, No. 40 at p. 27; GEA, No. 38 at p. 2)

DOE maintains that the interest rate associated with the specific source of funds (*e.g.*, credit card) used to purchase a clothes washer (*i.e.*, the marginal rate) is not the appropriate metric to measure the discount rate as defined for the LCC analysis. The marginal interest rate alone would only be the relevant discount rate if the consumer were restricted from re-balancing their debt and asset holdings (by redistributing debts and assets based on the relative interest rates available) over the entire time period modeled in the LCC analysis. The LCC is not analyzing a marginal decision; rather, it estimates net present value over the lifetime of the product, therefore the discount rate needs to reflect the opportunity cost of both the money flowing in (through operating cost savings) and out (through upfront cost expenditures) of the net present value calculation. In the context of the LCC analysis, the consumer is not only discounting based on their opportunity cost of money spent today, they are also discounting the stream of future benefits. A consumer might pay for an appliance with cash, thereby forgoing investment of those funds into one of the interest earning assets to which they might have access. Alternatively, a consumer might pay for the initial purchase by going into debt, subject to the cost of capital at the interest rate relevant for that purchase. However, a consumer will also receive a stream of future benefits in terms of annual operating cost savings that they could either put towards paying off that or other debts, or towards assets, depending on the restrictions they face in their debt payment requirements and the relative size of the interest rates on their debts and assets. All of these interest rates are relevant in the context of the LCC analysis, as they all reflect direct costs of borrowing, or opportunity costs of money either now or in the future. Additionally, while a clothes washer itself is not a readily tradable commodity, the money used to purchase it and the annual operating cost savings accruing to it over time flow from and to a household's pool of debt and assets, including mortgages, mutual funds, money market accounts, *etc*. Therefore, the weighted-average interest rate on debts and assets provides a reasonable estimate for a household's opportunity cost (and discount rate) relevant to future costs and savings. DOE maintains that the best proxy for this re-optimization of debt and asset holdings over the lifetime of the LCC analysis is to assume that the distribution of debts and assets in the future will be proportional to the distribution of debts and assets historically. Given the long time horizon modeled in the LCC, the application of a marginal rate alone would be inaccurate. DOE's methodology for deriving residential discount rates is in line with the weighted-average cost of capital used to estimate commercial discount rates. For these reasons, DOE is maintaining its existing approach to 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 top-loading standard-size, front-loading compact and standard-size RCWs for 2027, DOE used shipments-weighted energy efficiency ratio ("SWEER") for 2020 as a starting point, based on the information provided by AHAM. (AHAM, No. 54 at pp. 2–3) To project the trend in efficiency, DOE considered recent trends in DOE's RCW CCD and the potential effect of labeling programs such as ENERGY STAR on RCWs. DOE estimated an annual efficiency improvement of 0.4 and 0.1 percent for top-loading standard-size and front-loading (compact and standard-size) clothes washers, respectively. For semi-automatic clothes washers, DOE used the CCD database to develop a product efficiency distribution under the no-new-standards case.

The estimated market shares for the no-new-standards case for RCWs are shown in Table IV.32 and Table IV.33. See chapter 8 of the NOPR TSD for further information on the derivation of the efficiency distributions.

Table IV.32 No-New-Standards Case Market Share in 2027: Semi-Automatic and Top-Loading Residential Clothes Washers

Efficiency Level	Semi-Automatic			Top-Loading, Ultra-Compact			Top-Loading, Standard-Size		
	EER *(lb/kWh /cycle)*	**WER** *(lb/gal /cycle)*	**Share** *(%)*	**EER** *(lb/kWh /cycle)*	**WER** *(lb/gal /cycle)*	**Share** *(%)*	**EER** *(lb/kWh /cycle)*	**WER** *(lb/gal /cycle)*	**Share** *(%)*
Baseline	1.60	0.17	21.0%	3.79	0.29	100%	3.50	0.38	61.0%
1	2.12	0.27	71.0%	--	--	--	3.89	0.47	5.9%
2	2.51	0.36	8.0%	--	--	--	4.27	0.57	27.4%
3	--	--	--	--	--	--	4.78	0.63	4.7%
4	--	--	--	--	--	--	5.37	0.67	1.0%

Table IV.33 No-New-Standards Case Market Share in 2027: Front-Loading Residential Clothes Washers

Efficiency Level	Front-Loading, Compact			Front-Loading, Standard-Size		
	EER *(lb/kWh /cycle)*	**WER** *(lb/gal /cycle)*	**Share** *(%)*	**EER** *(lb/kWh /cycle)*	**WER** *(lb/gal /cycle)*	**Share** *(%)*
Baseline	4.41	0.53	0.0	5.02	0.64	2.0%
1	4.80	0.62	38.7%	5.31	0.69	5.6%
2	5.02	0.71	45.8%	5.52	0.77	44.1%
3	5.53	0.75	14.5%	5.73	0.77	40.1%
4	5.97	0.80	1.0%	5.97	0.85	8.2%

The LCC Monte Carlo simulations draw from the efficiency distributions and randomly assign an efficiency to the RCW 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 baseline and higher efficiency levels, which assumes that consumers are agnostic to energy costs. AHAM stated that it is very unlikely that consumers with very high potential LCC savings would not have already decided to purchase a more efficient washer (*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. (AHAM, No. 40 at pp. 18-20)

While DOE acknowledges that economic factors may play a role when consumers decide on what type of clothes washer to install, assignment of clothes washer efficiency for a given installation based solely on economic measures such as life-cycle cost or simple payback period 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 further down. DOE maintains that the method of assignment is a reasonable approach and one that simulates behavior in the clothes washer 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 clothes washers 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.[81] There are also several behavioral factors that can influence the purchasing decisions of complicated multi-attribute products, such as clothes washers. For example, consumers (or decision makers in an organization) are highly influenced by choice architecture, defined as the framing of the decision, the

[81] 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).

surrounding circumstances of the purchase, the alternatives available, and how they are presented for any given choice scenario.[82] 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. Richard Thaler, who won the Nobel Prize in Economics in 2017 for his contributions to behavioral economics, and Cass 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.[83] These characteristics describe almost all purchasing situations of appliances and equipment, including RCWs. The installation of a new or replacement clothes washer is done very infrequently, as evidenced by the mean lifetime of 13.7 years. Additionally, it would take at least a few months for any impacts on operating costs to be fully apparent. Further, if the purchaser of the clothes washer 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.

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[82] 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).
[83] Thaler, R.H., and Sunstein, C.R. (2008). Nudge: Improving Decisions on Health, Wealth, and Happiness. New Haven, CT: Yale University Press.

The first of these market failures is 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 clothes washer to install, whereas the renter is responsible for paying energy bills. In addition to the split-incentive or principal-agent problem, there are other market failures that are likely to affect the choice of clothes washer efficiency made by consumers. Lucas Davis and Gilbert Metcalf[84] 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 are not economically optimal relative to how they utilize the equipment (*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

[84] 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).

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[85] indicates that there is a significant subset of consumers that appear to purchase appliances without taking into account their energy efficiency and operating costs at all.

The existence of market failures in the residential sector is well supported by the economics literature and by a number of case studies. If DOE developed an efficiency distribution that assigned clothes washer efficiency in the no-new-standards case solely according to energy and water use or economic considerations such as life-cycle cost or payback period, the resulting distribution of efficiencies within the household sample would not reflect any of the market failures or behavioral factors above. DOE thus concludes such a distribution would not be representative of the clothes washer market. Further, even if a specific household is not subject to the market failures above, the purchasing decision of clothes washer efficiency can be highly complex and influenced by several factors not captured by the information available in the RECS samples. These factors can lead to household owners choosing a clothes washer efficiency that deviates from the efficiency predicted using only energy and water use or economic considerations (as calculated using the information from RECS 2015). However, DOE

[85] 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).

intends to investigate this issue further, and it welcomes suggestions as to how it might improve its assignment of clothes washer efficiency in its analyses.

9. Payback Period Analysis

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

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

As noted previously, EPCA establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the first year’s energy savings resulting from the standard, as calculated under the applicable test procedure. (42 U.S.C. 6295(o)(2)(B)(iii)) For each considered efficiency level, DOE determined the value of the first year’s energy savings by calculating the energy savings in accordance with the applicable DOE test procedure, and multiplying those savings by the average energy price projection for the year in which compliance with the amended standards would be required.

10. Other Issues

Fraas cited a case study of DOE's 2001 RCW standards.[86] Fraas stated that this case study identified several issues that would result in lower cost saving estimates than projected in DOE's ex ante analyses. These included: (1) reduced product reliability and life; (2) additional operation and maintenance costs; and (3) overstatement of clothes washer usage relative to DOE's ex ante analysis. Fraas added that the case study illustrated the sensitivity of DOE's life cycle analysis to different usage and product life assumptions and showed that DOE could have improved its analysis by developing distributions for key components of its analysis. Finally, Fraas urged DOE to conduct a retrospective analysis of its existing standards as part of the rulemaking process, including collection of extensive data on usage, reliability, and life, to provide a basis for assessing prospective energy conservation standards. (Fraas, No. 35 at pp. 1–2)

DOE has reviewed Fraas & Miller 2020 and identified several fundamental misunderstandings in the paper with respect to the 2001 RCW rulemaking and standard (with compliance dates of 2004 and 2007). Specifically, the paper takes as a premise that the standards finalized in 2001 forced consumers to adopt front-loading clothes washers. This is fundamentally incorrect. DOE established separate product classes and standards for front-loading and top-loading clothes washers. While the 2001 standard set the same

[86] The final rule establishing these standards was published on January 12, 2001. 66 FR 3313.

efficiency level for both of these classes, DOE noted in the final rule that there were both top- and front-loading clothes washers in the market at all of the efficiency levels prescribed in the final rule and that all efficiency levels were technologically feasible for both top- and front-loading clothes washers. (January 12, 2021; 66 FR 3314, 3318.) Therefore, manufacturers were able to choose how to invest in meeting standards across top-loading and front-loading models. Top-loading clothes washers continue to be available for purchase today and consumers may choose them if they wish. While there have been changes to top-loading clothes washer market share over time, today they have a market share greater than 70%.

With regard to reduced product reliability, the paper attempts to establish a causal link between regulation and litigation that they claim is evidence of reduced product reliability. However, all litigation evidence presented in the paper would apply to both baseline (pre-standards) and more efficient front-loading clothes washers, and there is no causal connection to regulation. The paper ignores past and parallel trends in litigation in the market for both the same products, and other, similar products. Additionally, there is no counter-factual argument.

With regard to reduced product life, the paper questions the estimates used in DOE's lifetime analyses, but compares lifetime estimates spanning 23 years. DOE's lifetime estimates are always based on the best available data at the time, and were reviewed by stakeholders before publishing the final rule. In the follow-up rulemaking, culminating in the May 2012 Final Rule, DOE performed a statistical analysis of historical shipments data and RECS 2005, which resulted in a lifetime estimate consistent with DOE's prior lifetime estimate. 10 CFR 430.32. This lifetime methodology is peer-reviewed.

The argument with respect to additional operation and maintenance costs also ignores product class differentiation. Baseline front-loading units would have the same considerations, and therefore the incremental repair rate and operation and maintenance costs of higher efficiency units are the relevant parameters for DOE's analyses; these are typically negligible.

With respect to the possible overstatement of clothes washer usage relative to DOE's ex ante analysis, DOE again notes that its assumptions are based on the latest available data at the time of the rulemaking, particularly RECS. For the 2012 rulemaking, the average number of loads per year in the analysis decreased, in line with RECS 2005 results compared to RECS 1993.[87] Consumer behavior can indeed evolve over time.

Regarding the point that DOE could have improved its analysis by developing distributions for key components of its analysis, DOE notes that in the current rulemaking, lifetime, usage, energy consumption, and discount rates, among other things, are all characterized by distributions.

[87] Department of Energy - Energy Information Administration, Residential Energy Consumption Survey, 1993 and 2005. Available at *www.eia.gov/consumption/residential/*.

With respect to the recommendation to conduct a retrospective analysis as part of this rulemaking, DOE acknowledges that parameters such as lifetime and product usage can change over time. In this rulemaking, DOE uses the best available data to develop new estimates of such parameters. To the extent that the estimates have changed over time, this is not evidence that DOE could have made a better assumption in the previous rulemakings, as it was relying on the best available data at that time, and the difference between estimates in two years would not be sufficient to make adjustments to estimates in future years.

For all of the previous reasons, DOE is not making any methodology changes to its analyses, but it updated inputs based on data availability including repair and maintenance costs, energy and water usage, product lifetime, and product efficiency distribution.

G. Shipments Analysis

DOE uses projections of annual product shipments to calculate the national impacts of potential amended energy conservation standards on energy use, NPV, and future manufacturer cash flows.[88] 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

[88] 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.

input to calculations of both the NES and NPV, because operating costs for any year depend on the age distribution of the stock.

To project RCW shipments under the no-new-standards case, DOE utilized historical shipments data from AHAM. DOE estimated RCW shipments by projecting shipments into two market segments: (1) replacement of existing RCWs; (2) new housings.

To project RCW replacement shipments, DOE developed retirement functions from RCW lifetime estimates and applied them to the existing products in the housing stock, which are tracked by vintage. To estimate shipments to new housings, DOE used projections of new housing starts coupled with RCWs' saturation data. In other words, to project the shipments for new housings for any given year, DOE multiplied the housing projections by the estimated saturation of RCWs for new housing units. For new housing completions and mobile home placements, DOE used recorded data through 2020,[89] and adopted the projections from *AEO2022* for 2021–2050. DOE used the data contained in the 2015 RECS to characterize ownership of RCWs in households across various housing types, including multi-family housing.

DOE then aggregated the above two market segments for any given year during the analysis period (2027–2056) and divided total RCW shipments into its five product classes. For this NOPR, DOE estimated the market share between top-loading and front-

[89] U.S. Census. Characteristics of New Housing. Available at *www.census.gov/construction/chars/*.

loading clothes washers would remain at the current level based on the historical shipments data by washer loading type (2004–2021) provided by AHAM. (AHAM, No. 40, at p.11) DOE estimated market share for top-loading and front-loading clothes washers would remain at 75 percent and 25 percent, respectively. DOE then disaggregated top-loading clothes washer market share into three product classes (*i.e.*, semi-automatic, ultra-compact, and standard-size) and front-loading into two product classes (*i.e.*, compact and standard-size). In addition, DOE assumed annual growth rate for semi-automatic and top-loading ultra-compact clothes washers would be at 0.2 percent. Table IV.34 shows the estimated market share and shipments for each product class.

Table IV.34 Market Share and Shipments by Product Class in 2027

Product Class	**Market Share** *(%)*	**Shipments** (*million*)
Semi-Automatic	1.6	0.16
Top-Loading, Ultra-Compact	0.5	0.05
Top-Loading, Standard-Size	72.9	7.54
Front-Loading, Compact	1.6	0.16
Front-Loading, Standard-Size	23.4	2.42
Total	**100**	**10.35**

DOE seeks comment on the approach and inputs used to develop no-new standards case shipments projection and market share for each product class.

To project RCW shipments under a standards-case, DOE used a price elasticity parameter, which relates the incremental total installed cost to total RCW shipments, and an efficiency elasticity parameter, which relates the change in the operating cost to RCW shipments. Both types of elasticity relate changes in demand to changes in the corresponding characteristic (price or efficiency). A regression analysis estimated these terms separately from each other and found that the price elasticity of demand for several appliances is on average –0.45.[90] Thus, for example, a price increase of 10 percent would result in a shipments decrease of 4.5 percent, all other factors held constant. The same regression analysis found that the efficiency elasticity is estimated to be on average 0.2 (*i.e.*, a 10-percent efficiency improvement, equivalent to a 10-percent decrease in operating costs, would result in a shipments increase of 2 percent, all else being equal).

DOE assumed when market impact occurs, *i.e.*, when shipments drop under a standards-case, the affected consumers would repair their product rather than replace it. Under this method, DOE does not assume that consumers completely forgo the use of the product. The model instead assumes about the length of time that the life of the product is extended. This market impact is thus effectively applied to the repair or replacement decision. The second-hand market for used appliances is a potential alternative to consumers purchasing a new unit or repairing a broken unit. An increase in the purchases of older, less-efficient second-hand units due to a price increase resulting from a more stringent standard could potentially decrease projected energy savings. DOE assumed that purchases on the second-hand market would not change significantly due to the proposed standard level and did not include their impact on product shipments.

[90] Fujita, S., Estimating Price Elasticity using Market-Level Appliance Data. LBNL-188289 (August 2015). Available at: *eta-publications.lbl.gov/sites/default/files/lbnl-188289.pdf.*

DOE requests data on the market size and typical selling price of units sold through the second-hand market for residential clothes washers.

ASAP *et al*. encouraged DOE to more thoroughly model market shifts under standards implementations. ASAP *et al*. commented that in the September 2021 Preliminary TSD, DOE's logistic regression model that captured the relationship between the market share of front- and top-loading clothes washers, their prices, and their energy usage indicates that the front-loading market share is negatively correlated with top-loading price and energy usage. ASAP *et al*. therefore commented that the model predicts that the front-loading market share will decrease if higher standards are implemented for both top- and front-loading clothes washers. However, ASAP *et al*. noted that the estimated average price difference between front-loading and top-loading clothes washers is $323 at the baseline versus only $186 at EL 4. ASAP *et al*. stated that it is plausible that increasing standards could move the market towards, rather than away from, front-loading clothes washers. ASAP *et al*. therefore suggested that DOE should analyze how estimated first costs for each product class may affect market share projections. (ASAP *et al*., No. 37 at pp. 4–5)

The consumer choice model developed under the September 2021 Preliminary Analysis lacked historical retail pricing, sales data, and clothes washer energy use data necessary for DOE to project market share between front-loading and top-loading RCWs, directly using their first cost and sales data as suggested by ASAP *et al*. DOE explored a method, but the regression statistic results indicate a low R-squared, which means the predicted model would not fit with the historical market share data. Recent historical shipments data presented by AHAM (AHAM, No. 40, at p.11) indicate that the proportion of front-loading clothes washers compared to total clothes washer shipments appears to have leveled off. Therefore, for this NOPR analysis, DOE used a frozen scenario for market shifting (*e.g.*, no market shifting) under the standards case.

For details on the shipments analysis, see chapter 9 of the NOPR TSD.

H. National Impact Analysis

The NIA assesses the national energy savings (NES), national water savings (NWS), and the NPV from a national perspective of total consumer costs and savings that would be expected to result from new or amended standards at specific efficiency levels. ("Consumer" in this context refers to consumers of the product being regulated.) DOE calculates the NES, NWS, and NPV for the potential standard levels considered based on projections of annual product shipments, along with the annual energy and water consumption and total installed cost data from the energy and water use and LCC analyses. For the present analysis, DOE projected the energy and water savings, operating cost savings, product costs, and NPV of consumer benefits over the lifetime of RCWs sold from 2027 through 2056.

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

Table IV.35 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.35 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: Annual shipments-weighted efficiency improvement of 0.4 percent for top-loading standard-size and 0.1 percent for both front-loading compact and standard-size clothes washers. Standards cases: "Roll up" equipment to meet potential efficiency level.
Annual Energy and Water Consumption per Unit	Annual weighted-average values are a function of energy and water use at each TSL.
Total Installed Cost per Unit	Annual weighted-average values are a function of cost at each TSL. Incorporates projection of future product prices based on historical data.
Annual Energy and Water Cost per Unit	Annual weighted-average values as a function of the annual energy and water consumption per unit and energy and water prices.
Repair and Maintenance Cost per Unit	Annual values change between non-ENERGY STAR and ENERGY STAR efficiency levels.
Energy and Water Price Trends	*AEO2022* projections (to 2050) and constant value based on average between 2046–2050 thereafter. Historical PPI extrapolated projection (to 2050) and constant value based on average between 2046–2050 thereafter.
Energy Site-to-Primary and FFC Conversion	A time-series conversion factor based on *AEO2022*.
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 standard. To project the trend in efficiency absent amended standards for RCWs over the entire shipments projection period, DOE considered recent trends in DOE's CCD data and the potential effect of programs such as ENERGY STAR. As discussed in section IV.F.8 of this document, DOE estimated an annual efficiency improvement of 0.4 and 0.1 percent for top-loading standard-size and front-loading (compact and standard-size) clothes washers, respectively.

For the standards cases, DOE used a “roll-up” scenario to establish the shipment-weighted efficiency for the year that standards are assumed to become effective (2027). In this scenario, the market shares of products in the no-new-standards case that do not meet the standard under consideration would “roll up” to meet the new standard level, and the market share of products above the standard would remain unchanged.

2. National Energy and Water Savings

The national energy and water savings analysis involves a comparison of national energy and water consumption of the considered products between each potential standards case (or TSL) and the case with no 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 *AEO2022*. Cumulative energy and water savings are the sum of the NES and NWS for each year over the timeframe of the analysis.

Use of higher-efficiency products is sometimes associated with a direct rebound effect, which refers to an increase in utilization of the product due to the increase in efficiency. As described in section IV.E.2, DOE did not find any data on the rebound effect specific to RCWs and did not apply a rebound effect.

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 NAS, DOE announced its intention to use FFC measures of energy use and greenhouse gas and other emissions in the national impact analyses and emissions analyses included in future energy conservation standards rulemakings. 76 FR 51281 (Aug. 18, 2011). After evaluating the approaches discussed in the August 18, 2011 notice, DOE published a statement of amended policy in which DOE explained its determination that EIA's National Energy Modeling System ("NEMS") is the most appropriate tool for its FFC analysis and its intention to use NEMS for that purpose. 77 FR 49701 (Aug. 17, 2012). NEMS is a public domain, multi-sector, partial equilibrium model of the U.S. energy sector[91] that EIA uses to prepare its *Annual Energy Outlook*. The FFC factors incorporate losses in production and delivery in the case of natural gas (including fugitive emissions) and additional energy used to produce and deliver the various fuels used by power plants. The approach used for deriving FFC measures of energy use and emissions is described in appendix 10B and 13A of the NOPR TSD.

[91] For more infomation on NEMS, refer to *The National Energy Modeling System: An Overview 2009*, DOE/EIA-0581(2009), October 2009. Available at *www.eia.gov/outlooks/aeo/nems/documentation/archive/pdf/0581(2009).pdf* (last accessed June 12, 2022).

3. Net Present Value Analysis

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

As discussed in section IV.F.1 of this document, DOE developed RCW 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 RCW price is projected to drop 14.4 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 RCWs. In addition to the default price trend, DOE considered two product price sensitivity cases: (1) a high price decline case based on PPI data for the period 1980–2021 and (2) a low price decline case based on PPI data for the period 1948–1979. The derivation of these price trends and the results of these sensitivity cases are described in appendix 10C of the NOPR TSD.

The energy and water cost savings are calculated using the estimated energy and water savings in each year and the projected price of the appropriate form of energy and water. To estimate energy prices in future years, DOE multiplied the average regional energy prices by the projection of annual national-average residential energy price changes in the Reference case from *AEO2022*, which has an end year of 2050. To estimate price trends after 2050, the 2046–2050 average was used for all years. To estimate water prices in future years, DOE multiplied the average national water prices by the projection of annual national-average residential water price changes in the extrapolated future water price trend, which is based on the historical water price index from 1988 to 2021. To estimate price trends after 2050, DOE used a constant value derived from the average values from 2046 through 2050. As part of the NIA, DOE also analyzed scenarios that used inputs from variants of the *AEO2022* Reference case that have lower and higher economic growth. Those cases have lower and higher energy price trends compared to the Reference case. NIA results based on these cases are presented in appendix 10C of the NOPR TSD.

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.[92]

[92] United States Office of Management and Budget. *Circular A-4: Regulatory Analysis*. September 17, 2003. Section E. Available at *obamawhitehouse.archives.gov/omb/circulars_a004_a-4/* (last accessed June 12, 2022).

The discount rates for the determination of NPV are in contrast to the discount rates used in the LCC analysis, which are designed to reflect a consumer's perspective. The 7-percent real value is an estimate of the average before-tax rate of return to private capital in the U.S. economy. The 3-percent real value represents the "social rate of time preference," which is the rate at which society discounts future consumption flows to their present value.

I. Consumer Subgroup Analysis

In analyzing the potential impact of new or amended energy conservation standards on consumers, DOE evaluates the impact on identifiable subgroups of consumers that may be disproportionately affected by a new or amended national standard. The purpose of a subgroup analysis is to determine the extent of any such disproportional impacts. DOE evaluates impacts on particular subgroups of consumers by analyzing the LCC impacts and PBP for those particular consumers from alternative standard levels. For this 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 2015 RECS sample composed of households that meet the criteria for the two subgroups. DOE used the LCC and PBP spreadsheet model to estimate the impacts of the considered efficiency levels on these subgroups. The sections below discuss the individual subgroups, and additional details are found in chapter 11 of the NOPR TSD.

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.

The CA IOUs recommended that DOE consider adjustments to its consumer subgroup analysis by creating a low-income renter subgroup. The CA IOUs commented that it is more likely that the incremental clothes washer purchase costs to the average low-income household would be paid by a landlord and passed along to the low-income household across multiple months, such that the benefits of lower energy and water costs would offset the incremental cost increases of higher efficiency products. (CA IOUs, No. 43 at pp. 1–2)

NYSERDA recommended that DOE conduct additional analysis on the implications to renters as part of its low-income consumer subgroup assessment. NYSERDA noted that within low-income households, there are important distinctions between renters and owners, and renters often bearing the operational costs of energy and water with limited input on the choice of products. (NYSERDA, No. 36 at p. 2)

For this NOPR analysis, DOE divided low-income households into three sub-subgroups: 1) renters who pay energy bill; 2) renters who do not pay energy bill; and 3) homeowners. The 2015 RECS includes data on whether a household pays for the energy bill, allowing DOE to categorize households in the analysis narrowly,[93] excluding any costs or benefits that are accrued by either a landlord or subsidized housing agency. This allows DOE to determine whether low-income households are disproportionately affected by an amended energy conservation standard in a more accurate manner. Table IV.36 shows the distribution of low-income household clothes washer users with respect to whether they rent or own and whether they pay the energy bill.

Table IV.36 Characterization of Low-Income Households in the Sample for Clothes Washers

Type of Household*	Percentage of Low-Income Sample				Impact of Higher Efficiency on Energy Bill	Impact of First Cost Increase
	Top-Loading, Standard-Size	Front-Loading, Standard-Size	Semi-Automatic, Top-Loading, Ultra-Compact	Front-Loading, Compact		
Renters (Pay for Energy Bill)**	37%	28%	50%	41%	Full/Partial savings	None***
Renters (Do Not Pay for Energy Bill)**	5%	4%	11%	14%	None	None***
Owners	58%	69%	39%	46%	Full/Partial savings	Full

* RECS 2015 lists three categories: (1) Owned or being bought by someone in your household (here classified as "Owners" in this table); (2) Rented (here 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 2015 does not distinguish homes in subsidized or public housing.
** RECS 2015 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).
*** Low-income renters typically do not purchase a clothes washer. Therefore, it is unclear if the renters would be asked to pay the full or partial of the total installed cost. As a result, DOE estimated there would be no impact of first cost increase for low-income renters and occupants in public housing and other households that do not pay rent.

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

AHAM commented that increased efficiency standards would eliminate the lowest priced top-loading RCWs, which would have a disproportionate, negative impact on low-income households. AHAM added that, while low-income consumers would receive payback over time due to savings on utility bills, these consumers are unlikely to have the extra funds to pay for a more efficient, but more expensive RCW. (AHAM, No. 40 at pp. 12−13)

Whirlpool expressed concern about the impacts of amended standards on low-income consumers and believe that amended standards for clothes washers could have potentially devastating impacts on racial and economic equity. Whirlpool commented that any increase to purchase cost driven by amended standards may be difficult or impossible for many low-income households to accept and may further widen the equity gap rather than help close it. (Whirlpool, No. 39 at pp. 16−17)

As described in section V.B.1 of this document, the percent of low-income RCW consumers experiencing a net cost at the proposed standard level (TSL 4) is smaller (13 percent for top-loading standard-size washers) than in the full LCC sample (25 percent for top-loading standard-size washers). The main reason is that a high portion of low-income household renters would not have to pay the total cost of a higher-efficiency washer because renters do not select nor pay for the clothes washer itself (CA IOUs, No.43 at pp. 1−2).

2. Senior-only Households

Annual clothes washer usage for senior-only households is significantly less than the full household sample because the household size for senior-only families is typically either one or two people. A household size equal to or larger than three members accounts for only 8 percent of senior-only households. Therefore, as described in section V.B.1 of this document, the percentage of senior-only RCW consumers experiencing a net cost at the TSL 4 is greater (35 percent for top-loading standard-size washers) than in the full LCC sample (25 percent for top-loading standard-size washers). The simple payback period for senior-only households at TSL 4 is 2 years longer than in the full LCC sample.

For households who would be negatively impacted by amended energy conservation standards, a potential rebate program to reduce the total installed costs would be effective in lowering the percentage of consumers with a net cost and reducing simple payback period. DOE is aware of 80 rebate programs currently available for residential clothes washers meeting ENERGY STAR requirements initiated by 63 organizations in various States as described in chapter 17 of the NOPR TSD.[94] DOE is seeking comment about how amended energy conservation standards may impact the low-income and senior-only consumer economics being presented and considered in this proposed rulemaking.

[94] As of June, 2022, 80 rebate programs were available for residential clothes washers meeting ENERGY STAR requirements: *www.energystar.gov/rebate-finder?scrollTo=363.6363525390625&sort_by=utility&sort_direction=asc&page_number=0&lastpage=0&zip_code_filter=&search_text=&product_clean_filter=Clothes+Washers&product_clean_isopen=0&product_types=Select+a+Product+Category.*

DOE is seeking comment about definable subpopulations in addition to low-income and senior-only households and the associated data required to differentiate how such subpopulation use clothes washers.

Chapter 11 in the NOPR TSD describes the consumer subgroup analysis.

J. Manufacturer Impact Analysis

1. Overview

DOE performed an MIA to estimate the financial impacts of amended energy conservation standards on manufacturers of RCWs and to estimate the potential impacts of such standards on direct employment and manufacturing capacity. The MIA has both quantitative and qualitative aspects and includes analyses of projected industry cash flows, the INPV, investments in research and development ("R&D") and manufacturing capital, and domestic manufacturing employment. Additionally, the MIA seeks to determine how amended energy conservation standards might affect manufacturing employment, capacity, and competition, as well as how standards contribute to overall regulatory burden. Finally, the MIA serves to identify any disproportionate impacts on manufacturer subgroups, including small business manufacturers.

The quantitative part of the MIA primarily relies on the Government Regulatory Impact Model ("GRIM"), an industry cash flow model with inputs specific to this rulemaking. The key GRIM inputs include data on the industry cost structure, unit production costs, product shipments, manufacturer markups, and investments in R&D and manufacturing capital required to produce compliant products. The key GRIM outputs are the INPV, which is the sum of industry annual cash flows over the analysis period, discounted using the industry-weighted average cost of capital, and the impact to domestic manufacturing employment. The model uses standard accounting principles to estimate the impacts of more-stringent energy conservation standards on a given industry by comparing changes in INPV and domestic manufacturing employment between a no-new-standards case and the various standards cases (*i.e.*, TSLs). 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 RCW manufacturing industry based on the market and technology assessment and publicly-available information. This included a top-down analysis of RCW 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 RCW manufacturing industry, including company filings of Form 10-Ks from the SEC,[95] corporate annual reports, the U.S. Census Bureau's *Annual Survey of Manufactures* ("*ASM*"),[96] and reports from Dun & Bradstreet.[97]

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

In addition, during Phase 2, DOE developed interview guides to distribute to manufacturers of RCWs 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.

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[95] U.S. Securities and Exchange Commission, *Electronic Data Gathering, Analysis, and Retrieval (EDGAR) system*. Available at: *www.sec.gov/edgar/search/* (Last accessed July 1, 2022).
[96] 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).
[97] The Dun & Bradstreet Hoovers login is available at: *app.dnbhoovers.com* (Last accessed July 15, 2022).

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 ("LVMs"), 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 an amended energy conservation standard. The GRIM spreadsheet uses the inputs to arrive at a series of annual cash flows, beginning in 2022 (the base year of the analysis) and continuing to 2056. DOE calculated INPVs by summing the stream of annual discounted cash flows during this period. For manufacturers of RCWs, DOE used a real discount rate of 9.3 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 gathered from industry stakeholders during the course of manufacturer interviews. 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. DOE conducted this analysis using the physical teardown approach. The resulting bill of materials provides the basis for the MPC estimates. In this proposed rulemaking, DOE relies on an efficiency-level approach, supplemented with the design-option approach for certain "gap fill" efficiency levels. The efficiency-level approach is appropriate for

RCWs, given the availability of certification data to determine the market distribution of existing products and to identify efficiency level "clusters" that already exist on the market. 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 2022 (the base year) to 2056 (the end year of the analysis period). See chapter 9 of the NOPR TSD for additional details or section IV.G of this document.

c. Product and Capital Conversion Costs

Amended energy conservation standards could cause manufacturers to incur conversion costs to bring their production facilities and equipment 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 equipment necessary to adapt or change existing production facilities such that new compliant product designs can be fabricated and assembled. Product conversion costs are investments in research, development, testing, marketing, and other non-capitalized costs necessary to make product designs comply with 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 TSLs. During interviews, DOE asked manufacturers to estimate the capital conversion costs (*e.g.,* changes in production processes, equipment, and tooling) to meet the various efficiency 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 re-rating basic models in accordance with Appendix J, as detailed in the June 2022 TP Final Rule. 87 FR 33316. Manufacturer data was aggregated to better reflect the industry as a whole and to protect confidential information. DOE then scaled up the aggregate capital and product conversion cost feedback from interviews to estimate total industry conversion costs.

DOE acknowledges that manufacturers may follow different design paths to reach the various efficiency levels analyzed. An individual manufacturer's investments depend on a range of factors, including the company's current product offerings and product platforms, existing production facilities and infrastructure, and make vs. buy decisions for components. DOE's conversion cost methodology incorporated feedback from all manufacturers that took part in interviews and extrapolated industry values. While industry average values may not represent any single manufacturer, DOE's modeling provides reasonable estimates of industry-level investments.

DOE assumes all conversion-related investments occur between the year of publication of the final rule and the year by which manufacturers must comply with the new standard. The conversion cost figures used in the GRIM can be found in section V.B.2 of this document. For additional information on the estimated capital and product conversion costs, see chapter 12 of the NOPR TSD.

d. Manufacturer Markup Scenarios

MSPs include direct manufacturing production costs (*i.e.*, labor, materials, and overhead estimated in DOE's MPCs) and all non-production costs (*i.e.*, SG&A, R&D, and interest), along with profit. To calculate the MSPs in the GRIM, DOE applied manufacturer markups to the MPCs estimated in the engineering analysis for each product class and efficiency level. Modifying the manufacturer markups in the standards case yields different sets of impacts on manufacturers. For the MIA, DOE modeled two standards-case scenarios to represent uncertainty regarding the potential impacts on prices and profitability for manufacturers following the implementation of amended energy conservation standards: (1) a preservation of gross margin percentage scenario; and (2) a preservation of operating profit scenario. These scenarios lead to different markup values that, when applied to the MPCs, result in varying revenue and cash flow impacts.

Under the preservation of gross margin percentage scenario, DOE applied a single uniform "gross margin percentage" across all efficiency levels, which assumes that manufacturers would be able to maintain the same amount of profit as a percentage of revenues at all efficiency levels within a product class. As manufacturer production costs increase with efficiency, this scenario implies that the per-unit dollar profit will increase. DOE assumed a gross margin percentage of 18 percent for all product classes.[98] Manufacturers tend to believe it is optimistic to assume that they would be able to maintain the same gross margin percentage as their production costs increase, particularly for minimally efficient products. Therefore, this scenario represents a high bound of industry profitability under an amended energy conservation standard.

In the preservation of operating profit scenario, as the cost of production goes up under a standards case, manufacturers are generally required to reduce their manufacturer markups to a level that maintains base-case operating profit. DOE implemented this scenario in the GRIM by lowering the manufacturer markups at each TSL to yield approximately the same earnings before interest and taxes in the standards case as in the no-new-standards case in the year after the expected compliance date of the amended

[98] The gross margin percentage of 18 percent is based on a manufacturer markup of 1.22.

standards. The implicit assumption behind this scenario is that the industry can only maintain its operating profit in absolute dollars after the standard takes effect.

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

3. Manufacturer Interviews

DOE interviewed manufacturers representing approximately 82 percent of domestic RCW 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 potential increases in energy conservation standards for RCWs. 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 non-disclosure agreements ("NDAs"), so DOE does not document these discussions in the same way that it does public comments in the comment summaries and DOE's responses throughout the rest of this document.

a. Product Classes

In interviews, manufacturers had differing views on the appropriate RCW product class structure. Generally, manufacturers specializing in standard-size front-loading clothes washers recommended that DOE combine product classes and remove the product class delineation based on load configuration. These manufacturers emphasized that front-loading clothes washers are more efficient than top-loading counterparts. These manufacturers noted that even energy-conscious consumers often just look for the ENERGY STAR certification and are unaware of the energy usage differences between top-loading and front-loading models.

Several manufacturers recommended an array of updates to the product class structure as it relates to the classification of standard-size versus compact-size products. Some manufacturers suggested differentiating product classes based on cabinet width instead of tub capacity. These manufacturers noted that consumers often purchase compact front-loading RCWs due to size constraints at the installation location. Other manufacturers encouraged DOE to align the capacity cutoff for top-loading compact clothes washers with the capacity cutoff for front-loading compact clothes washers analyzed in the September 2021 Preliminary Analysis (*i.e.,* 3.0 ft^3). 86 FR 53886. Some manufacturers suggested splitting up the standard-size product classes by varying cabinet-size (or capacity) thresholds. One manufacturer noted that entry-level products are typically on the smaller side, with capacities under 4.0 ft^3. These smaller standard-size products are often less expensive than larger capacity RCW models. Additionally, the technology options may vary based on capacity. For example, this manufacturer asserted that larger capacity models can better handle increased spin speeds and have an inherent advantage for efficiency ratings due to the larger weighted-average load-size compared to smaller capacity models.

b. Ability to Serve Certain Consumer Segments

In interviews, manufacturers emphasized that consumer preferences vary and as a result, there are a range of RCW models available that appeal to different consumer segments. Currently, manufacturers balance achieving energy and water efficiency metrics with other considerations, such as cycle time, noise levels, fabric care, cleaning performance, and upfront cost. Multiple manufacturers expressed concerns about their ability to meet some consumer requirements under amended standards. For instance, several manufacturers stated that they would need to increase cycle times at certain efficiencies to recover cleaning performance at reduced water levels. These manufacturers noted that consumers often expect wash cycle times to align with dryer cycle times. Other manufacturers expressed concerns about diminished fabric care and heightened noise under levels that require notably faster spin speeds. Some manufacturers stated that it would require significant engineering time and capital investment to develop a range of platforms that meet more stringent energy standards as well as a range of consumer performance requirements. A few manufacturers recommended DOE explore instituting a cleaning performance metric, like the concept proposed for dishwashers in a NOPR published on December 22, 2021. 86 FR 72738.

Some manufacturers stated that a large segment of "traditionalist" consumers prefer "traditional" top-loading RCWs with specific characteristics and the manufacturers asserted that more stringent standards would threaten the viability of these "traditional" top-loading clothes washers that met requirements of this consumer segment. These manufacturers described "traditionalist" consumers as preferring top-loading clothes washers with agitators, visible water levels, and flexible (*i.e.*, manual) fill options.

Specifically, manufacturers stated that an agitator design would not be feasible at or above the current ENERGY STAR level (EL 2). Some manufacturers asserted, based on their product research and reported shifts in consumer demand for agitator washers, that some "traditionalist" consumers would be dissatisfied with top-loading designs that lacked the agitator and instead used a wash plate. One manufacturer noted that they recently introduced RCWs with agitators due to consumer preferences for such features.

Several manufacturers also noted that amending standards would raise the cost of baseline RCWs, which would disproportionately impact low-income consumers since they typically purchase entry-level, "traditional" top-loading clothes washers. These manufacturers raised concerns about their future ability to offer low-cost RCWs and serve the low-income consumer market under amended standards.

c. Supply Chain Constraints

In interviews, some manufacturers expressed concerns about potential supply chain constraints. Those manufacturers noted concerns about the ongoing supply constraints for microprocessors and electronics. Any shift towards direct drive motors would require that industry source more advanced microprocessors, which are already difficult to secure. Some manufacturers were also uncertain about industry's ability to source enough direct drive motors – particularly for standard-size top-loading clothes washers – to meet market demand at and above the current ENERGY STAR level (EL 2). Manufacturers asserted that if these supply constraints continue through the end of the conversion period, industry could face production capacity constraints.

4. Discussion of MIA Comments

In response to the September 2021 Preliminary Analysis, 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 the GRIM. (AHAM, No. 40 at p. 7) AHAM noted other regulations impact RCW manufacturers such as consumer clothes dryers, commercial clothes washers, consumer refrigerator/freezers, miscellaneous refrigeration products, cooking products, dishwashers, room air conditioners, dehumidifiers, and portable air conditioners rulemakings. (AHAM, No. 40 at p. 8) 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, particularly for rulemakings where there is only partial overlap of manufacturers. Conversion costs would be spread over a larger revenue base and result in less severe INPV impacts, when evaluated on a percent change basis.

To consider to 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.

AHAM requested DOE plan its rulemaking process such that the compliance dates for residential clothes washers and clothes dryers are identical or very nearly identical. AHAM further explained that this would allow manufacturers to design these products simultaneously to meet amended standards and so that there is less confusion for manufacturers, retailers, and consumers as products would need to be re-floored leading up to and on the compliance date of any amended energy conservation standards. (AHAM, No. 40 at pp. 7–8) Whirlpool also stated that if DOE decides to amend standards for both clothes washers and clothes dryers, then compliance dates should be aligned to allow for manufacturers to invest in clothes washers and clothes dryers as a pair, which prevents unnecessary cost, confusion, and burden for manufacturers and retailers. (Whirlpool, No. 39 at p. 20) Whirlpool added that it believes DOE has the statutory authority to align these compliance dates. (*Id.*)

Pursuant to a consent decree entered on September 20, 2022, DOE has agreed to sign and post on DOE's publicly accessible website a rulemaking document for RCWs and consumer clothes dryers by February 29, 2024, that, when effective, would be DOE's final agency action for standards for these products.[99] As such, DOE expects that, if these two rulemakings result in amended energy conservations standards, the compliance dates would be similar.

Whirlpool stated that more stringent standards would disproportionately harm the company due to its broad lineup of RCWs that includes broad offerings at entry-level price points. Whirlpool noted that the company would need to devote a high level of engineering resources to incorporate design options such as stainless-steel wash baskets, wash plates, direct drive motors, and product structural changes. Whirlpool added that moving from traditional agitators to high-efficiency agitators or wash plates would lead to increased costs associated with redesigning models and retooling factories. In contrast, Whirlpool emphasized that many competitors would not need to make additional investments to meet amended standards since they cater to a more targeted consumer segment. (Whirlpool, No. 39 at p. 18)

DOE uses the GRIM, as described in section IV.J.2, to determine the quantitative impacts on the RCW industry as a whole. Impacts on individual manufacturers may vary from industry averages due to a wide range of company-specific factors including, but not limited to, differences in efficiency of current product offerings, production volumes, and legacy investments in manufacturing plants. DOE recognizes that the industry impacts do not apply evenly across manufacturers. However, as many of the GRIM inputs (*e.g.*, industry financials) account for U.S. market share weights, the GRIM is most

[99] *Natural Resources Defense Council, Inc., et al. v Granholm, et al*, No. 1:20-cv-09127 (S.D.N.Y.), and *State of New York, et al. v Granholm, et al*. No. 1:20-cv-09362 (S.D.NY).

reflective of large manufacturers, like Whirlpool. Additionally, DOE's modeling incorporates estimate conversion costs associated with the product changes, such as stainless-steel wash baskets, wash plates, direct drive motors, and product structural enhancements, identified by Whirlpool.

Whirlpool expressed concern that direct drive and BPM motors are more expensive than PSC motors. (Whirlpool, No. 39 at p. 6) DOE incorporates the higher cost of direct drive and BPM motors in its engineering analysis, as discussed in section IV.C.4 of this document.

Whirlpool noted concerns about being able to secure an adequate domestic supply of direct drive motors, if DOE amends standard, since direct drive motors typically come from foreign suppliers. (Whirlpool, No. 39 at p.6) Samsung commented that direct drive motors have matured over the years and have become highly cost competitive. (Samsung, No. 41 at pp. 2–3) More stringent standards would likely necessitate adoption of more efficient technologies, such as direct drive motors. DOE notes that amended standards, if adopted, could provide regulatory certainty for manufacturers and suppliers to establish additional capacity in the supply chain.

DOE seeks comment on the availability of direct drive motors in quantities required by industry if DOE were to adopt amended standards.

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 electric power sector emissions of CO_2, NO_X, SO_2, and Hg uses emissions factors intended to represent the marginal impacts of the change in electricity consumption associated with amended or new standards. The methodology is based on results published for the *AEO*, including a set of side cases that implement a variety of efficiency-related policies. The methodology is described in appendix 13A in the NOPR TSD. The analysis presented in this notice uses projections from *AEO2022*. Power sector emissions of CH_4 and N_2O from fuel combustion are estimated using Emission Factors for Greenhouse Gas Inventories published by the EPA.[100]

The on-site operation of RCWs requires combustion of fossil fuels and results in emissions of CO_2, NO_X, SO_2 CH_4, and N_2O where these products are used. Site emissions of these gases were estimated using Emission Factors for Greenhouse Gas

[100] Available at *www.epa.gov/sites/production/files/2021-04/documents/emission-factors_apr2021.pdf* (last accessed June 12, 2022).

Inventories and, for NO_X and SO_2 emissions intensity factors from an EPA publication.[101]

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

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

1. Air Quality Regulations Incorporated in DOE's Analysis

DOE's no-new-standards case for the electric power sector reflects the *AEO*, which incorporates the projected impacts of existing air quality regulations on emissions. *AEO2022* generally represents current legislation and environmental regulations, including recent government actions, that were in place at the time of preparation of *AEO2022*, including the emissions control programs discussed in the following paragraphs.[102]

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[101] U.S. Environmental Protection Agency. External Combustion Sources. In *Compilation of Air Pollutant Emission Factors*. AP-42. Fifth Edition. Volume I: Stationary Point and Area Sources. Chapter 1. Available at *www.epa.gov/ttn/chief/ap42/index.html* (Last accessed June 12, 2022).
[102] For further information, see the Assumptions to *AEO2022* report that sets forth the major assumptions used to generate the projections in the Annual Energy Outlook. Available at *www.eia.gov/outlooks/aeo/assumptions/* (Last accessed June 12, 2022).

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.[103] *AEO2022* incorporates implementation of CSAPR, including the update to the CSAPR ozone season program emission budgets and target dates issued in 2016. 81 FR 74504 (Oct. 26, 2016). Compliance with CSAPR is flexible among EGUs and is enforced through the use of tradable emissions allowances. Under existing EPA regulations, 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 the Mercury and Air Toxics Standards ("MATS") for power plants. 77 FR 9304 (Feb. 16, 2012). In the MATS final rule, EPA established a standard for hydrogen chloride as a surrogate for acid gas hazardous air pollutants ("HAP"), and also established a standard

[103] 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).

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 *AEO2022*.

CSAPR also established limits on NO_X emissions for numerous States in the eastern half of the United States. Energy conservation standards would have little effect on NO_X emissions in those States covered by CSAPR emissions limits if excess NO_X emissions allowances resulting from the lower electricity demand could be used to permit offsetting increases in NO_X emissions from other EGUs. In such 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 *AEO2022* data to derive NO_X emissions factors for the group of States not covered by CSAPR.

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

L. Monetizing Emissions Impacts

As part of the development of this 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.

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

1. Monetization of Greenhouse Gas Emissions

DOE estimates the monetized benefits of the reductions in emissions of CO_2, CH_4, and N_2O by using a measure of the social cost ("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 ("February 2021 SC-GHG TSD"). 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, which included DOE and other executive branch agencies and offices, was established to ensure that agencies were using the best available science and to promote consistency in the social cost of carbon (*i.e.*, 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 (*i.e.*, SC-CH_4) and nitrous oxide (*i.e.*, 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.* [104] 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

[104] Marten, A. L., E. A. Kopits, C. W. Griffiths, S. C. Newbold, and A. Wolverton. Incremental CH4 and N_2O mitigation benefits consistent with the U.S. Government's SC-CO_2 estimates. *Climate Policy*. 2015. 15(2): pp. 272–298.

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).[105] Shortly thereafter, in March 2017, President Trump issued Executive Order 13783, which disbanded the IWG, withdrew the previous TSDs, and directed agencies to ensure SC-CO_2 estimates used in regulatory analyses are consistent with the guidance contained in OMB's Circular A-4, "including with respect to the consideration of domestic versus international impacts and the consideration of appropriate discount rates" (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

[105] 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.

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 SC-GHG 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,[106] and recommended that discount rate uncertainty and relevant aspects of intergenerational ethical considerations be accounted for in selecting future discount rates.

Furthermore, the damage estimates developed for use in the SC-GHG are estimated in consumption-equivalent terms, and so an application of OMB Circular A-4's guidance for regulatory analysis would then use the consumption discount rate to calculate the SC-GHG. DOE agrees with this assessment and will continue to follow developments in the literature pertaining to this issue. DOE also notes that while OMB Circular A-4, as published in 2003, recommends using 3- 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

[106] 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 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*.

assumptions." On discounting, Circular A-4 recognizes that "special ethical considerations arise when comparing benefits and costs across generations," and Circular A-4 acknowledges that analyses may appropriately "discount future costs and consumption benefits [...] at a lower rate than for intragenerational analysis." In the 2015 Response to Comments on the Social Cost of Carbon for Regulatory Impact Analysis, OMB, DOE, and the other IWG members recognized that "Circular A-4 is a living document" and "the use of 7 percent is not considered appropriate for intergenerational discounting. There is wide support for this view in the academic literature, and it is recognized in Circular A-4 itself." Thus, DOE concludes that a 7-percent discount rate is not appropriate to apply to value the social cost of greenhouse gases 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 SC-GHG TSD recommends "to ensure internal consistency—*i.e.*, future damages from climate change using the SC-GHG at 2.5 percent should be discounted to the base year of the analysis using the same 2.5 percent rate." DOE has also consulted the National Academies' 2017 recommendations on how SC-GHG estimates can "be combined in RIAs with other cost and benefits estimates that may use different discount rates." The National Academies reviewed several options, including "presenting all discount rate combinations of other costs and benefits with [SC-GHG] estimates."

As a member of the IWG involved in the development of the February 2021 SC-GHG TSD, DOE agrees with the above assessment and will continue to follow developments in the literature pertaining to this issue. While the IWG 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 use 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.[107] 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 SC-GHG TSD, the IWG has recommended

[107] 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/*.

that, taken together, the limitations suggest that the interim SC-GHG estimates used in this proposed rule likely underestimate the damages from GHG emissions. DOE concurs with this assessment.

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

a. Social Cost of Carbon

The SC-CO_2 values used for this NOPR were based on the values presented for IWG's February 2021 SC-GHG TSD. Table IV.37 shows the updated sets of SC-CO_2 estimates from the IWG's February 2021 SC-GHG TSD in 5-year increments from 2020 to 2050. The full set of annual values that DOE used 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.[108]

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

Table IV.37 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
2025	17	56	83	169
2030	19	62	89	187
2035	22	67	96	206
2040	25	73	103	225
2045	28	79	110	242
2050	32	85	116	260

For 2051 to 2070, DOE used SC-CO_2 estimates published by EPA, adjusted to 2020$.[109] These estimates are based on methods, assumptions, and parameters identical to the 2020-2050 estimates published by the IWG. DOE expects additional climate benefits to accrue for any longer-life RCWs after 2070, but a lack of available SC-CO_2 estimates for emissions years beyond 2070 prevents DOE from monetizing these potential benefits in this analysis.

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

[109] See EPA, *Revised 2023 and Later Model Year Light-Duty Vehicle GHG Emissions Standards: Regulatory Impact Analysis*, Washington, D.C., December 2021. Available at: *www.epa.gov/system/files/documents/2021-12/420r21028.pdf* (last accessed January 13, 2022).

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. 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. 40 at p. 32)

As stated in section III.F.1.f of this document, DOE maintains that environmental and public health benefits associated with the more efficient use of energy, including those connected to global climate change, are important to take into account when considering the need for national energy conservation, which is one of the factors that EPCA requires DOE to evaluate in determining whether a potential energy conservation standard is economically justified. 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 SC-GHG TSD. Table IV.38 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.38 Annual SC-CH4 and SC-N2O Values from 2021 Interagency Update, 2020–2050 (2020$ per Metric Ton)

Year	SC-CH4				SC-N2O			
	Discount Rate and Statistic				Discount Rate and Statistic			
	5%	3%	2.5%	3%	5%	3%	2.5 %	3%
	Average	Average	Average	95th percentile	Average	Average	Average	95th percentile
2020	670	1500	2000	3900	5800	18000	27000	48000
2025	800	1700	2200	4500	6800	21000	30000	54000
2030	940	2000	2500	5200	7800	23000	33000	60000
2035	1100	2200	2800	6000	9000	25000	36000	67000
2040	1300	2500	3100	6700	10000	28000	39000	74000
2045	1500	2800	3500	7500	12000	30000	42000	81000
2050	1700	3100	3800	8200	13000	33000	45000	88000

DOE multiplied the 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.

2. Monetization of Other Emissions Impacts

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.[110] DOE used EPA's values for $PM_{2.5}$-related benefits associated with NO_X and SO_2 and for ozone-related benefits associated with NO_X for 2025 2030, and 2040, calculated with discount rates of 3 percent and 7 percent. DOE used linear interpolation to define values for the years not given in the 2025 to 2040 period; for years beyond 2040 the values are held constant. DOE derived values specific to the sector for RCWs using a method described in appendix 14B of the NOPR TSD.

DOE also estimated the monetized value of NO_X and SO_2 emissions reductions from site use of natural gas in RCWs using benefit-per-ton estimates from the EPA's Benefits Mapping and Analysis Program. Although none of the sectors covered by EPA refers specifically to residential and commercial buildings, the sector called "area sources" would be a reasonable proxy for residential and commercial buildings.[111] The EPA document provides high and low estimates for 2025 and 2030 at 3- and 7-percent

[110] *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.*
[111] "Area sources" represents all emission sources for which states do not have exact (point) locations in their emissions inventories. Because exact locations would tend to be associated with larger sources, "area sources" would be fairly representative of small dispersed sources like homes and businesses.

discount rates.[112] DOE used the same linear interpolation and extrapolation as it did with the values for electricity generation.

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

M. Utility Impact Analysis

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

[112] "Area sources" are a category in the 2018 document from EPA, but are not used in the 2021 document cited above. Available at: *www.epa.gov/sites/default/files/2018-02/documents/sourceapportionmentbpttsd_2018.pdf*.

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 employees of manufacturers of the products subject to standards, their suppliers, and related service firms. The MIA addresses those impacts. Indirect employment impacts are changes in national employment that occur due to the shift in expenditures and capital investment caused by the purchase and operation of more-efficient appliances. Indirect employment impacts from standards consist of the net jobs created or eliminated in the national economy, other than in the manufacturing sector being regulated, caused by (1) reduced spending by consumers on energy, (2) reduced spending on new energy supply by the utility industry, (3) increased consumer spending on the products to which the new standards apply and other goods and services, and (4) the effects of those three factors throughout the economy.

One method for assessing the possible effects on the demand for labor of such shifts in economic activity is to compare sector employment statistics developed by the Labor Department's Bureau of Labor Statistics ("BLS"). BLS regularly publishes its estimates of the number of jobs per million dollars of economic activity in different sectors of the economy, as well as the jobs created elsewhere in the economy by this same economic activity. Data from BLS indicate that expenditures in the utility sector generally create fewer jobs (both directly and indirectly) than expenditures in other sectors of the economy.[113] 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").[114] ImSET is a special-purpose version of the "U.S. Benchmark National Input-Output" ("I-O") model, which was designed to estimate the national employment and income effects of energy-saving technologies. The ImSET software includes a computer- based I-O model having structural coefficients that characterize economic flows among 187 sectors most relevant to industrial, commercial, and residential building energy use.

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[113] See U.S. Department of Commerce–Bureau of Economic Analysis. *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II)*. 1997. U.S. Government Printing Office: Washington, DC. Available at *apps.bea.gov/scb/pdf/regional/perinc/meth/rims2.pdf* (Last accessed June 22, 2022).
[114] 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.

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 (2027–2031), 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 RCWs. It addresses the TSLs examined by DOE, the projected impacts of each of these levels if adopted as energy conservation standards for RCWs, 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.

In the analysis conducted for this NOPR, DOE analyzed the benefits and burdens of five TSLs for RCWs. 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 through Table V.3 present the TSLs and the corresponding efficiency levels that DOE has identified for potential amended energy conservation standards for RCWs. TSL 5 represents the max-tech energy and water efficiency for all product classes. TSL 4 represents the ENERGY STAR Most Efficient level for the front-loading product classes, the CEE Tier 1 level for the top-loading standard-size product class, and a gap fill level for the semi-automatic product class. TSL 3 represents the current ENERGY STAR efficiency level for all product classes that are eligible for the program, and a gap fill level for the semi-automatic product class. TSL 2 represents the non-max-tech efficiency levels providing the highest LCC savings. TSL 1 represents EL 1 across all product classes.

Table V.1 Trial Standard Levels for Semi-Automatic, Residential Clothes Washers

TSL	Semi-Automatic		
	Efficiency Level	EER (lb/kWh/cycle)	WER (lb/gal/cycle)
1–4	1	2.12	0.27
5	2	2.51	0.36

Table V.2 Trial Standard Levels for Top-Loading Residential Clothes Washers

TSL	Top-Loading, Ultra-Compact			Top-Loading, Standard-Size		
	Efficiency Level	EER (lb/kWh/cycle)	WER (lb/gal/cycle)	Efficiency Level	EER (lb/kWh/cycle)	WER (lb/gal/cycle)
1	Baseline	3.79	0.29	1	3.89	0.47
2	Baseline	3.79	0.29	1	3.89	0.47
3	Baseline	3.79	0.29	2	4.27	0.57
4	Baseline	3.79	0.29	3	4.78	0.63
5	Baseline	3.79	0.29	4	5.37	0.67

Table V.3 Trial Standard Levels for Front-Loading Residential Clothes Washers

TSL	Front-Loading, Compact			Front-Loading, Standard-Size		
	Efficiency Level	EER (lb/kWh/cycle)	WER (lb/gal/cycle)	Efficiency Level	EER (lb/kWh/cycle)	WER (lb/gal/cycle)
1	1	4.80	0.62	1	5.31	0.69
2	1	4.80	0.62	2	5.52	0.77
3	1	4.80	0.62	2	5.52	0.77
4	2	5.02	0.71	3	5.73	0.77
5	4	5.97	0.80	4	5.97	0.85

While not all efficiency levels were included in the TSLs, DOE considered all efficiency levels as part of its analysis.[115]

B. Economic Justification and Energy Savings

1. Economic Impacts on Individual Consumers

DOE analyzed the economic impacts on RCW 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.

[115] Efficiency levels that were analyzed for this NOPR are discussed in section IV.C.1 of this document. Results by efficiency level are presented in chapters 8, 10, and 12 of the NOPR TSD.

a. Life-Cycle Cost and Payback Period

In general, higher-efficiency products affect consumers in two ways: (1) purchase price increases and (2) annual operating costs decrease. Inputs used for calculating the LCC and PBP include total installed costs (*i.e.*, product price plus installation costs), and operating costs (*i.e.*, annual energy use, energy prices, energy price trends, repair costs, and maintenance costs). The LCC calculation also uses product lifetime and a discount rate. Chapter 8 of the NOPR TSD provides detailed information on the LCC and PBP analyses.

Table V.4 through Table V.13 show the LCC and PBP results for the TSLs considered for each product class. In the first of each pair of tables, the simple payback is measured relative to the baseline product. In the second table, 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.

Table V.4 Average LCC and PBP Results for Semi-Automatic Residential Clothes Washers

TSL	Efficiency Level	Average Costs *2021$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	$553	$136	$1,532	$2,085	--	13.7
1-4	1	$561	$107	$1,195	$1,756	0.3	13.7
5	2	$568	$93	$1,044	$1,612	0.4	13.7

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

Table V.5 Average LCC Savings Relative to the No-New-Standards Case for Semi-Automatic Residential Clothes Washers

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2021$*	Percent of Consumers that Experience Net Cost
1-4	1	$329	0%
5	2	$219	0%

* The savings represent the average LCC for affected consumers.

Table V.6 Average LCC and PBP Results for Top-Loading, Ultra-Compact Residential Clothes Washers

TSL	Efficiency Level	Average Costs *2021$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
1-5	Baseline	$904	$85	$958	$1,862	--	13.7

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level.

Table V.7 Average LCC Savings Relative to the No-New-Standards Case for Top-Loading, Ultra-Compact Residential Clothes Washers

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2021$*	Percent of Consumers that Experience Net Cost
1-5	Baseline	$0.00	0%

* The savings represent the average LCC for affected consumers.

Table V.8 Average LCC and PBP Results for Top-Loading, Standard-Size Residential Clothes Washers

TSL	Efficiency Level	Average Costs *2021$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	$706	$183	$2,080	$2,786	--	13.7
1, 2	1	$795	$164	$1,853	$2,649	4.6	13.7
3	2	$881	$157	$1,779	$2,660	6.8	13.7
4	3	$891	$152	$1,717	$2,608	5.9	13.7
5	4	$896	$149	$1,682	$2,578	5.5	13.7

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

Table V.9 Average LCC and PBP Results for Top-Loading, Standard-Size Residential Clothes Washers

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2021$*	Percent of Consumers that Experience Net Cost
1, 2	1	$138	14%
3	2	$115	28%
4	3	$134	25%
5	4	$157	23%

* The savings represent the average LCC for affected consumers.

Table V.10 Average LCC and PBP Results for Front-Loading, Compact Residential Clothes Washers

TSL	Efficiency Level	Average Costs *2021$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	$809	$100	$1,119	$1,929	--	13.7
1-3	1	$861	$93	$1,046	$1,907	0.0	13.7
4	2	$909	$89	$992	$1,901	9.1	13.7
5	4	$944	$81	$901	$1,845	7.1	13.7

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

Table V.11 Average LCC and PBP Results for Front-Loading, Compact Residential Clothes Washers

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2021$*	Percent of Consumers that Experience Net Cost
1-3	1	$0.0	0%
4	2	$7	24%
5	4	$56	29%

* The savings represent the average LCC for affected consumers.

Table V.12 Average LCC and PBP Results for Front-Loading, Standard-Size Residential Clothes Washers

TSL	Efficiency Level	Average Costs *2021$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	$1,195	$146	$1,664	$2,859	--	13.7
1	1	$1,213	$140	$1,589	$2,802	2.8	13.7
2, 3	2	$1,226	$133	$1,513	$2,740	2.4	13.7
4	3	$1,244	$131	$1,488	$2,732	3.2	13.7
5	4	$1,265	$126	$1,424	$2,689	3.4	13.7

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

Table V.13 Average LCC and PBP Results for Front-Loading, Standard-Size Residential Clothes Washers

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2021$*	Percent of Consumers that Experience Net Cost
1	1	$57	0%
2, 3	2	$78	0%
4	3	$19	24%
5	4	$55	18%

* 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.14 through

Table V.18 compares the average LCC savings and PBP at each efficiency level for the consumer subgroups with similar metrics for the entire consumer sample for each RCW product class. The percent of low-income RCW consumers experiencing a net cost is smaller than the full LCC sample in all cases, largely due to the proportion of renter households. The percent of senior-only households experiencing a net cost is higher than the full LCC sample, largely due to the lower washer usage frequency. Chapter 11 of the NOPR TSD presents the complete LCC and PBP results for the subgroups.

Table V.14 Comparison of LCC Savings and PBP for Consumer Subgroups and All Households; Semi-Automatic Residential Clothes Washers

	Low-Income Households	Senior-Only Households	All Households
Average LCC Savings (2021$)			
TSL 1–4	$389	$265	$329
TSL 5	$258	$174	$219
Payback Period (years)			
TSL 1–4	0.1	0.4	0.3
TSL 5	0.2	0.5	0.4
Consumers with Net Benefit (%)			
TSL 1–4	18%	21%	21%
TSL 5	80%	92%	92%
Consumers with Net Cost (%)			
TSL 1–4	0%	0%	0%
TSL 5	0%	0%	0%

Table V.15 Comparison of LCC Savings and PBP for Consumer Subgroups and All Households; Top-Loading, Ultra-Compact Residential Clothes Washers

	Low-Income Households	Senior-Only Households	All Households
Average LCC Savings (2021$)			
TSL 1–5	$0	$0	$0
Payback Period (years)			
TSL 1–5	--	--	--
Consumers with Net Benefit (%)			
TSL 1–5	0%	0%	0%
Consumers with Net Cost (%)			
TSL 1–5	0%	0%	0%

Table V.16 Comparison of LCC Savings and PBP for Consumer Subgroups and All Households; Top-Loading, Standard-Size Residential Clothes Washers

	Low-Income Households	Senior-Only Households	All Households
Average LCC Savings (2021$)			
TSL 1, 2	$175	$77	$138
TSL 3	$186	$37	$115
TSL 4	$189	$62	$134
TSL 5	$214	$81	$157
Payback Period (years)			
TSL 1, 2	2.7	6.3	4.6
TSL 3	4.0	9.4	6.8
TSL 4	3.5	8.1	5.9
TSL 5	3.2	7.6	5.5
Consumers with Net Benefit (%)			
TSL 1, 2	47%	39%	46%
TSL 3	45%	29%	39%
TSL 4	72%	59%	69%
TSL 5	78%	66%	76%
Consumers with Net Cost (%)			
TSL 1, 2	8%	22%	14%
TSL 3	15%	38%	28%
TSL 4	13%	35%	25%
TSL 5	13%	33%	23%

Table V.17 Comparison of LCC Savings and PBP for Consumer Subgroups and All Households; Front-Loading, Compact Residential Clothes Washers

	Low-Income Households	Senior-Only Households	All Households
Average LCC Savings (2021$)			
TSL 1–3	$0	$0	$0
TSL 4	$27	$3	$7
TSL 5	$73	$44	$56
Payback Period (years)			
TSL 1–3	0.0	0.0	0.0
TSL 4	6.7	9.9	9.1
TSL 5	5.2	7.8	7.1
Consumers with Net Benefit (%)			
TSL 1–3	0%	0%	0%
TSL 4	21%	14%	15%
TSL 5	65%	67%	70%
Consumers with Net Cost (%)			
TSL 1–3	0%	0%	0%
TSL 4	10%	25%	24%
TSL 5	14%	32%	29%

Table V.18 Comparison of LCC Savings and PBP for Consumer Subgroups and All Households; Front-Loading, Standard-Size Residential Clothes Washers

	Low-Income Households	**Senior-Only Households**	**All Households**
Average LCC Savings (2021$)			
TSL 1	$56	$39	$57
TSL 2, 3	$80	$52	$78
TSL 4	$25	$8	$19
TSL 5	$63	$32	$55
Payback Period (years)			
TSL 1	2.0	3.8	2.8
TSL 2, 3	1.7	3.3	2.4
TSL 4	2.3	4.3	3.2
TSL 5	2.4	4.5	3.4
Consumers with Net Benefit (%)			
TSL 1	1%	2%	2%
TSL 2, 3	6%	7%	7%
TSL 4	29%	22%	28%
TSL 5	65%	63%	74%
Consumers with Net Cost (%)			
TSL 1	0%	0%	0%
TSL 2, 3	1%	1%	0%
TSL 4	19%	31%	24%
TSL 5	20%	29%	18%

c. Rebuttable Presumption Payback

As discussed in section III.F.2 of this document, EPCA establishes a rebuttable presumption that an energy conservation standard is economically justified if the increased purchase cost for a product that meets the standard is less than three times the value of the first-year energy savings resulting from the standard. In calculating a rebuttable presumption payback period for each of the considered TSLs, DOE used discrete values, and, as required by EPCA, based the energy use calculation on the DOE test procedure for RCWs. 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.19 presents the rebuttable-presumption payback periods for the considered TSLs for RCWs. While DOE examined the rebuttable-presumption criterion, it 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.19 Rebuttable-Presumption Payback Periods

Product Class	**Trial Standard Level**				
	1	**2**	**3**	**4**	**5**
	years				
Semi-Automatic	0.2	0.2	0.2	0.2	0.3
Top-Loading, Ultra-Compact*	n.a.	n.a.	n.a.	n.a.	n.a.
Top-Loading, Standard-Size	4.2	4.2	6.2	5.3	4.8
Front-Loading, Compact	6.5	6.5	6.5	7.5	6.0
Front-Loading, Standard-Size	2.8	2.5	2.5	3.3	3.4

*The entry "n.a." means not applicable because the evaluated standard is the baseline.

2. Economic Impacts on Manufacturers

DOE performed an MIA to estimate the impact of amended energy conservation standards on manufacturers of RCWs. 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. See section V.B.1 of this document for a discussion of the potential impacts on consumers.

a. Industry Cash Flow Analysis Results

In this section, DOE provides GRIM results from the analysis, which examines changes in the industry that would result from a standard. The following tables summarize the estimated financial impacts (represented by changes in INPV) of potential amended energy conservation standards on manufacturers of RCWs, as well as the conversion costs that DOE estimates manufacturers of RCWs would incur at each TSL.

The impact of potential amended energy conservation standards were analyzed under two scenarios: (1) the preservation of gross margin percentage; and (2) the preservation of operating profit, as discussed in section IV.J.2.d of this document. The preservation of gross margin percentage applies a "gross margin percentage" of 18 percent for all product classes and all efficiency levels.[116] 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 preservation of operating profit scenario reflects manufacturers' concerns about their inability to maintain margins as MPCs increase to reach more-stringent efficiency levels. In this scenario, while manufacturers make the necessary investments required to convert their facilities to produce compliant products, operating profit does not change in absolute dollars and decreases as a percentage of revenue. The

[116] The gross margin percentage of 18 percent is based on a manufacturer markup of 1.22.

preservation of operating profit scenario results in the lower (or more severe) 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 base year through the end of the analysis period (2022–2056). 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.20 Manufacturer Impact Analysis Results for Residential Clothes Washers

	Unit	No-New-Standards Case	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
INPV	*2021$ millions*	1,738.3	1,680.4 to 1,746.4	1,636.5 to 1,702.9	1,490.3 to 1,631.0	1,208.1 to 1,376.7	798.7 to 985.9
Change in INPV*	*%*	-	(3.3) to 0.5	(5.9) to (2.0)	(14.3) to (6.2)	(30.5) to (20.8)	(54.1) to (43.3)
Free Cash Flow (2026)*	*2021$ millions*	139.9	117.5	90.8	13.7	(150.0)	(396.7)
Change in Free Cash Flow (2026)*	*%*	-	(16.0)	(35.1)	(90.2)	(207.3)	(383.7)
Conversion Costs	*2021$ millions*	-	56.5	118.7	302.2	690.8	1,253.8

*Parentheses denote negative (-) values.

The majority of the INPV impacts are associated with standard-size product classes because standard-size top-loading and front-loading RCWs comprise approximately 96 percent of the total RCW domestic shipments. More specifically, the majority of the INPV impacts are associated with top-loading clothes washers due to the high-volume of shipments, the high percentage of shipments at minimum efficiency, and the likely design paths required to meet more stringent standards. Top-loading clothes washers account for approximately 76 percent of current standard-size RCW shipments. DOE’s shipments analysis estimates approximately 69 percent of top-loading shipments are at the baseline efficiency level. Additionally, the engineering analysis, informed by conversations with manufacturers indicates that the likely design path to meet the efficiencies required at TSL 4 and TSL 5 would require notable capital investments. In particular, standard-size top-loading units with capacities of less than 4.7 ft^3 would require significant redesign associated with increasing tub capacity to meet these higher efficiencies. In contrast, only 3 percent of current front-loading shipments are at the baseline efficiency level and DOE’s engineering analysis suggests that increases in tub capacity would not be required for front-loading clothes washer models to reach max-tech. Thus, as DOE considers increasingly stringent TSLs, the standard-size top-loading product class tends to drive industry investments and negative INPV impacts. See chapter 5 of the NOPR TSD for a detailed discussion of design paths to reach higher efficiencies.

At TSL 1, the standard represents the least stringent efficiencies (EL 1) for all product classes. The change in INPV is expected to range from -3.3 to 0.5 percent. At this level, free cash flow is estimated to decrease by 16.0 percent compared to the no-new-standards case value of $139.9 million in the year 2026, the year before the standards year. DOE’s shipments analysis estimates approximately 48 percent of current shipments meet this level.

At TSL 1, DOE expects most manufacturers would incur limited conversion costs to reach the efficiencies required. The conversion costs primarily stem from changes required for top-loading standard-size clothes washers. DOE’s shipments analysis estimates approximately 31 percent of current standard-size top-loading clothes washers meet this level (EL 1). In contrast, nearly all the front-loading standard-size clothes washers currently meet the efficiencies required at this level. Industry capital conversion costs include tooling updates and costs associated with transitioning models with porcelain wash baskets to stainless-steel wash baskets. Product conversion costs may be necessary for product development and testing. DOE expects industry to incur some re-flooring costs. DOE estimates capital conversion costs of $30.1 million and product conversion costs of $26.3 million. Conversion costs total $56.5 million.

At TSL 1, the shipment-weighted average MPC for all RCWs is expected to increase by 6.9 percent relative to the no-new-standards case shipment-weighted average MPC for all RCWs in 2027. In the preservation of gross margin percentage scenario, the slight increase in cashflow slightly outweighs the $56.5 million in conversion costs, causing a minor positive change in INPV at TSL 1 under this scenario. Under the preservation of operating profit scenario, the manufacturer markup decreases in 2028, the year after the analyzed compliance year. This reduction in the manufacturer markup and the $56.5 million in conversion costs incurred by manufacturers cause a slightly negative change in INPV at TSL 1 under the preservation of operating profit scenario.

At TSL 2, the standard represents the non-max-tech efficiency levels providing the highest LCC savings for all product classes. The change in INPV is expected to range from -5.9 to -2.0 percent. At this level, free cash flow is estimated to decrease by 35.1 percent compared to the no-new-standards case value of $139.9 million in the year 2026, the year before the standards year. DOE's shipments analysis estimates approximately 47 percent of current shipments meet this level.

For standard-size front-loading clothes washers, TSL 2 corresponds to EL 2. For the remaining product classes, TSL 2 corresponds to the same efficiencies required at TSL 1 (EL 1). The increase in conversion costs from the prior TSL are entirely due to the efficiency level requirements for standard-size front-loading clothes washers. DOE's shipments analysis estimates approximately 91 percent of current standard-size front-loading clothes washer shipments meet or exceed TSL 2 efficiencies. Of the seven OEMs with standard-size front-loading clothes washer models, there is one OEM that does not currently offer a product that meets TSL 2 efficiencies. DOE assumed that this manufacturer would redesign and re-tool to meet TSL 2 in its estimate of conversion costs. That manufacturer accounts for the majority of the increase in conversion costs. DOE estimates capital conversion costs of $81.1 million and product conversion costs of $37.6 million. Conversion costs total $118.7 million.

At TSL 2, the shipment-weighted average MPC for all RCWs is expected to increase by 6.9 percent relative to the no-new-standards case shipment-weighted average MPC for all RCWs in 2027. In the preservation of gross margin percentage scenario, the slight increase in cashflow is outweighed by the $118.7 million in conversion costs, causing a slightly negative change in INPV at TSL 2 under this scenario. Under the preservation of operating profit scenario, the manufacturer markup decreases in 2028, the year after the analyzed compliance year. This reduction in the manufacturer markup and the $118.7 million in conversion costs incurred by manufacturers cause a slightly negative change in INPV at TSL 2 under the preservation of operating profit scenario.

At TSL 3, the standard represents the current ENERGY STAR efficiency level for all product classes that are eligible for the program, and a gap fill level for the semi-automatic product class. The change in INPV is expected to range from -14.3 to -6.2 percent. At this level, free cash flow is estimated to decrease by 90.2 percent compared to the no-new-standards case value of $139.9 million in the year 2026, the year before the standards year. DOE's shipments analysis estimates approximately 45 percent of current shipments meet this level.

For standard-size top-loading clothes washers, TSL 3 corresponds to EL 2. For the remaining product classes, the efficiencies required at TSL 3 are the same as TSL 2. Approximately 29 percent of current standard-size top-loading clothes washer shipments meet the efficiencies required by TSL 3. However, most manufacturers with standard-size top-loading models offer products at or above the efficiencies required at this level. Of the nine OEMs with standard-size top-loading products, six OEMs offer models that meet the efficiencies required.

To meet TSL 3, DOE expects manufacturers would incorporate wash plate designs, direct drive motors, and hardware features enabling spin speed increases into standard-size top-loading RCWs. Beyond these design options, some manufacturers may need to increase the tub capacities of certain standard-size top-loading clothes washers (*i.e.*, models with capacities of less than 4.4 ft^3). Increasing clothes washer capacity could require a new cabinet, tub, and drum designs, which would necessitate costly investments in manufacturing equipment and tooling. Product conversion costs may be necessary for designing, prototyping, and testing new or updated platforms. Additionally, DOE expects industry to incur more re-flooring costs compared to prior TSLs as more display units would need to be replaced. The increase in conversion costs at TSL 3 are entirely due to the increased stringency for standard-size top-loading clothes washers. DOE estimates capital conversion costs of $216.4 million and product conversion of costs of $85.7 million. Conversion costs total $302.2 million.

At TSL 3, the shipment-weighted average MPC for all RCWs is expected to increase by 14.1 percent relative to the no-new-standards case shipment-weighted average MPC for all RCWs in 2027. In the preservation of gross margin percentage scenario, the increase in cashflow is outweighed by the $302.2 million in conversion costs, causing a slightly negative change in INPV at TSL 3 under this scenario. Under the preservation of operating profit scenario, the manufacturer markup decreases in 2028, the year after the analyzed compliance year. This reduction in the manufacturer markup and the $302.2 million in conversion costs incurred by manufacturers cause a negative change in INPV at TSL 3 under the preservation of operating profit scenario.

At TSL 4, the standard represents the ENERGY STAR Most Efficient level for the front-loading product classes, the CEE Tier 1 level for the top-loading standard-size product class, and a gap fill level for the semi-automatic product class. The change in INPV is expected to range from -30.5 to -20.8 percent. At this level, free cash flow is estimated to decrease by 207.3 percent compared to the no-new-standards case value of $139.9 million in the year 2026, the year before the standards year. DOE's shipments analysis estimates approximately 14 percent of current shipments meet this level.

For standard-size top-loading and standard-size front-loading clothes washers, TSL 4 corresponds to EL 3. For compact-size front-loading clothes washers, TSL 4 corresponds to EL 2. For semi-automatic clothes washers, TSL 4 corresponds to the same efficiency level as TSL 3 (EL 1). At this level, the increase in conversion costs is driven by the standard-size top-loading clothes washers product class. Currently, approximately 2 percent of standard-size top-loading shipments meet TSL 4 efficiencies. Of the nine OEMs with top-loading standard-size products, only two offer models that meet the efficiencies required at TSL 4. The remaining seven OEMs would need to redesign all their existing standard-size top-loading platforms to meet this level.

To meet TSL 4, top-loading clothes washer designs would likely need to incorporate hardware features to enable faster spin speeds. These hardware updates may include reinforced wash baskets, more robust suspension and balancing system, and more advanced sensors. An increasing portion of top-loading standard-size clothes washers (*i.e.*, those models with capacities less than 4.7 ft^3) may need an increase in tub capacity. Increasing clothes washer capacity could require new cabinet, tub, and drum designs. The changes would necessitate investments in new equipment and tooling. DOE expects industry to incur more re-flooring costs compared to prior TSLs as more display units would need to be replaced. DOE estimates capital conversion costs of $507.9 million and product conversion of costs of $200.8 million. Conversion costs total $708.6 million.

At TSL 4, 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.

At TSL 4, the shipment-weighted average MPC for all RCWs is expected to increase by 15.6 percent relative to the no-new-standards case shipment-weighted average MPC for all RCWs in 2027. In the preservation of gross margin percentage scenario, the increase in cashflow is outweighed by the $690.8 million in conversion costs, causing a notable change in INPV at TSL 4 under this scenario. Under the preservation of operating profit scenario, the manufacturer markup decreases in 2028, the year after the analyzed compliance year. This reduction in the manufacturer markup and the $690.8 million in conversion costs incurred by manufacturers cause a significant negative change in INPV at TSL 4 under the preservation of operating profit scenario.

At TSL 5, the standard represents the max-tech energy and water efficiencies for all product classes. The change in INPV is expected to range from -54.1 to -43.3 percent. At this level, free cash flow is estimated to decrease by 383.7 percent compared to the no-new-standards case value of $139.9 million in the year 2026, the year before the standards year. DOE's shipments analysis estimates approximately 3 percent of current shipments meet this level.

As previously discussed, the max-tech efficiencies required for standard-size clothes washers drive the increase in conversion costs from the prior TSLs. Currently, less than 1 percent of standard-size top-loading clothes washer shipments and approximately 9 percent of standard-size front-loading clothes washer shipments meet max-tech levels. Out of the nine standard-size top-loading OEMs, only one offers models that meet the efficiencies required by TSL 5. Out of the seven standard-size front-loading OEMs, only two offer models that meet the efficiencies required by TSL 5. Max-tech would require most manufacturers to significantly redesign their clothes washer platforms. DOE expects most standard-size clothes washer manufacturers would need to further increase spin speeds as compared to prior TSLs. An increasing portion of top-loading standard-size clothes washers (*i.e.*, models with capacities of less than 5.0 ft^3) may need to increase tub capacity to achieve the RMCs required at this level. In interviews, two manufacturers stated that max-tech levels would require a total renovation of existing production facilities. Some manufacturers further stated that their product portfolio would be limited due to the lack of differentiation possible under a max-tech standard, which would potentially limit their ability to serve certain consumer segments and hurt profitability. DOE expects industry would incur approximately the same re-flooring costs as TSL 4 since few models exist at the higher levels. At TSL 5, reaching max-tech efficiency levels is a billion-dollar investment for industry. DOE estimates capital conversion costs of $1,013.3 million and product conversion of costs of $240.5 million. Conversion costs total $1,253.8 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.

At TSL 5, the shipment-weighted average MPC for all RCWs is expected to increase by 17.1 percent relative to the no-new-standards case shipment-weighted average MPC for all RCWs in 2027. In the preservation of gross margin percentage scenario, the increase in cashflow is outweighed by the $1,253.8 million in conversion costs, causing a significant negative change in INPV at TSL 5 under this scenario. Under the preservation of operating profit scenario, the manufacturer markup decreases in 2028, the year after the analyzed compliance year. This reduction in the manufacturer markup and the $1,253.8 million in conversion costs incurred by manufacturers cause a significant negative change in INPV at TSL 5 under the preservation of operating profit scenario.

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 RCW 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 2020 *ASM*,[117] BLS employee compensation data,[118] results of the engineering analysis, and manufacturer interviews.

Labor expenditures related to product manufacturing depend on the labor intensity of the product, the sales volume, and an assumption that wages remain fixed in real terms over time. The total labor expenditures in each year are calculated by multiplying the total MPCs by the labor percentage of MPCs. The total labor expenditures in the GRIM were then converted to total production employment levels by dividing production labor expenditures by the average fully burdened wage multiplied by the average number of hours worked per year per production worker. To do this, DOE relied on the *ASM* inputs:

[117] 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).
[118] 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 July 27, 2022).

Production Workers Annual Wages, Production Workers Annual Hours, Production Workers for Pay Period, and Number of Employees. DOE also relied on the BLS employee compensation data to determine the fully burdened wage ratio. The fully burdened wage ratio factors in paid leave, supplemental pay, insurance, retirement and savings, and legally required benefits.

The number of production employees is then multiplied by the U.S. labor percentage to convert total production employment to total domestic production employment. The U.S. labor percentage represents the industry fraction of domestic manufacturing production capacity for the covered product. This value is derived from manufacturer interviews, product database analysis, and publicly available information. DOE estimates that 92 percent of RCWs 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 rulemaking.

Non-production workers account for the remainder of the direct employment figure. The non-production employees estimate covers domestic workers who are not directly involved in the production process, such as sales, engineering, human resources, and management. Using the amount of domestic production workers calculated previously, 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 9,222 domestic workers for RCWs in 2027. Table V.21 shows the range of the impacts of energy conservation standards on U.S. manufacturing employment in the RCW industry. The following discussion provides a qualitative evaluation of the range of potential impacts presented in Table V.21.

Table V.21 Domestic Direct Employment Impacts for Residential Clothes Washer Manufacturers in 2027

	No-New-Standards Case	**TSL 1**	**TSL 2**	**TSL 3**	**TSL 4**	**TSL 5**
Direct Employment (Production Workers + Non-Production Workers)	9,222	10,511	10,504	11,710	11,973	11,939
Potential Changes in Direct Employment Workers*		(8,121) to 1,289	(8,121) to 1,282	(8,121) to 2,488	(8,121) to 2,751	(8,121) to 2,717

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

The direct employment impacts shown in Table V.21 represent the potential domestic employment changes that could result following the compliance date for the RCWs covered in this proposal. The upper bound estimate corresponds to an increase in the number of domestic workers that results 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. At lower TSLs, 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, as amended standards increase in stringency and both the complexity and cost of production facility updates increases, manufacturers are more likely to revisit their production location decisions. At max-tech, manufacturers representing a large portion of the market noted concerns about the level of investment, about the potential need to relocate production lines in order to remain competitive, and about the conversion period of 3 years being insufficient to make the necessary manufacturing line updates.

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, meeting the efficiencies required for each TSL would require varying levels of resources and investment. A standard level requiring notably faster spin speeds, namely TSL 4 and TSL 5, would necessitate product redesign to account for the increased spin speeds as well as the noise, vibration, and fabric care concerns related to the spin speeds required to meet these higher TSLs. These updates may include designing and manufacturing reinforced wash baskets, instituting a more robust suspension and balancing system, increasing the number of sensors, and incorporating more advanced sensors. For standard-size top-loading clothes washers, manufacturers would also need to increase tub capacity of smaller models to meet the efficiencies required at higher TSLs. Many manufacturers would need to invest in new tooling and equipment to either produce entirely new wash basket lines or ramp up production of their existing larger capacity wash baskets. Based on a review of CCD model listings, DOE's engineering analysis indicates that tub capacity would need to increase to 4.4 ft^3 at TSL 3, 4.7 ft^3 at TSL 4, and 5.0 ft^3 at TSL 5 for the top-loading standard-size product class.[119] In interviews, some manufacturers expressed concerns – particularly at max-tech – that the 3-year period between the announcement of the final rule and the compliance date of the amended energy conservation standard might be insufficient to update production facilities and design, test, and manufacture the necessary number of products to meet demand.

For the remaining TSLs (*i.e.,* TSL 1, TSL 2, and TSL 3) most manufacturers could likely maintain manufacturing capacity levels and continue to meet market demand under amended energy conservation standards.

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

[119] Based on the increase in cost associated with implementing a larger capacity tub, DOE expects that if a higher efficiency level were possible to achieve without an increase in capacity, such products would be available on the market.

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 proposed 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."[120] Based on this classification, DOE identified one domestic OEM that qualifies as a small business. For a discussion of the impacts on the small business manufacturer 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

[120] 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 August 16, 2022).

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 RCW manufacturers that take effect approximately three years before or after the 2027 compliance date.

In response to the September 2021 Preliminary Analysis, stakeholders commented on the cumulative regulatory burden analysis. See section IV.J.3.c for a summary of stakeholder comments and DOE's initial responses.

Table V.22 Compliance Dates and Expected Conversion Expenses of Federal Energy Conservation Standards Affecting Residential Clothes Washer Original Equipment 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%
Room Air Conditioners† 87 FR 20608 (April 7, 2022)	8	4	2026	$22.8 (2020$)	0.5%
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	12	2027	$149.7 (2020$)	1.8%
Microwave Ovens† 87 FR 52282 (August 24, 2022)	18	9	2026	$46.1 (2021$)	0.7%
Consumer Conventional Cooking Products† 88 FR 6818 (February 1, 2023)	34	9	2027	$183.4 (2021$)	1.2%
Consumer Refrigerators, Refrigerator-Freezes, and Freezers†‡	49	12	2027	$1,323.6 (2021$)	3.8%

* This column presents the total number of OEMs identified in the energy conservation standard rule contributing to cumulative regulatory burden.
** This column presents the number of OEMs producing RCWs that are also listed as OEMs in the identified 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 final rule. The conversion period typically ranges from 3 to 5 years, depending on the energy conservation standard.
† These rulemakings are in the proposed rule stage and all values are subject to change until finalized.
‡ At the time of issuance of this RCW proposed rule, this rulemaking has been issued and is pending publication in the *Federal Register*. Once published, the consumer refrigerators, refrigerator-freezers, and freezers proposed rule will be available at: *www.regulations.gov/docket/EERE-2017-BT-STD-0003.*

DOE requests information regarding the impact of cumulative regulatory burden on manufacturers of RCWs 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 national energy and water savings 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 RCWs, 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.23 and Table V.24 present DOE's projections of the national energy and water savings for each TSL considered for RCWs, respectively. The savings were calculated using the approach described in section IV.H of this document.

Table V.23 Cumulative National Energy Savings for Residential Clothes Washers; 30 Years of Shipments (2027–2056)

	Trial Standard Level				
	1	2	3	4	5
	quads				
Primary energy	0.59	0.59	0.70	1.39	2.15
FFC energy	0.61	0.62	0.74	1.45	2.27

Table V.24 Cumulative National Water Savings for Residential Clothes Washers; 30 Years of Shipments (2027–2056)

	Trial Standard Level				
	1	2	3	4	5
	trillion gallons				
Water Savings	1.26	1.27	2.07	2.53	2.94

OMB Circular A-4[121] 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.[122] The review timeframe established in EPCA is generally not synchronized with the product lifetime, product manufacturing cycles, or other factors specific to RCWs. 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.25

[121] 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 June 12, 2022).

[122] Section 325(m) of 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.

and Table V.26. The impacts are counted over the lifetime of RCWs purchased in 2027–2035.

Table V.25 Cumulative National Energy Savings for Residential Clothes Washers; 9 Years of Shipments (2027–2035)

	Trial Standard Level				
	1	**2**	**3**	**4**	**5**
	quads				
Primary energy	0.24	0.25	0.29	0.50	0.72
FFC energy	0.26	0.26	0.31	0.53	0.75

Table V.26 Cumulative National Water Savings for Residential Clothes Washers; 9 Years of Shipments (2027–2035)

	Trial Standard Level				
	1	**2**	**3**	**4**	**5**
	trillion gallons				
Water Savings	0.51	0.52	0.79	0.93	1.04

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 RCWs. In accordance with OMB's guidelines on regulatory analysis,[123] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. Table V.27 shows the consumer NPV results with impacts counted over the lifetime of products purchased in 2027–2056.

[123] U.S. Office of Management and Budget. *Circular A-4: Regulatory Analysis*. September 17, 2003. Available at *obamawhitehouse.archives.gov/omb/circulars_a004_a-4/* (Last accessed June 12, 2022).

Table V.27 Cumulative Net Present Value of Consumer Benefits for Residential Clothes Washers; 30 Years of Shipments (2027–2056)

Discount Rate	Trial Standard Level				
	1	2	3	4	5
	billion 2021$				
3 percent	8.39	8.50	8.13	14.52	20.77
7 percent	3.36	3.41	2.48	5.14	7.68

The NPV results based on the aforementioned 9-year analytical period are presented in Table V.28. 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.28 Cumulative Net Present Value of Consumer Benefits for Residential Clothes Washers; 9 Years of Shipments (2027–2035)

Discount Rate	Trial Standard Level				
	1	2	3	4	5
	billion 2021$				
3 percent	3.90	3.97	3.68	6.13	8.35
7 percent	1.93	1.96	1.39	2.74	3.95

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

c. Indirect Impacts on Employment

It is estimated that that amended energy conservation standards for RCWs would reduce energy and water expenditures for consumers of those products, with the resulting net savings being redirected to other forms of economic activity. These expected shifts in spending and economic activity could affect the demand for labor. As described in section IV.N of this document, DOE used an input/output model of the U.S. economy to estimate indirect employment impacts of the TSLs that DOE considered. There are uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Therefore, DOE generated results for near-term timeframes (2027–2031), 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 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))

a. Performance Characteristics

EPCA authorizes DOE to design test procedures that measure energy efficiency, energy use, water use (in the case of showerheads, faucets, water closets and urinals), or estimated annual operating cost of a covered product during a representative average use cycle or period of use. (42 U.S.C. 6293(b)(3)) Currently, DOE's test procedure addresses the energy and water efficiency of clothes washers, and DOE's clothes washer test procedures do not prescribe a method for testing clothes washer cleaning performance or other consumer-relevant attributes of performance.

Representative average use of a clothes washer reflects, in part, a consumer using the clothes washer to achieve an acceptable level of cleaning performance. DOE recognizes that in general, a consumer-acceptable level of cleaning performance can be easier to achieve through the use of higher amounts of energy and water use during the clothes washer cycle. Conversely, maintaining acceptable cleaning performance can be more difficult as energy and water levels are reduced. Improving one aspect of clothes washer performance, such as reducing energy and/or water use as a result of energy conservation standards, may require manufacturers to make a trade-off with one or more other aspects of performance, such as cleaning performance, depending on which performance characteristics are prioritized by the manufacturer. DOE expects, however, that consumers maintain the same expectations of cleaning performance regardless of the efficiency of the clothes washer. As the clothes washer market continuously evolves to higher levels of efficiency—either as a result of mandatory minimum standards or in response to voluntary programs such as ENERGY STAR—it becomes increasingly more important that DOE ensures that its test procedure continues to reflect representative use.

As such, the normal cycle that is used to test the clothes washer for energy and water performance must be one that provides a consumer-acceptable level of cleaning performance, even as efficiency increases.

Whirlpool commented that amended standards would result in an increase in purchase price and perceptible differences in product performance including cycle time, vibration and noise, fabric care, cleaning and rinse performance, and detergent effectiveness. (Whirlpool, No. 39 at pp. 8–9) Whirlpool commented that it does not recommend that DOE develop a performance requirement, like that under consideration for dishwashers currently, but rather referenced the EPCA requirement that DOE consider performance and the impacts to consumer utility as one of the seven statutory factors for considering whether a standard is justified. (*Id.*) Whirlpool recommended that DOE conclude that amended standards are not justified due to the potential to lessen utility and performance of clothes washers, particularly for top-loading standard-size clothes washers. (*Id.*)

Regarding cycle time specifically, Whirlpool commented that amended standards could require an increase in cycle time. (Whirlpool, No. 39 at p. 9) Specifically, Whirlpool explained that the wash phase of the cycle may need to be longer in order to compensate for decreased water temperatures and reduced load motion due to increased pauses to allow for motor cooling; the spin phase would need to be longer to reduce RMC; and that as spin speeds increase, cycle time could be increased due to a greater risk of out-of-balance conditions, which require more sensing and re-balancing to address. Whirlpool also commented that appendix J would require spinning at maximum speed for both small and large load sizes and noted that smaller loads do not extract moisture as well as larger loads, and therefore would require even more spin time. (*Id.*) Whirlpool also asserted that because increased spin time may lead to greater electrical energy use by the clothes washers, the annual energy consumption reported on the EnergyGuide label may show an increase in energy use for new higher-efficiency models, which would be counterintuitive for consumers. (*Id.*)

Regarding vibration and noise specifically, Whirlpool commented that it would expect higher overall noise and vibration levels as a result of increased spin speeds and spin times. (Whirlpool, No. 39 at p. 10) In addition, the drivetrain may produce louder sounds due to the additional motor torque required to move a load with lower water levels. (*Id.*) Whirlpool also commented that the higher risk of out-of-balance conditions from faster spin speeds may also contribute to higher noise and vibration levels. (*Id.*) Whirlpool recommended that DOE account for any additional product cost required to keep sound and vibration levels where they are currently to prevent consumer dissatisfaction at higher efficiency levels. (*Id.*)

Regarding fabric care specifically, Whirlpool commented if wash time is lengthened in order to compensate for reduced water temperatures, the additional agitation on the clothes may lead to increased fabric wear and damage. (Whirlpool, No. 39 at pp. 10–11) Whirlpool also commented that faster spinning would increase the degree of wrinkling in a load and that clothes may become more tangled. (*Id.*)

Regarding cleaning and rinsing performance specifically, Whirlpool commented that amended standards could result in biofilm accumulations on internal wash unit surfaces, white residues, difficulty removing detergent and particulates, redeposition, yellowing of clothes, and reduced stain removal, especially for oily or fatty soils. (Whirlpool, No. 39 at p. 11) Whirlpool added that some of these issues (*e.g.*, reduced stain removal) may be immediately apparent to consumers, whereas others (*e.g.*, biofilm accumulation) may become noticeable over time. (*Id.*) Whirlpool commented that a correlation exists between lower water temperatures and degraded cleaning performance. (*Id.*) Whirlpool added that oily or fatty solids are soluble around 85 °F, that detergents can do only some of the work removing oily or fatty soils at temperatures below 85 °F, and that natural skin oils will be harder to remove under lower temperatures. (*Id.*) Whirlpool also commented that rinse performance could suffer as a result of the need to make trade-offs in allocating the available water between the wash and rinse phases. Whirlpool commented that reduced water during the rinse phase makes it harder to effectively remove detergent and particulates from the wash load and increases re-deposition. (*Id.*)

Whirlpool commented that overall load motion, the degree to which the load moves in the wash bath and the amount of free water visible to the consumer, may be sacrificed as clothes washers move to faster spin and lower torque powertrains. (Whirlpool, No. 39 at p. 12) Whirlpool further commented that, according to its initial testing, a reduction in load motion of over 50 percent could result from the new powertrains needed for amended standards due to the lower available torque from the motor and reduced water levels needed to meet more stringent water efficiency requirements. (*Id*.)

Whirlpool commented in summary that cleaning in a clothes washer is a holistic experience that encompasses a consumer's expectation of product appearance, cleanliness of the clothes washer itself, water level, water temperatures, load motion, cycle time, and cleaning performance, including stain and soil removal, particulate removal, odor removal, and detergent rinsing. (Whirlpool, No. 39 at p. 12) Whirlpool added that if consumer expectations are not met at any point, they will likely have a negative perception of product performance and often voice complaints about it in the form of a negative review or call to the manufacturer. (*Id*.)

AHAM commented that DOE's proposed changes to the test procedure alone, and when coupled with amended energy conservation standards, are likely to drive product performance impacts. (AHAM, No. 40 at p. 9) AHAM further commented that increasing spin speed and spin time could cause increased vibration and noise, negatively impact fabric care due to tangling and wrinkling, and increase cycle time. (AHAM, No. 40 at pp. 9–10)

AHAM recommended that instead of adding a performance minimum to the test procedure, DOE should avoid changes that could impact clothes washer performance, and account for the potential impact of these changes in DOE's amended standards analysis, as required by EPCA. (AHAM, No. 40 at p. 10) AHAM also noted that conducting a performance test may not capture all the potential impacts that standards may have on clothes washer performance. (*Id*.) AHAM recommended that DOE further investigate these potential impacts during manufacturer interviews. (*Id*.)

AHAM commented that efficiency standards that require increased cycle times beyond an acceptable length would negatively impact consumers and could result in cycle times that are not synchronized with clothes dryer cycle times. (AHAM, No. 40 at p. 10) AHAM recommended against introducing a maximum cycle length requirement; instead, AHAM recommended that any potential impact of cycle time should be avoided and accounted for in DOE's amended standards, as required by EPCA. (*Id*.)

In addition to considering the comments summarized in this section, DOE also discussed performance characteristics in detail as part of its confidential interviews with manufacturers. DOE has considered potential impacts to the various attributes of product performance as part of its consideration of amended standards, as discussed further in section V.C.1 of this document.

DOE is aware of high-efficiency clothes washers that achieve equal or better cleaning performance than lower-efficiency clothes washers in third-party performance reviews. For example, DOE has consulted performance ratings published by Consumer Reports,[124] which DOE recognizes is one popular resource for consumers seeking independent reviews of consumer products. According to information provided on their website, the test method used by Consumer Reports appears to be similar in nature to

[124] Consumer Reports ratings of clothes washers available at *www.consumerreports.org/appliances/washing-machines/*. Last accessed September 23, 2022.

AHAM's cleaning performance test procedure, but inconsistent with the test conditions prescribed by DOE's appendix J test procedure;[125] nevertheless, its test results provide an objective measure of the performance capabilities for products currently on the market.

For top-loading standard-size RCWs, Consumer Reports ratings indicate that models rated at or above TSL 4 achieve equal or better cleaning performance than models with lower efficiency ratings. Specifically, among 4 tested top-loading standard-size models with an IMEF/IWF rating[126] at or above TSL 4, all of them receive a relative "washing performance" rating of 5 out of 5. Among 70 tested top-loading standard-size models with an IMEF/IWF rating below TSL 4, 11 models (16 percent) receive a relative rating of 5 out of 5, and 26 models (37 percent) receive a relative rating of 4 out of 5 – for a total of only 53 percent of units receiving a score of 4 or 5 out of 5. These ratings suggest that top-loading standard-size RCWs with efficiency ratings at or above TSL 4 can achieve equal or better overall cleaning performance scores than models with lower efficiency ratings.

For front-loading standard-size RCWs, Consumer Reports ratings indicate no significant differences between models rated at or above TSL 4 and models with lower efficiency ratings. Specifically, among 27 tested front-loading standard-size models with an IMEF/IWF rating at or above TSL 4, 20 models (74 percent) receive a relative rating of 5 out of 5, and 6 models (22 percent) receive a relative rating of 4 out of 5 – for a total

[125] The Consumer Reports describes its washing performance test as reflecting the degree of color change to swatches of fabric that were included in an 8-pound test load of mixed cotton items using the unit's "most aggressive" normal cycle.
[126] Although the efficiency levels are defined based on EER and WER, manufacturer ratings use IMEF and IWF.

of only 96 percent of units receiving a score of 4 or 5 out of 5. Among 20 tested front-loading standard-size models with an IMEF/IWF rating below TSL 4, 18 models (90 percent) receive a relative rating of 5 out of 5, and 2 models (10 percent) receive a relative rating of 4 out of 5 – for a total of 100 percent of units receiving a score of 4 or 5 out of 5. These ratings suggest that front-loading standard-size RCWs with efficiency ratings at or above TSL 4 can achieve roughly equivalent overall cleaning performance scores compared to models with lower efficiency ratings.

DOE seeks comment on whether the Consumer Reports test produces cleaning performance results that are representative of an average use cycle as measured by the DOE test procedure. DOE also seeks comment on how relative cleaning performance results would vary if tested under test conditions consistent with the DOE appendix J test procedure.

In addition to considering the Consumer Reports ratings, DOE conducted performance testing on a representative sample of top-loading standard-size and front-loading standard-size units, which collectively represent around 98 percent of RCW shipments. The detailed results of DOE's testing are provided in the performance characteristics test report, which is available in the docket for this rulemaking. In particular, DOE evaluated wash temperatures, stain removal, mechanical action (*i.e.*, "wear and tear"), and cycle duration across the range of efficiency levels considered in the analysis. Specifically, DOE evaluated wash temperatures and cycle time based on test data performed according to DOE's new appendix J test procedure; additionally, DOE evaluated cleaning performance and fabric care based on additional testing performed according to the soil/stain removal and mechanical action tests specified in AHAM's HLW-2-2020 test method: Performance Evaluation Procedures for Household Clothes Washers ("AHAM HLW-2-2020"). The AHAM HLW-2-2020 test method does not prescribe specific test conditions for performing the test (*e.g.*, inlet water temperatures conditions, load size, test cycle, or wash/rinse temperature selection). For each clothes washer in its test sample, DOE tested the Hot Wash/Cold Rinse ("Hot") temperature selection[127] in the Normal cycle[128] using the large load size[129] specified in appendix J, as well as using the inlet water temperatures and ambient conditions specified in appendix J. DOE specifically analyzed the Hot cycle with the large load size because (1) the Hot temperature selection would be the temperature selection most likely targeted for reduced wash temperature as a design option for achieving a higher energy efficiency rating; (2) the large load size is more challenging to clean than the small load size; and (3) all units in the test sample offer a Hot temperature selection (allowing for consistent comparison across units). DOE expects that the Hot temperature selection with the large load size is the cycle combination most likely to experience the types of performance compromises described by AHAM and manufacturers. In sum, DOE selected the most conservative assumptions for its performance testing investigation to allow DOE to better

[127] Figure 2.12.1.2 of appendix J provides a flow chart defining the Hot Wash/Cold Rinse temperature selection. Generally, the Hot Wash/Cold Rinse temperature selection corresponds to the hottest available wash temperature less than 140°F, with certain exceptions as provided in Figure 2.12.1.2.
[128] Section 1 of appendix J defines the Normal cycle as the cycle recommended by the manufacturer (considering manufacturer instructions, control panel labeling, and other markings on the clothes washer) for normal, regular, or typical use for washing up to a full load of normally soiled cotton clothing.
[129] Table 5.1 of appendix J defines the small and large load sizes to be tested according to the clothes washer's measured capacity.

understand the potential impacts on performance at various efficiency levels for clothes washers.

DOE requests comment on its use of the Hot temperature selection with the large load size to evaluate potential impacts on clothes washer performance as a result of amended standards.

More specifically, DOE performed the Soil/Stain Removal test specified in section 6 of AHAM HLW-2-2020 to measure relative cleaning performance among the test sample units. AHAM HLW-2-2020 states that the purpose of the Soil/Stain Removal test is to evaluate the performance of household clothes washers in removing representative soils and stains from fabric. DOE also performed the Mechanical Action test specified in section 7 of AHAM HLW-2-2020 to measure relative fabric wear and tear among the test sample units. AHAM HLW-2-2020 states that the purpose of the Mechanical Action test is to measure the mechanical action applied by the clothes washer to the textiles. AHAM HLW-2-2020 states that this test may be performed in conjunction with the Soil/Stain Removal test; therefore, DOE conducted both tests simultaneously on each test run. AHAM HLW-2-2020 specifies running three replications of the test method on each tested unit, with the results of the three replications averaged.

DOE requests comment on its use of the Soil/Stain Removal test and Mechanical Action test specified in AHAM HLW-2-2020 as the basis for evaluating performance-related concerns expressed by AHAM and manufacturers.

The performance characteristics test report provides detailed test results in table and graphical format. The discussion throughout the remainder of this section summarizes the key conclusions from the test results.

With regard to hot wash temperatures, manufacturer comments (as summarized previously in this section) suggested that decreasing water temperature to achieve higher efficiency could decrease cleaning performance by making it harder to remove fatty soils, which are soluble around 85°F. (*See* Whirlpool, No. 39 at p. 11) To evaluate whether more stringent standards may reduce water temperatures below the 85°F threshold and thus potentially decrease cleaning performance for fatty soils, DOE analyzed the wash temperature of the hottest temperature selection available in the Normal cycle for each clothes washer in the test sample. For front-loading standard-size RCWs, DOE's test data show no identifiable correlation between efficiency and the hottest available wash temperature in the Normal cycle. At the proposed standard level (*i.e.*, TSL 4, corresponding to EL 3), considering units both slightly higher and slightly lower than EL 3, the hottest available wash temperature in the Normal cycle ranges from around 70 °F to around 140 °F. This closely matches the range of the hottest wash temperatures available on units at lower efficiency levels, which range from around 80 °F to around 155 °F. Notably, at EL 3, multiple models from multiple manufacturers provide wash temperatures higher than the 85 °F threshold and would be able to dissolve and clean fatty soils.

For top-loading standard-size RCWs, DOE's test data show that for units at EL 2 and below, the hottest available wash temperature in the Normal cycle ranges from around 70 °F to around 110 °F. At EL 3 (considering units both slightly higher and slightly lower than EL 3), the hottest available wash temperature in the Normal cycle ranges from around 80 °F to around 100 °F. Several models from multiple manufacturers are available with temperatures higher than the 85 °F threshold and would be able to dissolve and clean fatty soils.

Based on this data, DOE tentatively concludes that the proposed standard level (*i.e.*, TSL 4), would not require a substantive reduction in hot water temperature on the hottest temperature selection in the Normal cycle, and would not preclude the ability to provide wash temperatures above the 85 °F threshold.

DOE requests comment on its wash temperature data presented in the performance characteristics test report and on its tentative conclusions derived from this data. DOE requests any additional data DOE should consider about wash temperatures at the proposed standard level, as DOE's data leads to the tentative conclusion that fatty soils would be able to be dissolved at this efficiency level.

With regard to stain removal, manufacturer comments (as summarized previously in this section) suggested that more stringent standards could result in reduced stain removal, especially for oily or fatty stains. (*See* Whirlpool, No. 39 at p. 11) To evaluate whether more stringent standards would result in a decrease in stain removal performance, DOE conducted the Soil/Stain Removal test specified in AHAM HLW-2-2020 using the Hot temperature selection with the largest load size, as described. In particular, one of the stains evaluated in the AHAM HLW-2-2020 Soil/Stain Removal test is sebum—an oily, waxy substance produced by skin glands.[130] For front-loading standard-size RCWs, DOE's test data show no observable correlation between efficiency and the total cleaning score as measured by the AHAM test method. At EL 3 (considering units both slightly higher and slightly lower than EL 3), total cleaning scores ranged from around 86 to around 99 (higher is better). At lower efficiency levels, total cleaning scores ranged from around 90 to around 96.

For top-loading standard-size RCWs, DOE's test data show that for units at EL 2 and below, total cleaning scores range from around 90 to around 98. The clustering of data at or above a score of 90 (as measured on the Hot temperature selection with the large load size) likely represents a market-representative threshold of stain removal performance as measured with this cycle configuration. DOE's total cleaning scores at EL 3 for stain removal also include 90, which indicates that manufacturers can produce clothes washers at EL 3 while maintaining a level of stain removal that is market-representative. DOE also looked at the implementation of prioritizing hardware design options over reduced wash temperatures. When hardware design options are implemented, DOE's analysis suggests that the proposed standard level would not preclude the ability to provide total cleaning scores for top-loading units equally as high as the highest scores currently achieved by units at lower efficiency levels.

[130] The standardized soil/stain strips used in the AHAM HLW-2-2020 test consist of square test fabric swatches carrying five different types of stains: red wine, chocolate and milk, blood, carbon black/mineral oil, and pigment/sebum.

DOE requests comment on its stain removal data presented in the performance characteristics test report and on its conclusions derived from this data. In particular, DOE requests comment on whether the clustering of data at or above a score of 90 (as measured on the Hot temperature selection with the large load size) corresponds to a market-representative threshold of stain removal performance as measured with this cycle configuration. DOE additionally requests comment on its analysis indicating that implementing additional hardware design options, rather than reducing wash temperatures, on EL 2 units could enable total cleaning scores at EL 3 that are equally as high as the highest scores currently achieved by units at lower efficiency levels.

With regard to wear and tear, manufacturer comments (as summarized previously in this section) suggested that if wash time is lengthened to compensate for reduced water temperatures, the additional agitation on the clothes may lead to increased fabric wear and damage. (*See* Whirlpool, No. 39 at pp. 10–11; AHAM, No. 40 at pp. 9–10) To evaluate whether more stringent standards would result in an increase in wear and tear on clothing, DOE conducted the Mechanical Action test specified in AHAM HLW-2-2020 concurrently with the stain removal test as described. For top-loading standard-size RCWs, DOE's test data show that units at EL 3 have lower (*i.e.*, better) mechanical action scores than baseline-rated units, indicating that the higher-efficiency units provide less wear and tear than the baseline units in the test sample. Specifically, at EL 3, mechanical action scores ranged from around 150 to around 175, closely matching the range at EL 2, which ranged from around 150 to around 170. At lower efficiency levels, mechanical action scores ranged from around 190 to around 230. The data suggests that the better mechanical action scores at the higher efficiency levels may correlate with the use of wash plates (*i.e.*, impellers) at those levels, compared to the use of traditional agitators at the lower efficiency levels.

For front-loading standard-size RCWs, DOE's test data show that for units at or below EL 2, mechanical action scores range from around 135 to around 180. At EL 3 (considering units both slightly higher and slightly lower than EL 3), mechanical action scores range from around 160 to around 210. Although some units at EL 3 have higher (*i.e.*, worse) mechanical action scores than the lower-efficiency units, the low end of the range is less than (*i.e.*, better than) some of the baseline-rated units. DOE is not aware of any industry-accepted threshold for acceptable mechanical action performance, and there is no significant clustering of DOE's data to suggest any particular market-representative threshold.

Based on this data, DOE tentatively concludes that the proposed standard level (*i.e.*, TSL 4) would not preclude the ability to provide mechanical action scores comparable to the scores for units at lower efficiency levels.

DOE requests comment on its mechanical action data presented in the performance characteristics test report and on its conclusions derived from this data. In particular, DOE requests comment on whether there is a market-representative threshold of mechanical action performance as measured on the Hot temperature selection using the large load size. DOE also requests comment on whether better mechanical action scores at higher top-loading efficiency levels are attributable to the use of wash plates rather than traditional agitators in those higher-efficiency units.

With regard to cycle time, manufacturer comments (as summarized previously in this section) suggested that more stringent standards could require an increase in cycle time. (*See* Whirlpool, No. 39 at p. 9; AHAM, No. 40 at p. 10). To evaluate whether more stringent standards would result in an increase in cycle time, DOE measured the average cycle time as defined in appendix J for each unit in the test sample. For both top-loading standard-size and front-loading standard-size RCWs, DOE's test data show no observable correlation between efficiency and average cycle time. For top-loading standard-size RCWs, the average cycle time for the entire product class is around 50 minutes, as measured according to the appendix J test procedure. At EL 3 (considering units both slightly higher and slightly lower than EL 3), cycle time ranged from around 35 minutes to around 65 minutes. This closely matches the range of units at lower efficiency levels, which ranged from around 35 minutes to around 70 minutes. For front-loading standard-size RCWs, the average cycle time for the entire product class is around 45 minutes, as measured according to the appendix J test procedure. At EL 3 (considering units both slightly higher and slightly lower than EL 3), cycle time ranged from around 40 minutes to around 55 minutes. This closely matches the range of units at lower efficiency levels, which ranged from around 35 minutes to around 65 minutes.

Based on this data, DOE tentatively concludes that the proposed standard level (*i.e.*, TSL 4), would not result in an increase in average cycle time as measured by appendix J.

DOE requests comment on its cycle time data presented in the performance characteristics test report and on its conclusions derived from this data.

In summary, DOE's test data suggest that the proposed standard level (*i.e.*, TSL 4) can be achieved with key performance attributes (*e.g.*, wash temperatures, stain removal, mechanical action, and cycle duration) that are largely comparable to the performance of lower-efficiency units available on the market today. Based on DOE's testing of models that currently meet the proposed standards, DOE does not expect performance to be compromised at the proposed standard level.

DOE seeks comment on its testing and assessment of performance attributes (*i.e.*, wash temperatures, stain removal, mechanical action, and cycle duration), particularly at the proposed standard level (*i.e.*, TSL 4). In addition, DOE seeks additional data that stakeholders would like DOE to consider on performance attributes at TSL 4 efficiencies as well as the current minimum energy conservation standards.

b. Availability of "Traditional" Agitators

The inner drum of a baseline standard-size top-loading RCW typically contains a vertically oriented agitator in the center of the drum, which undergoes a twisting motion. The motion of the agitator, which is powered by an electric motor, circulates the clothes around the center of the wash basket. Some agitators have a corkscrew-like design that also circulates the clothing vertically from the bottom to the top of the basket. Higher-efficiency top-loading RCWs typically use a disk-shaped "wash plate," rather than a vertical agitator, to move the clothes within the basket. The rotation of the wash plate underneath the clothing circulates the clothes throughout the wash drum.

A conventional agitator requires clothing to be fully suspended in water; as the agitator rotates, the agitator vanes catch the clothing and move the garments through the water. A rotating wash plate, however, requires a much lower water level inside the wash tub to clean the clothing properly. The wet clothing load sits on top of the wash plate, and as the wash plate rotates, raised fins catch the clothing along the bottom of the wash tub to rotate the garments.

AHAM presented shipment data that showed the number of shipments of clothes washers with and without agitators during 2011–2020. (AHAM, No. 40 at pp. 11−12) Based on this data, AHAM concluded that consumer preference has shifted over the years in favor of clothes washers with agitators. (*Id.*) AHAM commented that manufacturers have introduced or re-introduced top-loading clothes washers with agitator technology due to increasing demand from consumers and from consumer complaints that there does not appear to be enough water in the wash load, and that clothes do not appear to be getting clean, in top-loading clothes washers without agitators. (*Id.*) AHAM asserted that the efficiency levels DOE analyzed in the September 2021 Preliminary Analysis are likely to remove products from the market that are highly rated for consumer satisfaction and reliability, and recommended that DOE's efficiency standards not lead to these products being removed from the market. (*Id.*)

Whirlpool commented that consumers are increasingly demanding top-loading clothes washers with agitators, perhaps due in part to any negative experiences that consumers may have had with previous front-loading or top-loading clothes washers with a wash plate. (Whirlpool, No. 39 at p. 15) Whirlpool presented data showing that 72 percent of top-loading clothes washer shoppers are looking for a clothes washer with an agitator. (*Id.*) Whirlpool also presented data showing that top-loading clothes washers with wash plates once made up about 54 percent of all top-loading shipments, and that number has since declined to 34 percent. (*Id.*) Whirlpool commented that manufacturers have responded to this demand shift in large part by offering a broad assortment of agitator clothes washers. (*Id.*) Whirlpool noted that two major competitors to Whirlpool have recently introduced their first ever top-loading agitator models over the past few years. (*Id.*) Whirlpool asserted that any amended standards from DOE that would preclude manufacturers from being able to offer top-loading clothes washers with agitators would be problematic for their consumers. (*Id.*)

Whirlpool expressed concern that if the top-loading standard level were amended to EL 2 or above, agitators would be phased out from the U.S. market and would be replaced by wash plates. (Whirlpool, No. 39 at pp. 3–4) Whirlpool recommended that DOE consider not amending the top-loading clothes washer standards, which would allow traditional agitator clothes washers to stay on the market. (Whirlpool, No. 39 at p. 20)

Whirlpool described the two different types of agitators used in clothes washers today: traditional agitators that have an internal mechanism driving the barrel of the agitator in a single direction, and high-efficiency agitators that have the barrel of the agitator fixed to or molded as part of the wash plate. (*Id.*) Whirlpool further explained that traditional agitators operate in deeper water, and the motion of the agitator generates the flow of clothing within the wash bath; whereas high-efficiency agitators use less water and rely on fabric-to-fabric shear to move the clothing within the drum. (*Id*.) Whirlpool commented that consumers may notice that high-efficiency agitator clothes washers use less water or require a longer cycle time than traditional agitator clothes washers. (*Id*.) Whirlpool asserted that many consumers have used traditional agitator clothes washers for their entire lives and may not readily accept the performance, water level, and wash motion differences between agitator and non-agitator models. (*Id*.)

As discussed further in section V.C.1 of this document, DOE is proposing to adopt an amended standard for top-loading, standard-size clothes washers that corresponds to the CEE Tier 1 level. DOE's market analysis indicates that top loading models currently on the market at TSL 4 use wash plates (*i.e.*, do not have agitators). DOE is aware of top-loading clothes washers without an agitator that achieve equal or better cleaning performance than top-loading clothes washers with a traditional-style agitator in third-party performance reviews. According to Consumer Reports, among 40 tested RCW models with a traditional-style agitator, 4 models (10 percent) receive a relative "washing performance" rating of 5 out of 5, and 13 models (33 percent) receive a relative rating of 4 out of 5 – for a total of 43 percent of units receiving a score of 4 or 5 out of 5. Among 36 tested models with a high-efficiency wash plate design, 11 models (30 percent) receive a relative rating of 5 out of 5, and 14 models (39 percent) receive a relative rating of 4 out of 5 – for a total of 69 percent of units receiving a score of 4 or 5 out of 5. These ratings indicate that clothes washers with high-efficiency wash plate designs can achieve equal or better overall cleaning performance scores than clothes washers with traditional-style agitators.

As discussed, DOE recognizes that the Consumer Reports cleaning performance test method is inconsistent with the test conditions prescribed by DOE's appendix J test procedure and that products with superior cleaning performance ratings may sacrifice or trade off with one or more other aspects of consumer-relevant performance.

DOE seeks comment on any aspects of cleaning performance that provide differentiation between the use of an agitator or a wash plate that are not reflected in the Consumer Reports washing performance ratings evaluated in this NOPR.

DOE seeks comment on whether any lessening of the utility or performance of top-loading standard-size RCWs, in accordance with 42 U.S.C. 6295(o)(2)(B)(i)(IV), would result from a potential standard that would preclude the use of a traditional agitator. In particular, DOE seeks information and data on how such utility or performance would be measured or evaluated.

c. Water Levels

Each higher efficiency level considered by DOE corresponds to a higher WER value compared to the baseline level. Higher WER values are achieved through the use of less water during the cycle, which generally achieved through lower water levels during the wash and/or rinse portions of the cycle.

Whirlpool expressed concern that decreasing water levels and wash temperatures would negatively impact consumer perceptions that their clothes washers are working correctly. (Whirlpool, No. 39 at pp. 12–14) Whirlpool stated that across all manufacturers and brands, it saw customer sentiment scores for water level and wash temperatures were net positive for clothes washers that were rated at 6.5 IWF (the current DOE baseline level for top-loading clothes washers), and that customer sentiment scores were net negative for clothes washers rated at 4.3 IWF (the ENERGY STAR Most Efficient level for standard-size clothes washers). (*Id.*) Whirlpool added that decreasing water usage, and therefore increasing detergent concentration, does not correlate to improved consumer satisfaction. (*Id.*) Whirlpool commented that it received consumer complaints about water levels being too low and not completely covering their clothes, and predicted that consumer complaints would increase with any amended standards that would drive a further decrease in water levels. (*Id.*) Whirlpool added that lowering water levels in order to meet amended standards may leave its clothes washers without enough free water to support the degree of load motion needed to maintain consumer satisfaction. (*Id.*)

Whirlpool further stated that consumers strongly demand flexibility in water level. (Whirlpool, No. 39 at p. 15) Whirlpool commented that manufacturers have responded to this demand for flexibility by offering deep fill and deep-water wash options on top-loading clothes washers. (*Id.*) Whirlpool commented that in the entire top-loading clothes washer segment, Whirlpool is only aware of three models that do not have deep fill options. (*Id.*) Whirlpool expressed concern that amended standards could erode Whirlpool's ability to offer consumers this flexibility. (*Id.*)

Whirlpool commented that manufacturers have taken several actions during and since the last updates to DOE and ENERGY STAR standards to communicate, educate, and set appropriate consumer expectations for performance. (Whirlpool, No. 39 at pp. 14–16) For example, Whirlpool explained that on its websites, it has created a page that describes the various differences between clothes washers with agitators versus clothes washers with wash plates that details how both types of clothes washers work to clean clothes, the differences in water levels between these types of clothes washers, the benefits of each type of clothes washer, and how to find the right type of clothes washer. (*Id.*) Whirlpool added that it also works to educate retail associates about these fundamental differences between clothes washers to communicate this information to consumers and answer any questions they may have while shopping. (*Id.*) Whirlpool commented that despite manufacturers' collective efforts to educate consumers about efficient clothes washers and how they perform, consumers may still not accept new clothes washers that use less energy and water. (*Id.*)

Whirlpool stated that higher levels of torque are needed to move clothes in top-loading clothes washers with lower water levels, which creates more resistance when trying to move clothes around during the wash phase. (Whirlpool, No. 39 at p. 8) Whirlpool commented that increased resistance and torque create higher levels of stress on many components, cause components to wear out more quickly, and lead to hotter motor temperatures, which requires increased dwell period for cooling. (*Id.*) Whirlpool suggested that DOE capture the cost and product changes necessitated by the additional torque needed to move clothes in a wash basket with lower wash levels. (*Id.*)

Whirlpool commented that it would expect a rebound effect to occur for clothes washers as a result of amended standards. Whirlpool commented that consumers who are dissatisfied with the water level in the DOE-tested cycle will likely take some sort of action to compensate, including adding their own water to the cycle or choosing to largely or exclusively use deep fill and deep water wash options on their clothes washer. Whirlpool added that if consumers are dissatisfied with cleaning and rinse performance, they may decide to wash smaller loads (thereby increasing the number of annual cycles), use warmer wash temperatures, pretreat clothes or use options such as second rinse and pre-soak, or wash a load multiple times. (Whirlpool, No. 39 at pp. 17−18) GEA commented that based on its consumer preference data, consumers expressed a strong preference for control over the amount of water used in their clothes washers. (GEA, No. 38 at p. 2) GEA found that typically, consumers prefer to add more water to their wash load. (*Id*.)

AHAM commented that manufacturers have experienced consumer pushback as a result of reducing water use. (AHAM, No. 40 at p. 11) AHAM noted that, while consumers typically use the normal cycle, most top-loading clothes washers include a deep fill option in order to address consumer interest in the ability to increase water levels. (*Id*.) AHAM added that as a result of reduced water use, consumers tend to rely on deep-fill settings, or add water to their clothes washers themselves. (*Id*.) AHAM commented that a significant portion of consumers dislike clothes washers with low water levels. (*Id*.)

AHAM commented that the effects of strict water requirements may lead to consumer perceptions of inadequate cleaning performance, and will likely cause consumers to take actions that cause efficiency performance to diverge from DOE's projections. AHAM added that this could amount to a negative "rebound effect," where higher efficiency requirements lead to increased energy and water use due to consumers responding to inadequate performance at stringent efficiency levels. (AHAM, No. 40 at p. 10)

AHAM noted that, while consumers typically use the normal cycle, most top-loading clothes washers include a deep fill option in order to address consumer interest in the ability to increase water levels.

As discussed, DOE has considered potential impacts to the various attributes of product performance as part of its consideration of amended standards, as discussed further in section V.C.1 of this document. To the extent that water levels correlate with cleaning and rinsing performance or other relevant attributes of clothes washer performance, DOE has considered such impacts as part of its analysis.

DOE requests comment and information on sales of RCWs with deep fill and/or deep rinse options or settings and the frequency of use of cycles with these options or settings selected.

d. Availability of Portable Products

As discussed, top-loading portable RCWs are generally mounted on caster wheels, which allows the clothes washer to be moved more easily.

AHAM commented that the proposed energy conservation standards could impact portable clothes washers and cause features of portability and lower price points to be lost. (AHAM, No. 40 at p. 16) AHAM added that the loss of low priced and portable top-loading clothes washers would raise equity concerns. (*Id.*)

DOE's testing and analysis of top-loading standard-size portable units indicates that such products would be able to achieve the proposed standard level for the top-loading standard-size product class with only small changes to the final spin portion of the cycle (*e.g.*, to implement "consistent spin") and a minor reduction in water use. Accordingly, DOE tentatively determines that the proposed standard level would not preclude the availability of portable clothes washers from the market.

e. Conclusion

For the reasons discussed in the previous sections, DOE has tentatively concluded that the standards proposed in this NOPR would not lessen the utility or performance of the RCWs under consideration in this proposed rulemaking.

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 RCWs is expected to yield environmental benefits in the form of reduced emissions of certain air pollutants and greenhouse gases. Table V.29 provides DOE's estimate of cumulative emissions reductions expected to result from the TSLs considered in this proposed rulemaking. The emissions were calculated using the multipliers discussed in section IV.K of this document. DOE reports annual emissions reductions for each TSL in chapter 13 of the NOPR TSD.

Table V.29 Cumulative Emissions Reduction for Residential Clothes Washers Shipped in 2027–2056

	Trial Standard Level				
	1	**2**	**3**	**4**	**5**
Power Sector Emissions					
CO_2 (*million metric tons*)	20.4	20.6	24.2	49.0	79.3
CH_4 (*thousand tons*)	1.5	1.5	1.8	3.4	4.9
N_2O (*thousand tons*)	0.2	0.2	0.2	0.5	0.7
NO_X (*thousand tons*)	11.4	11.5	13.2	28.3	48.8
SO_2 (*thousand tons*)	8.8	8.9	10.8	19.7	28.1
Hg (*tons*)	0.1	0.1	0.1	0.1	0.2
Upstream Emissions					
CO_2 (*million metric tons*)	1.7	1.7	1.9	4.2	7.3
CH_4 (*thousand tons*)	161.9	163.4	186.6	408.1	713.3
N_2O (*thousand tons*)	0.0	0.0	0.0	0.0	0.0
NO_X (*thousand tons*)	25.5	25.7	29.5	64.1	111.4
SO_2 (*thousand tons*)	0.1	0.1	0.1	0.2	0.3
Hg (*tons*)	0.0	0.0	0.0	0.0	0.0
Total FFC Emissions					
CO_2 (*million metric tons*)	22.1	22.3	26.1	53.2	86.6
CH_4 (*thousand tons*)	163.4	164.9	188.4	411.4	718.3
N_2O (*thousand tons*)	0.2	0.2	0.3	0.5	0.7
NO_X (*thousand tons*)	36.9	37.2	42.7	92.4	160.2
SO_2 (*thousand tons*)	8.9	9.0	10.9	199.9	28.5
Hg (*tons*)	0.1	0.1	0.1	0.1	0.2

As part of the analysis for this proposed 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 RCWs. Section IV.L of this document discusses the SC-CO_2 values that DOE used. Table V.30 presents the value of CO_2 emissions reduction at each TSL for each of the SC-CO_2 cases. The time-series of annual values is presented for the proposed TSL in chapter 14 of the NOPR TSD.

Table V.30 Present Value of CO_2 Emissions Reduction for Residential Clothes Washers Shipped in 2027–2056

TSL	SC-CO_2 Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	billion 2021$			
1	219	924	1,437	2,814
2	221	933	1,451	2,841
3	258	1,088	1,694	3,313
4	509	2,174	3,394	6,613
5	812	3,496	5,470	10,628

As discussed in section IV.L.2 of this document, DOE estimated the climate benefits likely to result from the reduced emissions of methane and N_2O that DOE estimated for each of the considered TSLs for RCWs. Table V.31 presents the value of the CH_4 emissions reduction at each TSL, and Table V.32 presents the value of the N_2O 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.31 Present Value of Methane Emissions Reduction for Residential Clothes Washers Shipped in 2027–2056

TSL	SC-CH_4 Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	billion 2021$			
1	74	214	297	567
2	74	216	299	572
3	84	246	341	652
4	179	530	738	1,403
5	307	917	1,280	2,428

Table V.32 Present Value of Nitrous Oxide Emissions Reduction for Residential Clothes Washers Shipped in 2027–2056

TSL	SC-N_2O Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	Billion 2021$			
1	0.80	3.11	4.79	8.28
2	0.80	3.14	4.84	8.36
3	0.96	3.77	5.81	10.02
4	1.76	6.97	10.78	18.56
5	2.56	10.22	15.84	27.21

DOE is well aware that scientific and economic knowledge about the contribution of CO_2 and other GHG emissions to changes in the future global climate and the potential resulting damages to the global and U.S. economy continues to evolve rapidly. DOE, together with other Federal agencies, will continue to review methodologies for estimating the monetary value of reductions in CO_2 and other GHG emissions. This ongoing review will consider the comments on this subject that are part of the public record for this and other rulemakings, as well as other methodological assumptions and issues. DOE notes 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 health benefits associated with NO_X and SO_2 emissions reductions anticipated to result from the considered TSLs for RCWs. The dollar-per-ton values that DOE used are discussed in section IV.L of this document. Table V.33 presents the present value for NO_X emissions reduction for each TSL calculated using 7-percent and 3-percent discount rates, and Table V.34 presents similar results for SO_2 emissions reductions. The results in these tables reflect application of EPA's low dollar-per-ton values, which DOE used to be conservative. The time-series of annual values is presented for the proposed TSL in chapter 14 of the NOPR TSD.

Table V.33 Present Value of NO_X Emissions Reduction for Residential Clothes Washers Shipped in 2027–2056

TSL	3% Discount Rate	7% Discount Rate
	million 2021$	
1	1,467	634
2	1,481	641
3	1,712	739
4	3,468	1,441
5	5,684	2,304

Table V.34 Present Value of SO_2 Emissions Reduction for Residential Clothes Washers Shipped in 2027–2056

TSL	3% Discount Rate	7% Discount Rate
	million 2021$	
1	505	225
2	510	227
3	615	272
4	1,098	472
5	1,540	650

DOE has not considered the monetary benefits of the reduction of Hg for this proposed rule. Not all the public health and environmental benefits from the reduction of greenhouse gases, NOx, and SO_2 are captured in the previous values, and additional unquantified benefits from the reductions of those pollutants as well as from the reduction of Hg, direct PM, and other co-pollutants may be significant.

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.35 presents the NPV values that result from adding the estimates of the potential economic benefits resulting from reduced GHG, NO_X, and SO_2 emissions to the NPV of consumer benefits calculated for each TSL considered in this proposed rulemaking. The consumer benefits are domestic U.S. monetary savings that occur as a result of purchasing the covered products, and are measured for the lifetime of products shipped in 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 RCWs shipped in 2027–2056.

Table V.35 Consumer NPV Combined with Present Value of Climate Benefits and Health Benefits

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Using 3% discount rate for Consumer NPV and Health Benefits (billion 2021$)					
5% Average SC-GHG case	10.7	10.8	10.8	19.8	29.1
3% Average SC-GHG case	11.5	11.6	11.8	21.8	32.4
2.5% Average SC-GHG case	12.1	12.2	12.5	23.2	34.8
3% 95th percentile SC-GHG case	13.7	13.9	14.4	27.1	41.1
Using 7% discount rate for Consumer NPV and Health Benefits (billion 2021$)					
5% Average SC-GHG case	4.5	4.6	3.8	7.7	11.8
3% Average SC-GHG case	5.4	5.4	4.8	9.8	15.1
2.5% Average SC-GHG case	6.0	6.0	5.5	11.2	17.4
3% 95th percentile SC-GHG case	7.6	7.7	7.5	15.1	23.7

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 RCWs 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 forego the purchase of a product in the standards case, this decreases sales for product manufacturers, and the impact on manufacturers attributed to lost revenue is included in the MIA. Second, DOE accounts for energy savings attributable only to products actually used by consumers in the standards case; if a standard decreases the number of products purchased by consumers, this decreases the potential energy savings from an energy conservation standard. DOE provides estimates of shipments and changes in the volume of product purchases in chapter 9 of the 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.[131]

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.[132] 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.

[131] 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*.
[132] Sanstad, A.H. *Notes on the Economics of Household Energy Consumption and Technology Choice*. 2010. Lawrence Berkeley National Laboratory. Available at *www1.eere.energy.gov/buildings/appliance_standards/pdfs/consumer_ee_theory.pdf* (Last accessed June 12, 2022).

1. Benefits and Burdens of TSLs Considered for Residential Clothes Washer Standards

Table V.36 and Table V.37 summarize the quantitative impacts estimated for each TSL for RCWs. The national impacts are measured over the lifetime of RCWs purchased in the 30-year period that begins in the anticipated year of compliance with amended standards (2027–2056). The energy savings, emissions reductions, and value of emissions reductions refer to full-fuel-cycle results. The efficiency levels contained in each TSL are described in section V.A of this document.

Table V.36 Summary of Analytical Results for Residential Clothes Washer TSLs: National Impacts

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Cumulative FFC National Energy Savings					
Quads	0.61	0.62	0.74	1.45	2.27
Cumulative FFC Emissions Reduction					
CO_2 (*million metric tons*)	22.11	22.32	26.13	53.21	86.62
CH_4 (*thousand tons*)	163.41	164.89	188.43	411.43	718.26
N_2O (*thousand tons*)	0.21	0.21	0.26	0.48	0.71
NO_X (*thousand tons*)	36.90	37.24	42.73	92.39	160.21
SO_2 (*thousand tons*)	8.88	8.96	10.88	19.93	28.45
Hg (*tons*)	0.06	0.06	0.07	0.13	0.18
Present Value of Benefits and Costs (*3% discount rate, billion 2021$*)					
Consumer Operating Cost Savings	13.46	13.60	19.88	27.83	35.68
Climate Benefits*	1.14	1.15	1.34	2.71	4.42
Health Benefits**	1.97	1.99	2.33	4.57	7.22
Total Benefits†	16.57	16.74	23.54	35.11	47.32
Consumer Incremental Product Costs‡	5.07	5.10	11.75	13.31	14.91
Consumer Net Benefits	8.39	8.50	8.13	14.52	20.77
Total Net Benefits	11.50	11.64	11.79	21.80	32.41
Present Value of Benefits and Costs (*7% discount rate, billion 2021$*)					
Consumer Operating Cost Savings	6.36	6.43	9.20	12.73	16.12
Climate Benefits*	1.14	1.15	1.34	2.71	4.42
Health Benefits**	0.86	0.87	1.01	1.91	2.95
Total Benefits†	8.36	8.45	11.55	17.35	23.50
Consumer Incremental Product Costs‡	3.00	3.02	6.72	7.58	8.45
Consumer Net Benefits	3.36	3.41	2.48	5.14	7.68
Total Net Benefits	5.36	5.43	4.83	9.77	15.05

Note: This table presents the costs and benefits associated with RCWs 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. On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22-30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana v. Biden*, No. 21-cv-1074-JDC-KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary

injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from "adopting, employing, treating as binding, or relying upon" the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. As reflected in this rule, DOE has reverted to its approach prior to the injunction and presents monetized benefits where appropriate and permissible under law.
** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. 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, but the Department does not have a single central SC-GHG point estimate. DOE emphasizes the importance and value of considering the benefits calculated using all four sets of SC-GHG estimates.
‡ Costs include incremental equipment costs as well as installation costs.

Table V.37 Summary of Analytical Results for Residential Clothes Washer TSLs: Manufacturer and Consumer Impacts

Category	TSL 1*	TSL 2*	TSL 3*	TSL 4*	TSL 5*
Manufacturer Impacts					
Industry NPV (*million 2021*$) (No-new-standards case INPV = 1,738)	1,680.4 to 1,746.4	1,636.5 to 1,702.9	1,490.3 to 1,631.0	1,208.1 to 1,376.7	798.7 to 985.9
Industry NPV *(% change)***	(3.3) to 0.5	(5.9) to (2.0)	(14.3) to (6.2)	(30.5) to (20.8)	(54.1) to (43.3)
Consumer Average LCC Savings (2021$)					
Semi-Automatic	$329	$329	$329	$329	$219
Top-Loading, Ultra-Compact	n.a.	n.a.	n.a.	n.a.	n.a.
Top-Loading, Standard-Size	$138	$138	$115	$134	$157
Front-Loading, Compact	$0	$0	$0	$7	$56
Front-Loading, Standard-Size	$57	$78	$78	$19	$55
Shipment-Weighted Average*	**$119**	**$124**	**$107**	**$107**	**$132**
Consumer Simple PBP (years)					
Semi-Automatic	0.3	0.3	0.3	0.3	0.4
Top-Loading, Ultra-Compact	n.a.	n.a.	n.a.	n.a.	n.a.
Top-Loading, Standard-Size	4.6	4.6	6.8	5.9	5.5
Front-Loading, Compact	0.0	0.0	0.0	9.1	7.1
Front-Loading, Standard-Size	2.8	2.4	2.4	3.2	3.4
Shipment-Weighted Average*	**4.0**	**3.9**	**5.5**	**5.2**	**4.9**
Percent of Consumers that Experience a Net Cost					
Semi-Automatic	0%	0%	0%	0%	0%
Top-Loading, Ultra-Compact	n.a.	n.a.	n.a.	n.a.	n.a.
Top-Loading, Standard-Size	14%	14%	28%	25%	23%
Front-Loading, Compact	0%	0%	0%	24%	29%
Front-Loading, Standard-Size	0%	0%	0%	24%	18%
Shipment-Weighted Average*	**11%**	**11%**	**20%**	**24%**	**21%**

The entry "n.a." means not applicable because there is no change in the standard at certain TSLs.
* Weighted by shares of each product class in total projected shipments in 2027.
** Parentheses indicate negative (-) values.

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)) 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)(I)-(VII)) For this NOPR, DOE considered the impacts of amended standards for RCWs 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.

Samsung commented that top-loading standard-size clothes washers, which cover roughly 70 percent of the marketplace, offer the greatest efficiency improvement opportunity and should be set to EL 3, which is included in TSL 4. (Samsung, No. 41 at pp. 2–3) Samsung added that DOE's analysis demonstrates a practical payback period of 4.2 years for top-loading standard-size RCWs, and DOE's engineering analysis shows that slight adjustments to wash temperature, spray rinse, and changing to a direct drive motor can contribute to a significant National Energy Savings of 1.85 quads. (*Id.*) Samsung added that direct drive motor and inverter control technology have matured over the years and have become highly cost competitive. (*Id.*) Samsung commented that it predicts these technologies will commonly be used in the near term given the benefits to energy efficiency, quiet operation, and high reliability. (*Id*.) Samsung noted that increasing efficiency for top-loading standard-size clothes washers becomes especially important if DOE's consumer choice model indicates that the top-loading market share will increase with increased minimum energy performance standards on top-loading standard-size clothes washers. (*Id*.)

Samsung recommended that to realize savings for front-loading standard-size clothes washers, DOE should adopt EL 2, which is included in TSL 2 and TSL 3. (Samsung, No. 41 at p. 3) Samsung commented that when comparing the models listed in DOE's CCD and those listed in EPA's Qualified Products List, 78 percent of front-loading standard-size models meet EL 2 proposed in the September 2021 Preliminary TSD. (*Id*.) Samsung noted that increasing the MEPS beyond EL 2 provides diminishing returns in the form of a longer payback period. (*Id*.) Samsung commented that going forward, if DOE expects consumers to adopt top-loading clothes washers, improvement in National Energy Savings for front-loading clothes washers becomes negligible as efficiency level increases. (*Id*.)

As discussed, DOE evaluated each TSL, beginning with the maximum technologically feasible level, to determine the highest efficiency level that is both technologically feasible and economically justified and saves a significant amount of energy. The following paragraphs summarize the results of this evaluation. In particular, the summary discussion emphasizes the impacts on the top-loading standard-size and front-loading standard-size product classes, which together represent 96 percent of the market, as presented in Table IV.34 of this document.

DOE first considered TSL 5, which represents the max-tech efficiency levels for all product classes. Specifically for top-loading standard-size RCWs, DOE's expected design path for TSL 5 (which represents EL 4 for this product class) incorporates the use of a stainless-steel basket, a direct drive motor, a wash plate, reduced hot and warm wash water temperatures compared to temperatures available on baseline units, an increased tub size compared to the baseline, and the fastest achievable spin speeds. In particular, the faster spin speeds and reduced hot and warm wash temperatures provide the improvement in efficiency at TSL 5 compared to TSL 4. For front-loading standard-size RCWs, DOE's expected design path for TSL 5 (which represents EL 4 for this product class) incorporates the use of the most efficient available direct drive motor, the implementation of advanced sensors, and the fastest achievable spin speeds. In particular, the more efficient motor, faster spin speeds, and advanced sensors provide the improvement in efficiency at TSL 5 compared to TSL 4. TSL 5 would save an estimated 2.27 quads of energy and 2.94 trillion gallons of water, an amount DOE considers significant. Under TSL 5, the NPV of consumer benefit would be $7.68 billion using a discount rate of 7 percent, and $20.77 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 5 are 86.62 Mt of CO_2, 28.45 thousand tons of SO_2, 160.21 thousand tons of NO_X, 0.18 tons of Hg, 718.26 thousand tons of CH_4, and 0.71 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 $4.42 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 5 is $2.95 billion using a 7-percent discount rate and $7.22 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 $15.05 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 5 is $32.41 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 5, the average LCC impact is a savings of $219 for semi-automatic, $157 for top-loading standard-size, $56 for front-loading compact, and $55 for front-loading standard-size clothes washers. The simple payback period is 0.4 years for semi-automatic, 5.5 years for top-loading standard-size, 7.1 years for front-loading compact, and 3.4 years for front-loading standard-size clothes washers. The fraction of consumers experiencing a net LCC cost is 0 percent for semi-automatic, 23 percent for top-loading standard-size, 29 percent for front-loading compact, and 18 percent for front-loading standard-size clothes washers. Notably, for the top-loading standard-size product class, which represents 73 percent of the market, TSL 5 would increase the first cost by $189, in comparison to an installed cost of $706 for baseline units. For the front-loading standard-size product class, which represents 23 percent of the market, TSL 5 would increase the first cost by $70, compared to an installed cost of $1,195 for baseline units. At TSL 5, the proposed standard for top-loading ultra-compact clothes washers is at the baseline, resulting in no LCC impact, no simple PBP, and no consumers experiencing a net LCC cost.

At TSL 5, the projected change in INPV ranges from a decrease of $939.6 million to a decrease of $752.4 million, which correspond to a decrease of 54.1 percent and 43.3 percent, respectively. The loss in INPV is largely driven by industry conversion costs as manufacturers work to redesign their portfolio of model offerings and re-tool entire factories to comply with amended standards at this level. Industry conversion costs could reach $1,253.8 million at this TSL.

Conversion costs at max-tech are significant, as nearly all existing RCW models would need to be redesigned to meet the required efficiencies. Currently, approximately 3 percent of RCW annual shipments meet the max-tech levels. For top-loading standard-size clothes washers, which account for 73 percent of annual shipments, less than 1 percent of current shipments meet this level. Of the nine OEMs offering top-loading standard-size products, one OEM offers models that meet the efficiencies required by TSL 5. The remaining eight OEMs would need to overhaul their existing platforms and make significant updates to their production facilities. Those manufacturers may need to incorporate increased tub capacities, wash plate designs, direct drive motors, reinforced wash baskets, robust suspension and balancing systems, and advanced sensors. These product changes require significant investment. In interviews, several manufacturers expressed concerns about their ability to meet existing market demand given the required scale of investment, redesign effort, and 3-year compliance timeline.

Based upon the above considerations, the Secretary tentatively concludes that at TSL 5 for RCWs, the benefits of energy and water savings, positive NPV of consumer benefits, and emission reductions would be outweighed by the impacts on manufacturers, including the large potential reduction in INPV. DOE estimated the potential loss in INPV to be as high as 54 percent. The potential losses in INPV are primarily driven by large conversion costs that must be made ahead of the compliance date. At max-tech, manufacturers would need to make significant upfront investments to update nearly all product lines and manufacturing facilities. Manufacturers expressed concern that they would not be able to complete product and production line updates within the 3-year conversion period. Additionally, when considering the estimated monetary value of emissions reductions—representing $4.42 billion in climate benefits (associated with the average SC-GHG at a 3-percent discount rate), and $7.22 billion (using a 3-percent discount rate) or $2.95 billion (using a 7-percent discount rate) in health benefits—DOE maintains its tentative conclusion that the overall benefits would be outweighed by the impacts on manufacturers. Consequently, the Secretary has tentatively concluded that TSL 5 is not economically justified.

DOE then considered TSL 4, which represents the ENERGY STAR Most Efficient level for the front-loading product classes, the CEE Tier 1 level for the top-loading standard-size product class, and a gap fill level for the semi-automatic product classes. Specifically, for top-loading standard-size RCWs, DOE's expected design path for TSL 4 (which represents EL 3 for this product class) incorporates many of the same technologies and design strategies as described for TSL 5. At TSL 4, top-loading standard-size units would incorporate a stainless-steel basket, a direct drive motor, and a wash plate, consistent with TSL 5. Models at TSL 4 would also incorporate reduced hot wash water temperatures compared to temperatures available at the baseline through TSL 3 levels, increased tub size compared to the baseline (although not as large as TSL 5), and faster spin speeds compared to the baseline (although not as fast as TSL 5). In particular, the faster spin speeds, reduced hot wash temperatures, and use of a wash plate provide the improvement in efficiency at TSL 4 compared to TSL 3. For front-loading standard-size RCWs, DOE's expected design path for TSL 4 (which represents EL 3 for this product class) incorporates the use of the most efficient direct drive motor available and spin speeds that are faster than the baseline level but not as fast as at TSL 5. In particular, more efficient motor and faster spin speeds provide the improvement in efficiency at TSL 4 compared to TSL 3. TSL 4 would save an estimated 1.45 quads of energy and 2.53 trillion gallons of water, an amount DOE considers significant. Under TSL 4, the NPV of consumer benefit would be \$5.14 billion using a discount rate of 7 percent, and \$14.52 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 4 are 53.21 Mt of CO_2, 19.93 thousand tons of SO_2, 92.39 thousand tons of NO_X, 0.13 tons of Hg, 411.41 thousand tons of CH_4, and 0.48 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 \$2.71 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 4 is \$1.91 billion using a 7-percent discount rate and \$4.57 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 \$9.77 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL

4 is $21.80 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 $329 for semi-automatic, $134 for top-loading standard-size, $7 for front-loading compact, and $19 for front-loading standard-size clothes washers. The simple payback period is 0.3 years for semi-automatic, 5.9 years for top-loading standard-size, 9.1 years for front-loading compact, and 3.2 years for front-loading standard-size clothes washers. The fraction of consumers experiencing a net LCC cost is 0 percent for semi-automatic, 25 percent for top-loading standard-size, 24 percent for front-loading compact, and 24 percent for front-loading standard-size clothes washers. For the top-loading standard-size product class, TSL 4 would increase the first cost by $185, in comparison to an installed cost of $706 for baseline units. For the front-loading standard-size product class, TSL 4 would increase the first cost by $49, compared to an installed cost of $1,195 for baseline units. At TSL 4, the proposed standard for top-loading ultra-compact clothes washers is at the baseline resulting in no LCC impact, no simple PBP, and no consumers experiencing a net LCC cost. Overall, across all product classes, around 24 percent of consumers would experience a net LCC cost at TSL 4. DOE estimated that about 14 percent of low-income households would experience a net LCC cost at TSL 4, and as a result of smaller households and lower annual usage, about 33 percent of senior-only households would experience a net LCC cost at TSL 4.

At TSL 4, the projected change in INPV ranges from a decrease of $530.2 million to a decrease of $361.6 million, which correspond to a decrease of 30.5 percent and 20.8 percent, respectively. The loss in INPV is largely driven by industry conversion costs as manufacturers work to redesign their portfolio of model offerings and update production facilities to comply with amended standards at this level. Industry conversion costs could reach $690.8 million at this TSL.

At TSL 4, most top-loading standard-size products would need to be redesigned to meet these efficiencies; however, a substantial number of front-loading standard-size products are available on the market due to manufacturers' participation in the ENERGY STAR Most Efficient program. Currently, approximately 14 percent of RCW shipments meet TSL 4 efficiencies, including nearly 46 percent of standard-size front-loading shipments. Of the seven OEMs with standard-size front-loading products, five OEMs offer 87 basic models (representing approximately 50 percent of all front-loading standard-size basic models) that meet TSL 4 efficiencies. For standard-size top-loading products, approximately two percent of shipments meet this level. Of the nine OEMs offering top-loading standard-size products, two OEMs offer around 20 basic models (representing approximately 4 percent of all top-loading standard-size basic models) that meet the efficiencies required by TSL 4. At this level, the remaining seven manufacturers would likely implement largely similar design options as at TSL 5, but to a lesser extent for the increase in tub size and hardware changes associated with faster spin speeds (*e.g.,* reinforced wash baskets, robust suspension and balancing systems, and advanced sensors)—which are faster than the baseline level but not as fast as TSL 5. In interviews, manufacturers indicated that meeting TSL 4 efficiencies would require a less extensive redesign than meeting TSL 5 efficiencies.

At TSL 4, manufacturers expressed concerns—both through written comments as well as during confidential manufacturer interviews—regarding impacts to certain attributes of product performance, including wash temperatures, cleaning and rinsing performance, and fabric care, particularly for top-loading standard-size RCWs. As discussed in section V.B.4.a of this document, DOE recognizes that in general, a consumer-acceptable level of cleaning performance (*i.e.*, a representative average use cycle) can be easier to achieve through the use of higher amounts of energy and water use during the clothes washer cycle. Conversely, maintaining acceptable cleaning performance can be more difficult as energy and water levels are reduced. Improving one aspect of clothes washer performance, such as reducing energy and/or water use as a result of energy conservation standards, may require manufacturers to make a trade-off with one or more other aspects of performance, such as cleaning performance, depending on which performance characteristics are prioritized by the manufacturer. DOE expects, however, that consumers maintain the same expectations of cleaning performance regardless of the efficiency of the clothes washer.

Manufacturers did not provide any quantitative data to support the assertion that a standard level at TSL 4 would negatively impact product performance. As discussed in section V.B.4.a of this document, DOE's analysis of third-party clothes washer performance reviews suggests that both top-loading and front-loading RCWs models rated at TSL 4 can achieve equal or better overall cleaning performance scores than models with lower efficiency ratings. DOE also conducted its own performance testing on a representative sample of top-loading standard-size and front-loading standard-size RCWs, the results of which suggest that TSL 4 can be achieved with key performance attributes (*e.g.*, wash temperatures, stain removal, mechanical action, and cycle duration) that are largely comparable to the performance of lower-efficiency units available on the market today. In particular, DOE tentatively concludes that the proposed standard level at TSL 4: (1) would not require any substantive reduction in hot water temperature on the hottest temperature selection in the Normal cycle, and would not preclude the ability to provide wash temperatures above the 85 °F threshold at which fatty soils are soluble; (2) would be able to maintain total cleaning score of at least 90, the market-representative threshold as measured on the Hot temperature selection with the large load size; furthermore, by prioritizing hardware design options over reduced wash temperatures, the proposed standard level would not preclude the ability to provide total cleaning scores for top-loading units equally as high as the highest scores currently achieved by units at lower efficiency levels; (3) would not preclude the ability to provide mechanical action scores comparable to the scores for units at lower efficiency levels; and (4) would not result in an increase in average cycle time as measured by the appendix J test procedure.

In summary, based on DOE's testing of models that currently meet the proposed standards, DOE does not expect performance to be compromised at the proposed standard level. Furthermore, products are readily available on the market at each efficiency level analyzed in the NOPR, including TSL 4, indicating a certain degree of market acceptance at each efficiency level.

DOE requests data and information regarding any quantitative performance-related characteristics at TSL 4 in comparison to performance at the current baseline level (*e.g.*, cleaning performance, rinsing performance, fabric wear, *etc.*), particularly for top-loading standard-size RCWs.

As discussed, DOE's clothes washer test procedure does not prescribe a method for testing clothes washer cleaning performance or other relevant attributes of RCW performance. DOE, in partnership with EPA, has developed the ENERGY STAR Test Method for Determining Residential Clothes Washer Cleaning Performance[133] to determine cleaning performance for clothes washers that meet the ENERGY STAR Most Efficient criteria. Cleaning performance is determined on the same test units immediately following the energy and water consumption tests for ENERGY STAR qualification. Notably, however, this test method is designed to be performed in conjunction with DOE's appendix J2 test procedure—whereas the amended standards proposed by this NOPR would be based on testing conducted to the appendix J test procedure. Appendix J specifies different load sizes than appendix J2, among other changes, which can significantly affect any measurement of cleaning performance. Additional investigation would be required to develop a cleaning performance test procedure designed to be conducted in conjunction with appendix J.

[133] ENERGY STAR test method available at *www.energystar.gov/sites/default/files/asset/document/Test%20Method%20for%20Determining%20Residential%20Clothes%20Washer%20Cleaning%20Performance%20-%20July%202018_0.pdf.*

After considering the analysis and weighing the benefits and burdens, the Secretary has tentatively concluded that at a standard set at TSL 4 for RCWs would be economically justified. At this TSL, the weighted average LCC savings for all product classes is $107. An estimated 25 percent of top-loading standard-size clothes washer consumers and an estimated 24 percent of front-loading (compact and standard-size) clothes washer consumers would experience a net cost. DOE acknowledges the larger impact on senior-only households as a result of smaller households and lower average annual use, but notes that the average LCC savings are still positive. The FFC national energy and water savings are significant and the NPV of consumer benefits is positive using both a 3-percent and 7-percent discount rate. Notably, the benefits to consumers, considering low-income and senior-only subgroups as well, vastly outweigh the cost to manufacturers. At TSL 4, the NPV of consumer benefits, even measured at the more conservative discount rate of 7 percent is over 27 times higher than the maximum estimated manufacturers' loss in INPV. The standard levels at TSL 4 are economically justified even without weighing the estimated monetary value of emissions reductions. When those emissions reductions are included – representing $2.71 billion in climate benefits (associated with the average SC-GHG at a 3-percent discount rate), and $4.57 billion (using a 3-percent discount rate) or $1.91 billion (using a 7-percent discount rate) in health benefits – the rationale becomes stronger still.

Therefore, based on the above considerations, DOE proposes to adopt the energy conservation standards for RCWs at TSL 4. The proposed amended energy conservation standards for RCWs, which are expressed in EER and WER, are shown in Table V.38.

Table V.38 Proposed Amended Energy Conservation Standards for Residential Clothes Washers

Product Class	Minimum Energy Efficiency Ratio *(lb/kWh/cycle)*	Minimum Water Efficiency Ratio *(lb/gal/cycle)*
Semi-Automatic Clothes Washers	2.12	0.27
Automatic Clothes Washers		
Top-Loading, Ultra-Compact (less than 1.6 ft^3 capacity)	3.79	0.29
Top-Loading, Standard-Size (1.6 ft^3 or greater capacity)	4.78	0.63
Front-Loading, Compact (less than 3.0 ft^3 capacity)	5.02	0.71
Front-Loading, Standard-Size (3.0 ft^3 or greater capacity)	5.73	0.77

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.

Table V.39 shows the annualized values for RCWs under TSL 4, expressed in 2021$. The results under the primary estimate are as follows.

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 RCWs is $800.8 million per year in increased equipment costs, while the estimated annual benefits are $1,344.2 million from reduced equipment operating costs, $155.7 million from GHG reductions, and $202.0 million from reduced NO_X and SO_2 emissions. In this case, the net benefit amounts to $901.1 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the proposed standards for RCWs is $764.0 million per year in increased equipment costs, while the estimated annual benefits are $1,598.0 million from reduced equipment operating costs, $155.7 million from GHG reductions, and $262.2 million from reduced NO_X and SO_2 emissions. In this case, the net benefit amounts to $1,251.8 million per year.

Table V.39 Annualized Benefits and Costs of Proposed Energy Conservation Standards for Residential Clothes Washers (TSL 4)

	million 2021$/year		
	Primary Estimate	**Low-Net-Benefits Estimate**	**High-Net-Benefits Estimate**
3% discount rate			
Consumer Operating Cost Savings	1,598.0	1,544.5	1,657.8
Climate Benefits*	155.7	151.7	159.7
Health Benefits**	262.2	255.8	268.9
Total Benefits†	2,015.9	1,952.0	2,086.4
Consumer Incremental Product Costs‡	764.0	778.7	695.5
Net Benefits	1,251.8	1,173.4	1,390.9
7% discount rate			
Consumer Operating Cost Savings	1,344.2	1,302.8	1,389.7
Climate Benefits* (3% discount rate)	155.7	151.7	159.7
Health Benefits**	202.0	197.5	206.7
Total Benefits†	1,701.9	1,652.0	1,756.1
Consumer Incremental Product Costs‡	800.8	813.3	737.9
Net Benefits	901.1	838.7	1,018.3

Note: This table presents the costs and benefits associated with RCWs 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.3 of this document. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

* Climate benefits are calculated using four different estimates of the global SC-GHG (see section IV.L of this document). For presentational purposes of this table, the climate benefits associated with the average SC-GHG at a 3

percent discount rate are shown, but the Department does not have a single central SC-GHG point estimate, and it emphasizes the importance and value of considering the benefits calculated using all four sets of SC-GHG estimates. On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22-30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana v. Biden*, No. 21-cv-1074-JDC-KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from "adopting, employing, treating as binding, or relying upon" the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. As reflected in this rule, DOE has reverted to its approach prior to the injunction and presents monetized benefits where appropriate and permissible under law.
** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. See section IV.L of this document for more details.
† Total benefits include 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.

D. Reporting, Certification, and Sampling Plan

Manufacturers, including importers, must use product-specific certification templates to certify compliance to DOE. For RCWs, the certification template reflects the general certification requirements specified at 10 CFR 429.12 and the product-specific requirements specified at 10 CFR 429.20.

Ameren *et al.* encouraged DOE to require manufacturers to report average cycle time in the CCD. (Ameren *et al.*, No. 42 at pp. 10−12) Ameren *et al.* commented that reporting average cycle time increases stakeholder and consumer access to cycle time, which Ameren *et al.* identify as an important RCW performance attribute. (*Id.*) Ameren *et al.* commented that cycle time information is important for some consumers, particularly for RCW consumers who routinely wash serial loads. (*Id.*) Ameren *et al.* added that making cycle time widely available enables stakeholders to better evaluate the cycle time of a given clothes washer relative to its performance level, which could be even more important with possible increases to standards that may drive increases in spin times to decrease drying energy. (*Id.*) Ameren *et al.* also commented that reporting

RCW cycle time increases the transparency of the energy efficiency metrics since reporting additional information on cycle time helps improve the transparency of how the energy efficiency metric is derived for a given clothes washer. (*Id*.) Ameren *et al*. added that this is especially important considering the wide variation in the cycle time of top- and front-loading RCWs. (*Id*.) Ameren *et al*. further commented that reporting RCW cycle time enables continuous improvement of the test procedure and energy conservation standard over time. (*Id*.) Ameren *et al*. specified that having access to additional data on cycle time enables DOE and other stakeholder groups to consider more effectively the value of cycle time measurement as a performance feature in future rulemakings. (*Id*.) Ameren *et al*. presented data from NEEA that plotted cycle time versus rated IMEF of 18 top-loading and front-loading RCWs. (*Id*.) Ameren *et al*. found that cycle time varies widely across front-loading and top-loading standard-size product classes. (*Id*.) Ameren *et al*. added that according to NEEA's testing[134] some RCWs with identical IMEF ratings can have cycle times that are twice as long as other models. (*Id*.) Ameren *et al*. therefore concluded that these cycle times will also vary in laboratory testing (with the appendix J2 textiles) and that this variation represents real-world cycle time differences. (*Id*.)

The CA IOUs recommended that DOE consider disclosing other configurations such as stacked clothes washers and clothes dryers in the CCD. (CA IOUs, No. 43 at p. 6) The CA IOUs commented that there are several clothes washer configurations available on the market which might offer unique functionality to some consumers while

[134] NEEA's testing was conducted using an 8.45 lb load of AHAM cotton textiles, using the Normal Cycle on Warm Wash / Cold Rinse with default spin settings. Ameren *et al*. noted that NEEA's analysis confirms that the cycle times of cycles run with appendix J2 textiles and AHAM cotton textiles are nearly identical.

not warranting a separate product class. (*Id.*) For example, the CA IOUs listed combination all-in-one washer-dryers, pedestal type clothes washers, laundry centers,[135] and double clothes washer products,[136] and stated that all represent unique product configurations that are not differentiated in the CCD. (*Id.*) The CA IOUs commented that, while these configurations are clear and intuitive to consumers and retailers, the public does not have access to a reliable database denoting these unique product characterizations. (*Id.*) The CA IOUs commented that considering the increasing market share and marketing of these products, they encourage DOE to consider the disclosure of these product configurations into certification requirements and adding those attributes to the CCD. (*Id.*)

In response to Ameren *et al.* and the CA IOUs, the values for which DOE currently requires reporting for RCWs are product characteristics that are required in order for DOE to determine whether the product is in compliance with the applicable standards. For example, currently reported values include characteristics that determine product class (*e.g.*, loading axis, capacity), measured characteristics on which a standard depends (*e.g.*, IMEF, EER), and characteristics necessary for enforcement of standards (*e.g.*, RMC).

At this time, DOE tentatively concludes that cycle time and product configuration (as recommend by commenters) are not required to determine compliance with the applicable standard. In this NOPR, DOE is not proposing to amend the product-specific

[135] A laundry center is a single tall unit which contains both a clothes washer and a clothes dryer.
[136] The CA IOUs reference products with two integrated clothes washer drums, such as the Samsung FlexWash™ as "double clothes washers."

certification requirements for RCWs. DOE would consider any amendments to the reported values for RCWs in a separate rulemaking.

VI. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866 and 13563

Executive Order ("E.O.") 12866, "Regulatory Planning and Review," as supplemented and reaffirmed by E.O. 13563, "Improving Regulation and Regulatory Review," 76 FR 3821 (Jan. 21, 2011), 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 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 constitutes 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 prepared the following IRFA for the products that are the subject of this proposed rulemaking.

For manufacturers of RCWs, 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 proposed 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 RCWs is classified under NAICS 335220, "Major Household Appliance Manufacturing." The SBA sets a threshold of 1,500 employees or fewer for an entity to be considered as a small business for this category.

1. Description of Reasons Why Action Is Being Considered

DOE is proposing amended energy conservation standards for RCWs. EPCA prescribed energy conservation standards for these products (42 U.S.C. 6295(g)(2) and (9)(A)), and directs DOE to conduct future rulemakings to determine whether to amend these standards. (42 U.S.C. 6295(g)(4) and (9)(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)) This proposed rulemaking is in accordance with DOE's obligations under EPCA.

2. Objectives of, and Legal Basis for, Rule

EPCA authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. Title III, Part B of EPCA sets forth a variety of provisions designed to improve energy efficiency and established the Energy Conservation Program for Consumer Products Other Than Automobiles. These products include RCWs, the subject of this document. (42 U.S.C. 6292(a)(7)) EPCA prescribed energy conservation standards for these products (42 U.S.C. 6295(g)(2) and (9)(A)), and directs DOE to conduct future rulemakings to determine whether to amend these standards. (42 U.S.C. 6295(g)(4) and (9)(B)) This proposed rulemaking is in accordance the 6-year review required under 42 U.S.C. 6295(m)(1).

3. Description on Estimated Number of Small Entities Regulated

DOE reviewed this proposed rule under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. 68 FR 7990. DOE conducted a market survey to identify potential small manufacturers of RCWs. DOE began its assessment by reviewing DOE's CCD,[137] California Energy Commission's Modernized Appliance Efficiency Database System ("MAEDbS"),[138]

[137] U.S. Department of Energy's Compliance Certification Database is available at: *www.regulations.doe.gov/certification-data/#q=Product_Group_s%3A** (Last accessed March 25, 2022).
[138] California Energy Commission's Modernized Appliance Efficiency Database System is available at: *cacertappliances.energy.ca.gov/Pages/ApplianceSearch.aspx* (Last accessed March 25, 2022).

ENERGY STAR's Product Finder data set,[139] individual company websites, and prior RCW rulemakings to identify manufacturers of the covered product. DOE then consulted publicly available data, such as manufacturer websites, manufacturer specifications and product literature, import/export logs (*e.g.,* bills of lading from Panjiva[140]), and basic model numbers, to identify OEMs of RCWs. DOE further relied on public data and subscription-based market research tools (*e.g.,* Dun & Bradstreet reports[141]) to determine company location, headcount, and annual revenue. DOE also asked industry representatives if they were aware of any small manufacturers during manufacturer interviews. DOE screened out companies that do not offer products covered by this rulemaking, do not meet the SBA's definition of a "small business," or are foreign-owned and operated.

DOE initially identified 19 OEMs that sell RCWs in the United States. Of the 19 OEMs identified, DOE tentatively determined that one company qualifies as a small business and is not foreign-owned and operated.

DOE reached out to the small business and invited them to participate in a voluntary interview. The small business did not respond to DOE's interview request. DOE also requested information about small businesses and potential impacts on small businesses while interviewing large manufacturers.

[139] U.S. Environmental Protection Agency's ENERGY STAR Product Finder is available at: *www.energystar.gov/productfinder/* (Last accessed March 25, 2022).
[140] S&P Global. Panjiva Market Intelligence is available at: *panjiva.com/import-export/United-States* (Last accessed May 5, 2022).
[141] D&B Hoovers | Company Information | Industry Information | Lists, *app.dnbhoovers.com/* (Last accessed August 1, 2022).

4. Description and Estimate of Compliance Requirements Including Differences in Cost, if Any, for Different Groups of Small Entities

The one small business identified manufactures one standard-size top-loading clothes washer for residential use. DOE did not identify any RCW models manufactured by this small business listed in the CCD, MAEDbS, or ENERGY STAR databases. Instead, DOE identified this manufacturer through the prior rulemaking analysis. 77 FR 32307. There is limited public information about the energy and water efficiency of this small business's RCW model. Based on a review of available product literature and test data of a comparable RCW model, DOE estimates that their current design would not meet the efficiencies required at TSL 4. Furthermore, DOE's review of the product suggests that the design could not be easily adapted to meet TSL 4 efficiencies. DOE expects that the small manufacturer would likely need to make significant investments to redesign the product to meet the proposed efficiencies. Therefore, DOE is unable to conclude that the proposed rule would not have a "significant impact on a substantial number of small entities" at this time.

DOE seeks comments, information, and data on the number of small businesses in the industry, the names of those small businesses, and their market shares by product class. DOE also requests comment on the potential impacts of the proposed standard on small manufacturers. In particular, DOE seeks comment on the efficiency performance of the small manufacturer's RCW model and the estimated cost to redesign to the proposed standard level.

5. Duplication, Overlap, and Conflict with Other Rules and Regulations

DOE is not aware of any rules or regulations that duplicate, overlap, or conflict with the proposed rule.

6. Significant Alternatives to the Rule

The discussion in the previous section analyzes impacts on small businesses that would result from DOE's proposed rule, represented by TSL 4. In reviewing alternatives to the proposed rule, DOE examined energy conservation standards set at lower efficiency levels. While TSL 1, TSL 2, and TSL 3 would likely reduce the impacts on the one small business manufacturer, it would come at the expense of a reduction in energy savings. TSL 1 achieves 58 percent and TSL 2 achieves 57 percent lower energy savings compared to the energy savings at TSL 4. TSL 3 achieves 49 percent lower energy savings compared to the energy savings at TSL 4. Additionally, TSL 1 and TSL 2 achieve 50 percent and TSL 3 achieves 18 percent lower water savings compared to the water savings at TSL 4. TSL 5 were also analyzed, but it was determined this level would lead to greater costs to manufacturers.

Based on the presented discussion, establishing standards at TSL 4 balances the benefits of the energy and water savings at TSL 4 with the potential burdens placed on RCW manufacturers, including small business manufacturers. Accordingly, DOE does not propose one of the other TSLs considered in the analysis, or the other policy alternatives examined as part of the regulatory impact analysis and included in chapter 17 of the NOPR TSD.

Additional compliance flexibilities may be available through other means. EPCA provides that a manufacturer whose annual gross revenue from all of its operations does not exceed $8 million may apply for an exemption from all or part of an energy conservation standard for a period not longer than 24 months after the effective date of a final rule establishing the standard. (42 U.S.C. 6295(t)) Additionally, manufacturers subject to DOE's energy efficiency standards may apply to DOE's Office of Hearings and Appeals for exception relief under certain circumstances. Manufacturers should refer to 10 CFR part 430, subpart E, and 10 CFR part 1003 for additional details.

C. Review Under the Paperwork Reduction Act

Under the procedures established by the Paperwork Reduction Act of 1995 ("PRA"), a person is not required to respond to a collection of information by a Federal agency unless that collection of information displays a currently valid OMB Control Number.

OMB Control Number 1910-1400, Compliance Statement Energy/Water Conservation Standards for Appliances, is currently valid and assigned to the certification reporting requirements applicable to covered equipment, including RCWs.

DOE's certification and compliance activities ensure accurate and comprehensive information about the energy and water use characteristics of covered products and covered equipment sold in the United States. Manufacturers of all covered products and covered equipment must submit a certification report before a basic model is distributed in commerce, annually thereafter, and if the basic model is redesigned in such a manner to increase the consumption or decrease the efficiency of the basic model such that the certified rating is no longer supported by the test data. Additionally, manufacturers must report when production of a basic model has ceased and is no longer offered for sale as part of the next annual certification report following such cessation. DOE requires the manufacturer of any covered product or covered equipment to establish, maintain, and retain the records of certification reports, of the underlying test data for all certification testing, and of any other testing conducted to satisfy the requirements of part 429, part 430, and/or part 431. Certification reports provide DOE and consumers with comprehensive, up-to date efficiency information and support effective enforcement.

Revised certification data would be required for RCWs were this NOPR to be finalized as proposed; however, DOE is not proposing amended certification or reporting requirements for RCWs in this NOPR. Instead, DOE may consider proposals to establish certification requirements and reporting for RCWs under a separate rulemaking regarding appliance and equipment certification. DOE will address changes to OMB Control Number 1910-1400 at that time, as necessary.

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 equipment. 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 equipment, 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. Pub. L. 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 RCW 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 RCWs, 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 establish amended energy conservation standards for RCWs 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 42 U.S.C. 6295(o)(2)(A) and 42 U.S.C. 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 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 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 RCWs, 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.[142] 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

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[142] 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 June 12, 2022).

with the NAS to review DOE's analytical methodologies to ascertain whether modifications are needed to improve the Department's analyses. DOE is in the process of evaluating the resulting report.[143]

VII. Public Participation

A. Participation in the Webinar

The time and date of 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 at *www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=68*. 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

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

and the topics they wish to discuss. Such persons should also provide a daytime telephone number where they can be reached.

DOE requests persons selected to make an oral presentation to submit an advance copy of their statements at least two weeks before the webinar. At its discretion, DOE may permit persons who cannot supply an advance copy of their statement to participate, if those persons have made advance alternative arrangements with the Building Technologies Office. As necessary, requests to give an oral presentation should ask for such alternative arrangements.

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, as well as on any aspect of the proposed rulemaking.

The webinar will be conducted in an informal, conference style. DOE will present a general overview of the topics addressed in this proposed rulemaking, allow time for prepared general statements by participants, and encourage all interested parties to share their views on issues affecting this proposed 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 allow, 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 proposed 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 previous 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 document and will be accessible on the DOE website. 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 seeks comment on the product class structure analyzed in this NOPR.

(2) DOE seeks comment on the technology options not identified in this NOPR that manufacturers may use to attain higher efficiency levels of RCWs.

(3) DOE seeks comment on whether any additional technology options should be screened out on the basis of any of the screening criteria in this NOPR.

(4) DOE seeks comment on whether the baseline efficiency levels analyzed in this NOPR for each product class are appropriate.

(5) DOE seeks comment on whether the higher efficiency levels analyzed in this NOPR for each product class are appropriate.

(6) DOE seeks comment on whether the efficiency levels analyzed in this NOPR for semi-automatic RCWs are appropriate.

(7) DOE seeks comment on the baseline MPCs and incremental MPCs developed for each product class.

(8) DOE seeks comment on its tentative determination to use the DOE dataset as the basis for the translation equations rather than use the joint DOE-AHAM dataset.

(9) DOE seeks comment on its tentative determination not to merge the compact and standard-size translations, but to instead develop separate translations for each product class.

(10) DOE seeks comment on whether it should consider defining an "unadjusted" baseline efficiency level based on a translation between appendix J2 and appendix J metrics without consideration of any changes to spin implementations as a result of adopting the appendix J test procedure.

(11) DOE requests comment and information on the specific efficiency levels at which any potential rebound effects may happen, as well as the magnitude of the effect.

(12) DOE requests comment and information on frequency of cleaning cycles run per number of cycles used to clean clothes and associated data as compared to the recommendations in the manufacturer's use and care manuals.

(13) DOE requests comment and information on RCW lifetime.

(14) DOE seeks comment on the approach and inputs used to develop no-new standards case shipments projection and market share for each product class.

(15) DOE requests data on the market size and typical selling price of units sold through the second-hand market for residential clothes washers.

(16) For households who would be negatively impacted by amended energy conservation standards, a potential rebate program to reduce the total installed costs would be effective in lowering the percentage of consumers with a net cost and reducing simple payback period. DOE is aware of 80 rebate programs currently available for residential clothes washers meeting ENERGY STAR requirements initiated by 63 organizations in various States as described in chapter 17 of the NOPR TSD. DOE is seeking comment about how amended energy conservation standards may impact the low-income and senior-only consumer economics being presented and considered in this proposed rulemaking.

(17) DOE is seeking comment about definable subpopulations in addition to low-income and senior-only households and the associated data required to differentiate how such subpopulation use clothes washers.

(18) To consider to 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.

(19) DOE seeks comment on the availability of direct drive motors in quantities required by industry if DOE were to adopt amended standards.

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

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

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

(23) DOE seeks comment on whether the Consumer Reports test produces cleaning performance results that are representative of an average use cycle as measured by the DOE test procedure. DOE also seeks comment on how relative cleaning performance results would vary if tested under test conditions consistent with the DOE appendix J test procedure.

(24) DOE requests comment on its use of the Hot temperature selection with the large load size to evaluate potential impacts on clothes washer performance as a result of amended standards.

(25) DOE requests comment on its use of the Soil/Stain Removal test and Mechanical Action test specified in AHAM HLW-2-2020 as the basis for evaluating performance-related concerns expressed by AHAM and manufacturers.

(26) DOE requests comment on its wash temperature data presented in the performance characteristics test report and on its tentative conclusions derived from this data. DOE requests any additional data DOE should consider about wash temperatures at the proposed standard level, as DOE's data leads to the tentative conclusion that fatty soils would be able to be dissolved at this efficiency level.

(27) DOE requests comment on its stain removal data presented in the performance characteristics test report and on its conclusions derived from this data. In particular, DOE requests comment on whether the clustering of data at or above a score of 90 (as measured on the Hot temperature selection with the large load size) corresponds to a market-representative threshold of

stain removal performance as measured with this cycle configuration. DOE additionally requests comment on its analysis indicating that implementing additional hardware design options, rather than reducing wash temperatures, on EL 2 units could enable total cleaning scores at EL 3 that are equally as high as the highest scores currently achieved by units at lower efficiency levels.

(28) DOE requests comment on its mechanical action data presented in the performance characteristics test report and on its conclusions derived from this data. In particular, DOE requests comment on whether there is a market-representative threshold of mechanical action performance as measured on the Hot temperature selection using the large load size. DOE also requests comment on whether better mechanical action scores at higher top-loading efficiency levels are attributable to the use of wash plates rather than traditional agitators in those higher-efficiency units.

(29) DOE requests comment on its cycle time data presented in the performance characteristics test report and on its conclusions derived from this data.

(30) DOE seeks comment on its testing and assessment of performance attributes (i.e., wash temperatures, stain removal, mechanical action, and cycle duration), particularly at the proposed standard level (*i.e.*, TSL 4). In addition, DOE seeks additional data that stakeholders would like DOE to consider on performance attributes at TSL 4 efficiencies as well as the current minimum energy conservation standards.

(31) DOE requests comment and information on sales of RCWs with deep fill and/or deep rinse options or settings and the frequency of use of cycles with these options or settings selected.

(32) DOE requests data and information regarding any quantitative performance-related characteristics at TSL 4 in comparison to performance at the current baseline level (*e.g.*, cleaning performance, rinsing performance, fabric wear, etc.), particularly for top-loading standard-size RCWs.

(33) DOE seeks comments, information, and data on the number of small businesses in the industry, the names of those small businesses, and their market shares by product class. DOE also requests comment on the potential impacts of the proposed standard on small manufacturers. In particular, DOE seeks comment on the efficiency performance of the small manufacturer's RCW model and the estimated cost to redesign to the proposed standard level.

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 announcement of public meeting.

List of Subjects in 10 CFR Part 430

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

Signing Authority

This document of the Department of Energy was signed on February 9, 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 February 9, 2023

FRANCISCO MORENO

Digitally signed by FRANCISCO MORENO
Date: 2023.02.09 17:56:30 -05'00'

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. Removing paragraphs (g)(1) through (g)(3);

b. Redesignating paragraph (g)(4) as paragraph (g)(1);

c. Revising the introductory sentence of newly redesignated paragraph (g)(1); and

d. Adding new paragraph (g)(2).

The addition and revision read as follows:

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

*   *   *   *   *

(g) *Clothes washers*.

(1) Clothes washers manufactured on or after January 1, 2018, and before [*Date 3 years after date of publication of final rule in the Federal Register*], shall have an Integrated Modified Energy Factor no less than, and an Integrated Water Factor no greater than:***

(2) Clothes washers manufactured on or after [*Date 3 years after date of publication of final rule in the Federal Register*], shall have an Energy Efficiency Ratio and a Water Efficiency Ratio no less than:

Product Class	**Energy Efficiency Ratio** *(lb/kWh/cycle)*	**Water Efficiency Ratio** *(lb/gal/cycle)*
Semi-Automatic Clothes Washers	2.12	0.27
Automatic Clothes Washers		
Top-Loading, Ultra-Compact (less than 1.6 ft^3 capacity)	3.79	0.29
Top-Loading, Standard-Size (1.6 ft^3 or greater capacity)	4.78	0.63
Front-Loading, Compact (less than 3.0 ft^3 capacity)	5.02	0.71
Front-Loading, Standard-Size (3.0 ft^3 or greater capacity)	5.73	0.77

*   *   *   *   *