DEPARTMENT OF ENERGY

10 CFR Parts 429 and 430

[EERE–2017–BT–STD–0019]

RIN 1904–AD91

Energy Conservation Program: Energy Conservation Standards for Consumer Water Heaters

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

DATES: *Comments:* DOE will accept comments, data, and information regarding this NOPR no later than September 26, 2023.

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 August 28, 2023.

Meeting: DOE will hold a public meeting via webinar on September 13, 2023, from 1:00 p.m. to 4:00 p.m. See section VII, ''Public Participation,'' for webinar registration information, participant instructions, and information about the capabilities available to webinar participants.

ADDRESSES: Interested persons are encouraged to submit comments using the Federal eRulemaking Portal at *www.regulations.gov* under docket number EERE–2017–BT–STD–0019. Follow the instructions for submitting comments. Alternatively, interested persons may submit comments, identified by docket number EERE–2017–BT–STD–0019, by any of the following methods:

(1) *Email: ConsumerWaterHeaters2017STD0019@ee.doe.gov.* Include the docket number EERE–2017–BT–STD–0019 in the subject line of the message.

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

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

No telefacsimiles (''faxes'') will be accepted. For detailed instructions on submitting comments and additional information on this process, see section IV 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-0019.* 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 to 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 rulemaking.

FOR FURTHER INFORMATION CONTACT:

Ms. Julia Hegarty, 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. 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,[1] as amended, Public Law 94–163 (42 U.S.C. 6291–6317, as codified) authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. 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 water heaters, 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 new and amended energy conservation standards for consumer water heaters. The proposed standards, which are expressed in terms of uniform energy factor (''UEF''), are shown in Table I.1. These proposed standards, if adopted, would apply to all consumer water heaters listed in Table I.1 manufactured in, or imported into, the United States starting on the date 5 years after the

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

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

publication of the final rule for this proposed rulemaking.

TABLE I.1—PROPOSED ENERGY CONSERVATION STANDARDS FOR CONSUMER WATER HEATERS

Product class	Effective storage volume and input rating* (if applicable)	Draw pattern	Uniform energy factor
Gas-fired Storage Water Heater	<20 gal	Very Small	$0.2062 - (0.0020 \times V_{eff})$
		Low	$0.4893 - (0.0027 \times V_{eff})$
		Medium	$0.5758 - (0.0023 \times V_{eff})$
		High	$0.6586 - (0.0020 \times V_{eff})$
	≥20 gal and ≤55 gal	Very Small	$0.3925 - (0.0020 \times V_{eff})$
		Low	$0.6451 - (0.0019 \times V_{eff})$
		Medium	$0.7046 - (0.0017 \times V_{eff})$
		High	$0.7424 - (0.0013 \times V_{eff})$
	>55 gal and ≤100 gal	Very Small	$0.6470 - (0.0006 \times V_{eff})$
		Low	$0.7689 - (0.0005 \times V_{eff})$
		Medium	$0.7897 - (0.0004 \times V_{eff})$
		High	$0.8072 - (0.0003 \times V_{eff})$
	>100 gal	Very Small	$0.1482 - (0.0007 \times V_{eff})$
		Low	$0.4342 - (0.0017 \times V_{eff})$
		Medium	$0.5596 - (0.0020 \times V_{eff})$
		High	$0.6658 - (0.0019 \times V_{eff})$
Oil-fired Storage Water Heater	≤50 gal	Very Small	$0.2909 - (0.0012 \times V_{eff})$
		Low	$0.5730 - (0.0016 \times V_{eff})$
		Medium	$0.6478 - (0.0016 \times V_{eff})$
		High	$0.7215 - (0.0014 \times V_{eff})$
	>50 gal	Very Small	$0.1580 - (0.0009 \times V_{eff})$
		Low	$0.4390 - (0.0020 \times V_{eff})$
		Medium	$0.5389 - (0.0021 \times V_{eff})$
		High	$0.6172 - (0.0018 \times V_{eff})$
Very Small Electric Storage Water Heater	<20 gal	Very Small	$0.5925 - (0.0059 \times V_{eff})$
		Low	$0.8642 - (0.0030 \times V_{eff})$
		Medium	$0.9096 - (0.0020 \times V_{eff})$
		High	$0.9430 - (0.0012 \times V_{eff})$
Small Electric Storage Water Heater	≥20 gal and ≤35 gal	Very Small	$0.8808 - (0.0008 \times V_{eff})$
		Low	$0.9254 - (0.0003 \times V_{eff})$
Electric Storage Water Heaters	>20 and ≤55 gal (excluding small electric storage water heaters).	Very Small	2.30
		Low	2.30
		Medium	2.30
		High	2.30
	>55 gal and ≤120 gal	Very Small	2.50
		Low	2.50
		Medium	2.50
		High	2.50
	>120 gal	Very Small	$0.3574 - (0.0012 \times V_{eff})$
		Low	$0.7897 - (0.0019 \times V_{eff})$
		Medium	$0.8884 - (0.0017 \times V_{eff})$
		High	$0.9575 - (0.0013 \times V_{eff})$
Tabletop Water Heater	<20 gal	Very Small	$0.5925 - (0.0059 \times V_{eff})$
		Low	$0.8642 - (0.0030 \times V_{eff})$
	≥20 gal and ≤120 gal	Very Small	$0.6323 - (0.0058 \times V_{eff})$
		Low	$0.9188 - (0.0031 \times V_{eff})$
Instantaneous Gas-fired Water Heater	<2 gal and ≤50,000 Btu/h	Very Small	0.64
		Low	0.64
		Medium	0.64
		High	0.64
	<2 gal and >50,000 Btu/h	Very Small	0.89
		Low	0.91
		Medium	0.91
		High	0.93
	≥2 gal and ≤200,000 Btu/h	Very Small	$0.2534 - (0.0018 \times V_{eff})$
		Low	$0.5226 - (0.0022 \times V_{eff})$
		Medium	$0.5919 - (0.0020 \times V_{eff})$
		High	$0.6540 - (0.0017 \times V_{eff})$
Instantaneous Oil-fired Water Heater	<2 gal and ≤210,000 Btu/h	Very Small	0.61
		Low	0.61
		Medium	0.61
		High	0.61
	≥2 gal and ≤210,000 Btu/h	Very Small	$0.2780 - (0.0022 \times V_{eff})$
		Low	$0.5151 - (0.0023 \times V_{eff})$
		Medium	$0.5687 - (0.0021 \times V_{eff})$
		High	$0.6147 - (0.0017 \times V_{eff})$
Instantaneous Electric Water Heater	<2 gal	Very Small	0.91
		Low	0.91

TABLE I.1—PROPOSED ENERGY CONSERVATION STANDARDS FOR CONSUMER WATER HEATERS—Continued

Product class	Effective storage volume and input rating* (if applicable)	Draw pattern	Uniform energy factor
		Medium	0.91
		High	0.92
	≥2 gal	Very Small	$0.8086 - (0.0050 \times V_{eff})$
		Low	$0.9123 - (0.0020 \times V_{eff})$
		Medium	$0.9252 - (0.0015 \times V_{eff})$
		High	$0.9350 - (0.0011 \times V_{eff})$
Grid-Enabled Water Heater	>75 gal	Very Small	$1.0136 - (0.0028 \times V_{eff})$
		Low	$0.9984 - (0.0014 \times V_{eff})$
		Medium	$0.9853 - (0.0010 \times V_{eff})$
		High	$0.9720 - (0.0007 \times V_{eff})$
Gas-fired Circulating Water Heater	≤200,000 Btu/h	Very Small	$0.8000 - (0.0011 \times V_{eff})$
		Low	$0.8100 - (0.0011 \times V_{eff})$
		Medium	$0.8100 - (0.0011 \times V_{eff})$
		High	$0.8100 - (0.0011 \times V_{eff})$
Oil-fired Circulating Water Heater	≤210,000 Btu/h	Very Small	$0.6100 - (0.0011 \times V_{eff})$
		Low	$0.6100 - (0.0011 \times V_{eff})$
		Medium	$0.6100 - (0.0011 \times V_{eff})$
		High	$0.6100 - (0.0011 \times V_{eff})$
Electric Circulating Water Heater	≤12 kW; for heat pump type units ≤24 A at ≤250 V	Very Small	$0.9100 - (0.0011 \times V_{eff})$
		Low	$0.9100 - (0.0011 \times V_{eff})$
		Medium	$0.9100 - (0.0011 \times V_{eff})$
		High	$0.9200 - (0.0011 \times V_{eff})$

* Effective storage volume is the representative value of storage volume as determined in accordance with the DOE test procedure at appendix E to subpart B of 10 CFR part 430 and applicable sampling plans.

A. Benefits and Costs to Consumers

Table I.2 presents DOE's evaluation of the economic impacts of the proposed standards on consumers of consumer water heaters, as measured by the average life-cycle cost (''LCC'') savings and the simple payback period (''PBP'').[3] The average LCC savings are positive for all product classes, and the PBP is less than the average lifetime of consumer water heaters, which is estimated to be 15 years for storage and 20 years for instantaneous water heaters (see section IV.F of this document).

TABLE I.2—IMPACTS OF PROPOSED ENERGY CONSERVATION STANDARDS ON CONSUMERS OF CONSUMER WATER HEATERS

Product class	Effective storage volume and input rating (if applicable)	Average LCC savings (2022$)	Simple payback (years)
Gas-fired Storage Water Heater	≥20 gal and ≤55 gal	52	7.9
Oil-fired Storage Water Heater	≤50 gal	165	6.4
Electric Storage Water Heaters*	≥20 gal and ≤55 gal (excluding Small ESWHs)	1,868	3.0
	>55 gal and ≤120 gal	501	0.2
Instantaneous Gas-fired Water Heater	<2 gal and >50,000 Btu/h and <200,000 Btu/h	135	5.9

* DOE is not proposing amended standards for small electric storage water heaters (*i.e.,* electric storage water heaters greater than or equal to 20 gallons but less than 35 gallons in effective storage volume, with first-hour ratings less than 51 gallons), so those products are not impacted by the proposed rule.

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 (2023–2059). Using a real discount rate of 9.6 percent, DOE estimates that the INPV for manufacturers of consumer water heaters in the case without amended standards is $2,554.7 million in 2022$. Under the proposed standards, the change in INPV is estimated to range from negative 8.1 percent to positive 6.5 percent, which is a loss of $207.3 million to a gain of $165.5 million. In order to bring products into compliance with amended standards, it is estimated that the industry would incur total conversion costs of $228.1 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[4]

DOE's analyses indicate that the proposed energy conservation standards for consumer water heaters would save a significant amount of energy. Relative

[3] The average LCC savings refer to consumers that are affected by a standard and are measured relative to the efficiency distribution in the no-new-standards case, which depicts the market in the compliance year in the absence of new or amended standards (see section IV.F.8 of this document). The simple PBP, which is designed to compare specific efficiency levels, is measured relative to the baseline product (see section IV.F.9 of this document).

[4] All monetary values in this document are expressed in 2022 dollars.

to the case without amended standards, the lifetime energy savings for consumer water heaters purchased in the 30-year period that begins in the anticipated year of compliance with the amended standards (2030–2059) amount to 27 quadrillion British thermal units (''Btu''), or quads.[5] This represents a savings of 21 percent relative to the energy use of these products in the case without amended standards (referred to as the ''no-new-standards case'').

The cumulative net present value (''NPV'') of total consumer benefits of the proposed standards for consumer water heaters are $56 billion at a 7-percent discount rate and $161 billion at a 3-percent discount rate. This NPV expresses the estimated total value of future operating-cost savings minus the estimated increased product and installation costs for consumer water heaters purchased in 2030–2059.

In addition, the proposed standards for consumer water heaters 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, 2030–2059) of 501 million metric tons (''Mt'')[6] of carbon dioxide (''CO_2''), 143 thousand tons of sulfur dioxide (''SO_2''), 988 thousand tons of nitrogen oxides (''NO_X''), 4,541 thousand tons of methane (''CH_4''), 4.6 thousand tons of nitrous oxide (''N_2O''), and 1.0 tons of mercury (''Hg'').[7]

DOE estimates the value of climate benefits from a reduction in greenhouse gases (''GHG'') using four different estimates of the social cost of CO_2 (''SC–CO_2''), the social cost of methane (''SC–CH_4''), and the social cost of nitrous oxide (''SC–N_2O''). Together these represent the social cost of GHG (''SC–GHG'').'').[8] DOE used interim SC–GHG values developed by an Interagency Working Group on the Social Cost of Greenhouse Gases (''IWG'').[9] The derivation of these values is discussed in section IV.L of this document. For presentational purposes, the climate benefits associated with the average SC–GHG at a 3-percent discount rate are estimated to be $25 billion. DOE does not have a single central SC–GHG point estimate and it emphasizes the importance and value of considering the benefits calculated using all four sets of SC–GHG estimates.

DOE 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 $17 billion using a 7-percent discount rate, and $49 billion using a 3-percent discount rate.[10] DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions.

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

TABLE I.3—SUMMARY OF MONETIZED BENEFITS AND COSTS OF PROPOSED ENERGY CONSERVATION STANDARDS FOR CONSUMER WATER HEATERS

[TSL 2]

	Billion 2022$
3% discount rate	
Consumer Operating Cost Savings	198
Climate Benefits *	25
Health Benefits **	49
Total Monetized Benefits †	271
Consumer Incremental Product Costs ‡	36
Net Monetized Benefits	235
Change in Producer Cashflow (INPV ††)	(0.2) – 0.2
7% discount rate	
Consumer Operating Cost Savings	75
Climate Benefits * (3% discount rate)	25
Health Benefits **	17
Total Monetized Benefits †	117
Consumer Incremental Product Costs ‡	19
Net Monetized Benefits	98

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

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

[7] DOE calculated emissions reductions relative to the no-new-standards case, which reflects key assumptions in the *Annual Energy Outlook 2023* (''*AEO2023*''). *AEO2023* 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 *AEO2023* assumptions that effect air pollutant emissions. The *AEO 2023* reflects the impact of the Inflation Reduction Act.

[8] To monetize the benefits of reducing greenhouse gas emissions this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990* published in February 2021 by the Interagency Working Group on the Social Cost of Greenhouse Gases (IWG).

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

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

TABLE I.3—SUMMARY OF MONETIZED BENEFITS AND COSTS OF PROPOSED ENERGY CONSERVATION STANDARDS FOR CONSUMER WATER HEATERS—Continued

[TSL 2]

	Billion 2022$
Change in Producer Cashflow (INPV ††)	(0.2) − 0.2

Note: This table presents the monetized costs and benefits associated with consumer water heaters shipped in 2030–2059. These results include benefits to consumers which accrue after 2059 from the products shipped in 2030–2059.

* Climate benefits are calculated using four different estimates of the social cost of carbon (SC–CO_2), methane (SC–CH_4), and nitrous oxide (SC–N_2O) (model average at 2.5-percent, 3-percent, and 5-percent discount rates; 95th percentile at 3-percent discount rate) (see section IV.L of this document). Together these represent the global SC–GHG. For presentational purposes of this table, the climate benefits associated with the average SC–GHG at a 3-percent discount rate are shown, but DOE does not have a single central SC–GHG point estimate. To monetize the benefits of reducing greenhouse gas emissions this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990* published in February 2021 by the Interagency Working Group on the Social Cost of Greenhouse Gases (IWG).

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

† Total and net benefits include those consumer, climate, and health benefits that can be quantified and monetized. For presentation purposes, total and net benefits for both the 3-percent and 7-percent cases are presented using the average SC–GHG with 3-percent discount rate, but DOE does not have a single central SC–GHG point estimate. DOE emphasizes the importance and value of considering the benefits calculated using all four sets of SC–GHG estimates.

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

†† Operating Cost Savings are calculated based on the life cycle costs analysis and national impact analysis as discussed in detail below. See sections IV.F and IV.H. DOE's NIA includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the product and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (the MIA). See section IV.J. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the industry net present value (INPV). The change in industry NPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. Change in INPV is calculated using the industry weighted average cost of capital value of 9.6% that is estimated in the manufacturer impact analysis (see chapter 12 of the NOPR TSD for a complete description of the industry weighted average cost of capital). For consumer water heaters, those values are −$207 million and $166 million. DOE accounts for that range of likely impacts in analyzing whether a TSL is economically justified. See section V.A of this document. DOE is presenting the range of impacts to the industry net present value under two markup scenarios: the Preservation of Gross Margin scenario, which is the manufacturer markup scenario used in the calculation of Consumer Operating Cost Savings in this table, and the Preservation of Operating Profit Markup scenario, where DOE assumed manufacturers would not be able to increase per-unit operating profit in proportion to increases in manufacturer production costs. DOE includes the range of estimated INPV in the above table, drawing on the MIA explained further in Section IV.J, to provide additional context for assessing the estimated impacts of this proposal to society, including potential changes in production and consumption, which is consistent with OMB's Circular A–4 and E.O. 12866. If DOE were to include the industry net present value into the net benefit calculation for this proposed rule, the net benefits would be $235 billion at 3-percent discount rate and $98 billion at 7-percent discount rate. DOE seeks comment on this approach.

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 monetized value of climate and health benefits of emission reductions, all annualized.[11]

The national operating cost savings are domestic private U.S. consumer monetary savings that occur as a result of purchasing the covered products and are measured for the lifetime of consumer water heaters shipped in 2030–2059. The benefits associated with reduced emissions achieved as a result of the proposed standards are also calculated based on the lifetime of consumer water heaters shipped in 2030–2059. 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.1 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 NO_X and SO_2 emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the standards proposed in this rule is $2,235 million per year in increased equipment costs, while the estimated annual benefits are $7,876 million in reduced equipment operating costs, $1,429 million in monetized climate benefits, and $1,805 million in monetized health benefits. In this case, the net monetized benefit would amount to $8,875 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the proposed standards is $2,420 million per year in increased equipment costs, while the estimated annual benefits are $11,357 million in reduced operating costs, $1,429 million in monetized climate benefits, and $2,798 million in monetized health benefits. In this case, the net monetized benefit would amount to $13,164 million per year.

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

TABLE I.4—ANNUALIZED BENEFITS AND COSTS OF PROPOSED ENERGY CONSERVATION STANDARDS FOR CONSUMER WATER HEATERS

[TSL 2]

	Billion 2022$/year		
	Primary estimate	Low-net-benefits estimate	High-net-benefits estimate
3% discount rate			
Consumer Operating Cost Savings	11.357	10.633	12.096
Climate Benefits *	1.429	1.412	1.446
Health Benefits **	2.798	2.764	2.832
Total Monetized Benefits †	15.584	14.809	16.374
Consumer Incremental Product Costs ‡	2.420	2.488	2.356
Net Monetized Benefits	13.164	12.321	14.018
Change in Producer Cashflow (INPV ††)	(0.021) − 0.017	(0.021) − 0.017	(0.021) − 0.017
7% discount rate			
Consumer Operating Cost Savings	7.876	7.380	8.382
Climate Benefits * (3% discount rate)	1.429	1.412	1.446
Health Benefits **	1.805	1.784	1.825
Total Monetized Benefits †	11.110	10.576	11.653
Consumer Incremental Product Costs ‡	2.235	2.290	2.183
Net Monetized Benefits	8.875	8.286	9.470
Change in Producer Cashflow (INPV ††)	(0.021) − 0.017	(0.021) − 0.017	(0.021) − 0.017

Note: This table presents the costs and benefits associated with consumer water heaters shipped in 2030–2059. These results include benefits to consumers which accrue after 2059 from the products shipped in 2030–2059. The Primary, Low Net Benefits, and High Net Benefits Estimates utilize projections of energy prices from the AEO2023 Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental equipment costs reflect a medium decline rate in the Primary Estimate, a low decline rate in the Low Net Benefits Estimate, and a high decline rate in the High Net Benefits Estimate. The methods used to derive projected price trends are explained in sections IV.F.1 and IV.F.4 of this document. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

* To monetize the benefits of reducing greenhouse gas emissions this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990* published in February 2021 by the Interagency Working Group on the Social Cost of Greenhouse Gases (IWG). 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.

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

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

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

†† Operating Cost Savings are calculated based on the life cycle costs analysis and national impact analysis as discussed in detail below. See sections IV.F and IV.H of this document. DOE's NIA includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the product and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (the MIA). See section IV.J. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the industry net present value (INPV). The change in industry NPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. Change in INPV is calculated using the industry weighted average cost of capital value of 9.6% that is estimated in the manufacturer impact analysis (see chapter 12 of the NOPR TSD for a complete description of the industry weighted average cost of capital). For consumer water heaters, those values are −$21 million and $17 million. DOE accounts for that range of likely impacts in analyzing whether a TSL is economically justified. See section V.A of this document. DOE is presenting the range of impacts to the industry net present value under two markup scenarios: the Preservation of Gross Margin scenario, which is the manufacturer markup scenario used in the calculation of Consumer Operating Cost Savings in this table, and the Preservation of Operating Profit Markup scenario, where DOE assumed manufacturers would not be able to increase per-unit operating profit in proportion to increases in manufacturer production costs. DOE includes the range of estimated INPV in the above table, drawing on the MIA explained further in Section IV.J, to provide additional context for assessing the estimated impacts of this proposal to society, including potential changes in production and consumption, which is consistent with OMB's Circular A–4 and E.O. 12866. If DOE were to include the industry net present value into the net benefit calculation for this proposed rule, the net benefits would range from $13.143 billion to $13.181 billion at 3-percent discount rate and range from $8.854 billion to $8.892 billion at 7-percent discount rate. DOE seeks comment on this approach.

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 proposed 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 standards exceed the burdens of the proposed standards.

Using a 7-percent discount rate for consumer benefits and costs and NO_X and SO_2 reduction benefits, and a 3-percent discount rate case for GHG social costs, the estimated cost of the proposed standards for consumer water heaters is $2,235 million per year in increased product costs, while the estimated annual benefits are $7,876 million in reduced product operating costs, $1,429 million in monetized climate benefits and $1,805 million in monetized health benefits. The net monetized benefit amounts to $8,875 million per year.

The significance of energy savings offered by a new or amended energy conservation standard cannot be determined without knowledge of the specific circumstances surrounding a given rulemaking.[12] For example, some covered products and equipment have 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 standards are projected to result in estimated national energy savings of 27 quad FFC. In addition, they are projected to reduce CO_2 emissions by 501 Mt, the equivalent of the annual CO_2 emissions of 2.1 million homes over 30 years. Based on these findings, 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). A more detailed discussion of the basis for these tentative conclusions is contained in the remainder of this document and the accompanying technical support document (''TSD'').

DOE also considered more-stringent energy efficiency levels as potential standards, and is still considering them in this 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 consumer water heaters.

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 consumer water heaters, the subject of this document. (42 U.S.C. 6292(a)(4))

EPCA prescribed energy conservation standards for these products (42 U.S.C. 6295(e)(1)), and directed DOE to conduct two cycles of rulemakings[13] to determine whether to amend these standards. (42 U.S.C. 6295(e)(4)) 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(o)(3)(A) and 42 U.S.C. 6295(r)) Manufacturers of covered products must use the prescribed DOE test procedure as the basis for certifying to DOE that their products comply with the applicable energy conservation standards adopted under EPCA and when making representations to the public regarding the energy use or efficiency of those products. (42 U.S.C. 6293(c) and 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 consumer water heaters appear at title 10 of the Code of Federal Regulations (''CFR'') part 430, subpart B, appendix E (''appendix E'').

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

Moreover, DOE may not prescribe a standard: (1) for certain products, including consumer water heaters, if no test procedure has been established for the product, or (2) if DOE determines by rule that the standard is not technologically feasible or economically justified. (42 U.S.C. 6295(o)(3)(A)–(B)) In deciding whether a proposed standard is economically justified, DOE must determine whether the benefits of the standard exceed its burdens. (42 U.S.C. 6295(o)(2)(B)(i)) DOE must make this determination after receiving comments on the proposed standard, and by considering, to the greatest extent practicable, the following seven statutory factors:

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

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

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

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

[13] DOE completed the first of these rulemaking cycles on January 17, 2001, by publishing in the **Federal Register** a final rule amending the energy conservation standards for consumer water heaters. 66 FR 4474. Subsequently, DOE completed the second rulemaking cycle to amend the standards for consumer water heaters by publishing a final rule in the **Federal Register** on April 16, 2010. 75 FR 20112.

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

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

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

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

(42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII))

Further, EPCA establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the energy savings that the consumer will receive during the first year 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''), Public Law 110–140, any final rule for new or amended energy conservation standards promulgated after July 1, 2010, is required to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) Specifically, when DOE adopts a standard for a covered product after that date, it must, if justified by the criteria for adoption of standards under EPCA (42 U.S.C. 6295(o)), incorporate standby mode and off mode energy use into a single standard, or, if that is not feasible, adopt a separate standard for such energy use for that product. (42 U.S.C. 6295(gg)(3)(A)–(B)) DOE's current test procedures for consumer water heaters address standby mode and off mode energy use. In this rulemaking, DOE is proposing to apply the UEF metric (which addresses standby mode and off mode energy use) to all product classes of consumer water heaters, including those product classes for which there are no currently applicable UEF-based standards.

B. Background

1. Current Standards

As directed by EPCA (42 U.S.C. 6295(e)(4)), DOE conducted two cycles of rulemakings to determine whether to amend the statutory standards for consumer water heaters found in 42 U.S.C. 6295(e)(1). The most recent rulemaking from April 2010 resulted in amended standards using the energy factor (''EF'') metric originally prescribed by EPCA with a requirement for compliance starting on April 16, 2015. 75 FR 20112 (the ''April 2010 Final Rule''). Later amendments to EPCA directed DOE to establish a uniform efficiency metric for consumer water heaters (*see* 42 U.S.C. 6295(e)(5)(B)).[14] The Federal test procedure was revised to use a new metric, UEF, in a final rule published on July 11, 2014. 79 FR 40542. In a final rule published in the **Federal Register** on December 29, 2016, the existing EF-based energy conservation standards were then translated from EF to UEF using a ''conversion factor'' method for water heater basic models that were in existence at the time. 81 FR 96204 (''December 2016 Conversion Factor Final Rule'').

These standards are set forth in DOE's regulations at 10 CFR 430.32(d) and are repeated in Table II.1.

TABLE II.1—CURRENT UEF-BASED FEDERAL ENERGY CONSERVATION STANDARDS FOR CONSUMER WATER HEATERS

Product class	Rated storage volume and input rating (if applicable)	Draw pattern *	Uniform energy factor **
Gas-fired Storage Water Heater	≥20 gal and ≤55 gal	Very Small	$0.3456 - (0.0020 \times V_r)$
		Low	$0.5982 - (0.0019 \times V_r)$
		Medium	$0.6483 - (0.0017 \times V_r)$
		High	$0.6920 - (0.0013 \times V_r)$
	>55 gal and ≤100 gal	Very Small	$0.6470 - (0.0006 \times V_r)$
		Low	$0.7689 - (0.0005 \times V_r)$
		Medium	$0.7897 - (0.0004 \times V_r)$
		High	$0.8072 - (0.0003 \times V_r)$
Oil-fired Storage Water Heater	≤50 gal	Very Small	$0.2509 - (0.0012 \times V_r)$
		Low	$0.5330 - (0.0016 \times V_r)$
		Medium	$0.6078 - (0.0016 \times V_r)$
		High	$0.6815 - (0.0014 \times V_r)$
Electric Storage Water Heaters	≥20 gal and ≤55 gal	Very Small	$0.8808 - (0.0008 \times V_r)$
		Low	$0.9254 - (0.0003 \times V_r)$

[14] The requirement for a consumer water heater test procedure using uniform energy factor as a metric, as well as the requirement for DOE to undertake a conversion factor rulemaking to translate existing consumer water heater standards denominated in terms of EF to ones denominated in terms of UEF, were part of the amendments to EPCA contained in the American Energy Manufacturing Technical Corrections Act (AEMTCA), Public Law 112–210 (Dec. 18, 2012).

TABLE II.1—CURRENT UEF-BASED FEDERAL ENERGY CONSERVATION STANDARDS FOR CONSUMER WATER HEATERS—Continued

Product class	Rated storage volume and input rating (if applicable)	Draw pattern *	Uniform energy factor **
		Medium	$0.9307 - (0.0002 \times V_r)$
		High	$0.9349 - (0.0001 \times V_r)$
	>55 gal and ≤120 gal	Very Small	$1.9236 - (0.0011 \times V_r)$
		Low	$2.0440 - (0.0011 \times V_r)$
		Medium	$2.1171 - (0.0011 \times V_r)$
		High	$2.2418 - (0.0011 \times V_r)$
Tabletop Water Heater	≥20 gal and ≤120 gal	Very Small	$0.6323 - (0.0058 \times V_r)$
		Low	$0.9188 - (0.0031 \times V_r)$
		Medium	$0.9577 - (0.0023 \times V_r)$
		High	$0.9884 - (0.0016 \times V_r)$
Instantaneous Gas-fired Water Heater	<2 gal and >50,000 Btu/h	Very Small	0.80
		Low	0.81
		Medium	0.81
		High	0.81
Instantaneous Electric Water Heater	<2 gal	Very Small	0.91
		Low	0.91
		Medium	0.91
		High	0.92
Grid-enabled Water Heater	>75 gal	Very Small	$1.0136 - (0.0028 \times V_r)$
		Low	$0.9984 - (0.0014 \times V_r)$
		Medium	$0.9853 - (0.0010 \times V_r)$
		High	$0.9720 - (0.0007 \times V_r)$

* The draw pattern dictates the frequency and duration of hot water draws during the 24-hour simulated use test, and is an indicator of delivery capacity of the water heater. Draw patterns are assigned based on the first hour rating (''FHR''), for non-flow-activated water heaters, or maximum GPM rating (''Max GPM''), for flow-activated water heaters. For the specific FHR and Max GPM ranges which correspond to each draw pattern, see section 5.4.1 of appendix E to subpart B of 10 CFR part 430.

** V_r is the rated storage volume (in gallons), as determined pursuant to 10 CFR 429.17.

In the December 2016 Conversion Factor Final Rule, DOE declined to develop conversion factors and UEF-based standards for consumer water heaters of certain sizes (by rated storage volume or input rating) and of certain types (*i.e.,* oil-fired instantaneous water heaters) where models did not exist on the market at the time to inform the analysis of the standards conversion. 81 FR 96204, 96210–96211. For consumer water heaters that did not receive converted UEF-based standards, DOE provided its interpretation that the original statutory standards—found at 42 U.S.C. 6295(e)(1) and expressed in terms of the EF metric—still applied; however, DOE would not enforce those statutorily-prescribed standards until such a time conversion factors are developed for these products and they can be converted to UEF. *Id.* Thus, the EF-based standards specified by EPCA apply to any consumer water heaters which do not have UEF-based standards found at 10 CFR 430.32(d). These EF-based standards are set forth at 42 U.S.C. 6295(e)(1) and are repeated in Table II.2.

TABLE II.2—EF-BASED FEDERAL ENERGY CONSERVATION STANDARDS FOR CONSUMER WATER HEATERS

Product class	Energy factor *
Gas water heaters	$0.62 - (0.0019 \times V_r)$
Oil water heaters	$0.59 - (0.0019 \times V_r)$
Electric water heaters	$0.95 - (0.00132 \times V_r)$

* V_r is the rated storage volume (in gallons), as determined pursuant to 10 CFR 429.17.

2. History of the Current Standards Rulemaking for Consumer Water Heaters

On May 21, 2020, DOE initiated the current rulemaking by publishing in the **Federal Register** a request for information (''May 2020 RFI''), soliciting public comment on various aspects of DOE's planned analyses to help DOE determine whether to amend energy conservation standards for consumer water heaters. 85 FR 30853 (May 21, 2020). DOE subsequently published a notice requesting feedback on its preliminary analysis and technical support document (''preliminary TSD'') on March 1, 2022 (the ''March 2022 Preliminary Analysis'') with a 60-day comment period. 87 FR 11327 (Mar. 1, 2022). The comment period was extended by 14 days in a notice published on May 4, 2022. 87 FR 26303. DOE received comments in response to the preliminary analysis notice and accompanying technical support document from the interested parties listed in Table II.3.

On October 21, 2022, DOE received a set of recommendations on amended energy conservation standards for consumer water heaters from a coalition of public- and private-sector organizations, including water heater manufacturers, energy efficiency organizations, environmental groups, and consumer organizations—collectively the Joint Stakeholders. This coalition's submission is herein referred to as the ''Joint Recommendation.'' The Joint Recommendation addressed standards for electric storage water heaters, gas-fired storage water heaters, and gas-fired instantaneous water heaters and is discussed in further detail in section III.F of this document.

TABLE II.3—PRELIMINARY ANALYSIS AND JOINT RECOMMENDATION COMMENTS

Commenter(s)	Abbreviation	Comment No. in the docket*	Commenter type
American Council for an Energy-Efficient Economy, Appliance Standards Awareness Project, Bradford White Corporation, Consumer Federation of America, Natural Resources Defense Council, Northwest Energy Efficiency Alliance, Rheem Manufacturing Company.	Joint Stakeholders	49	Efficiency Organizations, Manufacturers, Consumer Advocacy Organization.
Air-Conditioning, Heating and Refrigeration Institute	AHRI	20, 31, 42	Trade Association.
Anonymous	Anonymous	19	Individual.
Atmos Energy Corporation	Atmos	27, 38	Utility.
Bradford White Corporation	BWC	32	Manufacturer.
California Investor-Owned Utilities (Pacific Gas and Electric Company, Southern California Edison, San Diego Gas & Electric Company).	CA IOUs	31, 39, 52	Utility Association.
Center for Energy and Environment	CEE	50	Efficiency Organization.
Benjamin Cirker	Cirker	30	Individual.
Edison Electric Institute	EEI	31, 43	Utility Association.
The American Gas Association, American Public Gas Association, National Propane Gas Association, Spire Inc., Spire Missouri Inc., and Spire Alabama Inc..	Gas Association Commenters.	26, 41, 54	Utility Association.
GE Appliances	GEA	46	Manufacturer.
Gas End-Use Advocacy Group	GEAG	36	Utility Association.
Appliance Standards Awareness Project, American Council for an Energy-Efficient Economy, California Energy Commission, Consumer Federation of America, National Consumer Law Center, Natural Resources Defense Council and Northeast Energy Efficiency Partnerships.	Joint Advocates	34	Efficiency Organization.
Northwest Energy Efficiency Alliance, American Council for an Energy-Efficient Economy, Northwest Power and Conservation Council.	NEEA, ACEEE, and NWPCC.	47	Efficiency Organization.
Northwest Energy Efficiency Alliance	NEEA	31	Efficiency Organization.
Natural Resources Defense Council and Rocky Mountain Institute	NRDC and RMI	37	Efficiency Organization.
National Rural Electric Cooperative Association	NRECA	33	Utility Association.
New York State Energy Research and Development Authority	NYSERDA	35, 51	Efficiency Organization.
ONE Gas Inc	ONE Gas	28, 44	Utility.
Plumbing-Heating-Cooling Contractors Association	PHCC	40	Trade Association.
Rheem Manufacturing Company	Rheem	45	Manufacturer.
Rinnai America Corporation	Rinnai	55	Manufacturer.
Southern Company	Southern Company	31	Manufacturer.
Southwest Energy Efficiency Project	SWEEP	53	Efficiency Organization.
Eriks Mota Vasquez	Vasquez	17	Individual.

*Comment No. 31 denotes comments recorded in the transcript of the public meeting held on April 12, 2022.

A parenthetical reference at the end of a comment quotation or paraphrase provides the location of the item in the public record.[15] To the extent that interested parties have provided written comments that are substantively consistent with any oral comments provided during the April 12, 2022 public meeting, DOE cites the written comments throughout this final rule. Any oral comments provided during the webinar that are not substantively addressed by written comments are summarized and cited separately throughout this final rule.

C. Deviation From Appendix A

In accordance with section 3(a) of 10 CFR part 430, subpart C, appendix A (''appendix A''), DOE has deviated from the provision in appendix A regarding the pre-NOPR stages for an energy conservation standards rulemaking (specifically, the publication of a framework document). As initially discussed in the March 2022 Preliminary Analysis, DOE opted to deviate from this step by publishing a preliminary analysis without a framework document. A framework document is intended to introduce and summarize the various analyses DOE conducts during the rulemaking process and requests initial feedback from interested parties. Prior to the notification of the preliminary analysis DOE published an RFI in which DOE identified and sought comment on the analyses conducted in support of the most recent energy conservation standards rulemakings for water heaters. 87 FR 11327, 11330.

For this NOPR, DOE further notes that it is deviating from the provision in appendix A regarding the NOPR stage for an energy conservation standards rulemaking. Section 6(f)(2) of appendix A specifies that the length of the public comment period for a NOPR will be not less than 75 calendar. For this NOPR, DOE has opted instead to provide a 60-day comment period. DOE is opting to deviate from the 75-day comment period because stakeholders have already been afforded multiple opportunities to provide comments on this rulemaking. As noted previously, DOE requested comment on its planned technical and economic analyses in the May 2020 RFI and provided stakeholders with a 45-day comment period. 85 FR 30853. Additionally, DOE initially provided a 60-day comment period for stakeholders to provide input on the analyses presented in the preliminary TSD. 87 FR 11327. Subsequently, in response to requests from stakeholders, DOE re-opened the comment period for an additional 14 days to provide additional time for stakeholders to provide input on the preliminary analysis. 87 FR 26303 (May 4, 2022). The analytical assumptions and approaches used for the analyses conducted for this NOPR are similar to those used for the preliminary analysis. Therefore, DOE believes a 60-day comment period is appropriate and will provide interested parties with a meaningful opportunity to comment on the proposed rule.

Section 8(d)(1) of appendix A requires that new or amended test procedures

[15] The parenthetical reference provides a reference for information located in the docket of DOE's rulemaking to develop energy conservation standards for consumer water heaters. (Docket No. EERE–2017–BT–STD–0019, which is maintained at *www.regulations.gov*). The references are arranged as follows: (commenter name, comment docket ID number, page of that document).

which impact measured energy use or efficiency are finalized at least 180 days prior to the close of comment period for a NOPR proposing new or amended energy conservation standards. However, in a final rule published on December 13, 2021, discussing the provisions of appendix A, DOE noted that this 180-day period may not always be necessary. 86 FR 70892, 70896. The comment period for this NOPR will close on September 26, 2023, which is X days after the date of finalization of the most recent consumer and residential-duty commercial water heaters test procedure final rule, June 21, 2023 (this test procedure final rule is discussed in section III.B of this document). As described in that test procedure final rule, the amendments adopted therein will not alter the measured efficiency of consumer water heaters, or require retesting or recertification solely as a result of DOE's adoption of the amendments to the test procedures. 88 FR 40406, 40412. As such, the test provisions required by the most recent test procedure final rule are expected to be generally understood by stakeholders and would not impact the analysis of this standards rulemaking.

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 provides a general overview of the approach taken to develop this proposal, with specific discussion of the methodology and comments received in section IV of this document.

A. Scope of Coverage

This NOPR covers those consumer products that meet the definition of ''water heater,'' as codified at 10 CFR 430.2 and as described by EPCA at 42 U.S.C. 6291(27).

Generally, DOE defines a ''water heater,'' consistent with EPCA's definition, as a product which utilizes oil, gas, or electricity to heat potable water for use outside the heater upon demand, including:

(a) Storage type units which heat and store water at a thermostatically controlled temperature, including gas storage water heaters with an input of 75,000 Btu per hour or less, oil storage water heaters with an input of 105,000 Btu per hour or less, and electric storage water heaters with an input of 12 kilowatts or less;

(b) Instantaneous type units which heat water but contain no more than one gallon of water per 4,000 Btu per hour of input, including gas instantaneous water heaters with an input of 200,000 Btu per hour or less, oil instantaneous water heaters with an input of 210,000 Btu per hour or less, and electric instantaneous water heaters with an input of 12 kilowatts or less; and

(c) Heat pump type units, with a maximum current rating of 24 amperes at a voltage no greater than 250 volts, which are products designed to transfer thermal energy from one temperature level to a higher temperature level for the purpose of heating water, including all ancillary equipment such as fans, storage tanks, pumps, or controls necessary for the device to perform its function.

10 CFR 430.2; (42 U.S.C. 6291(27))

In addition, at 10 CFR 430.2, DOE further defines several specific categories of consumer water heaters, as follows:

- ''Electric instantaneous water heater'' means a water heater that uses electricity as the energy source, has a nameplate input rating of 12 kW or less, and contains no more than one gallon of water per 4,000 Btu per hour of input.
- ''Electric storage water heater'' means a water heater that uses electricity as the energy source, has a nameplate input rating of 12 kW or less, and contains more than one gallon of water per 4,000 Btu per hour of input.
- ''Gas-fired instantaneous water heater'' means a water heater that uses gas as the main energy source, has a nameplate input rating less than 200,000 Btu per hour, and contains no more than one gallon of water per 4,000 Btu per hour of input.
- ''Gas-fired storage water heater'' means a water heater that uses gas as the main energy source, has a nameplate input rating of 75,000 Btu per hour or less, and contains more than one gallon of water per 4,000 Btu per hour of input.
- ''Grid-enabled water heater'' means an electric resistance water heater that—
  - Has a rated storage tank volume of more than 75 gallons;
  - Is manufactured on or after April 16, 2015;
  - Is equipped at the point of manufacture with an activation lock; and
  - Bears a permanent label applied by the manufacturer that—
    - Is made of material not adversely affected by water;
    - Is attached by means of non-water-soluble adhesive; and
    - Advises purchasers and end-users of the intended and appropriate use of the product with the following notice printed in 16.5 point Arial Narrow Bold font: ''IMPORTANT INFORMATION: This water heater is intended only for use as part of an electric thermal storage or demand response program. It will not provide adequate hot water unless enrolled in such a program and activated by your utility company or another program operator. Confirm the availability of a program in your local area before purchasing or installing this product.''
- ''Oil-fired instantaneous water heater'' means a water heater that uses oil as the main energy source, has a nameplate input rating of 210,000 Btu/h or less, and contains no more than one gallon of water per 4,000 Btu per hour of input.
- ''Oil-fired storage water heater'' means a water heater that uses oil as the main energy source, has a nameplate input rating of 105,000 Btu/h or less, and contains more than one gallon of water per 4,000 Btu per hour of input.

In the June 2023 Test Procedure Final Rule, DOE amended 10 CFR 430.2 (effective on July 21, 2023), adding the following definitions for circulating, low-temperature, and tabletop water heaters:

- ''Circulating water heater'' means an instantaneous or heat pump-type water heater that does not have an operational scheme in which the burner, heating element, or compressor initiates and/or terminates heating based on sensing flow; has a water temperature sensor located at the inlet or the outlet of the water heater or in a separate storage tank that is the primary means of initiating and terminating heating; and must be used in combination with a recirculating pump and either a separate storage tank or water circulation loop in order to achieve the water flow and temperature conditions recommended in the manufacturer's installation and operation instructions.
- ''Low-temperature water heater'' means an electric instantaneous water heater that is not a circulating water heater and cannot deliver water at a temperature greater than or equal to the set point temperature specified in section 2.5 of appendix E to subpart B of this part when supplied with water at the supply water temperature specified in section 2.3 of appendix E to subpart B of part 430 and the flow rate specified in section 5.2.2.1 of appendix E to subpart B of part 430.
- ''Tabletop water heater'' means a water heater in a rectangular box enclosure designed to slide into a kitchen countertop space with typical dimensions of 36 inches high, 25 inches deep, and 24 inches wide.

As stated in section I of this NOPR, EPCA prescribed energy conservation standards for all consumer water heaters (*i.e.,* those that meet the definition of ''water heater'' above). For the purposes of this NOPR, DOE is considering all consumer water heaters, as defined by EPCA. This includes consumer water heaters for which there are no current UEF-based standards codified at 10 CFR 430.32(d).

However, during this rulemaking, DOE has received inquiries from interested parties regarding the coverage, under current energy conservation standards, of hot water dispensing products. These products are generally used for food preparation (*e.g.,* brewing tea) and are installed in place of portable kettles. A small water-heating tank is connected to a sink's cold water supply to heat the water up to near-boiling temperatures. The hot water is piped out of the tank through a separate hot water faucet[16] specifically for use with this product. These products have very limited storage volume—often less than one gallon. All of the models that DOE has identified are all electric and run on less than 2 kilowatts of power. Note that these products are not to be confused with low-temperature electric instantaneous water heaters or point-of-use electric storage water heaters, both of which generally provide temperatures near or below 125 °F, the nominal delivery temperature in the appendix E test procedure that corresponds to normal household hot water temperatures for washing applications. Hot water dispensing products provide water at scalding-hot temperatures such as 160 °F to 210 °F.

DOE does not currently have energy conservation standards that cover hot water dispensing products and DOE's test procedure is not representative of an average use cycle for these products. Hot water dispensing products operate in a unique manner compared to the other consumer water heaters such as much higher temperatures, have smaller storage capacities, and can provide hot potable water at lower flow rates than typical consumer electric water heaters. While DOE has the authority to set standards for products that meet the definition of a consumer water heater (42 U.S.C. 6292(a)(4)), this rulemaking is not currently considering standards for hot water dispensing products.

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

[16] ''Low-pressure water dispenser'' means a terminal fitting that dispenses drinking water at a pressure of 105 kPA (15 psi) or less. (10 CFR 430.2) Low-pressure water dispensers operate at lower water pressures than conventional kitchen faucets (by definition) and are used for the purpose of gently filling a relatively small vessel (*e.g.,* a glass).

B. Test Procedure

EPCA sets forth generally applicable criteria and procedures for DOE's adoption and amendment of test procedures. (42 U.S.C. 6293) Manufacturers of covered products must use these test procedures to certify to DOE that their product complies with energy conservation standards and to quantify the efficiency of their product. DOE's current energy conservation standards for consumer water heaters are expressed in terms of UEF. (*See* 10 CFR 430.32(d)).

DOE recently amended the test procedure for these products at appendix E to subpart B of 10 CFR 430 in the consumer and residential-duty commercial water heater test procedure final rule published on June 21, 2023 (''June 2023 TP Final Rule'') pursuant to the 7-year review requirement as specified by EPCA. (42 U.S.C. 6293(b)(1)(A) and 42 U.S.C. 6314(a)(1)(A)) In the June 2023 TP Final Rule, DOE added definitions and where necessary additional test procedure provisions for circulating water heaters, low-temperature water heaters, and tabletop water heaters, as well as provisions for high temperature testing. DOE also established effective storage volume as a metric and provided additional optional ambient test conditions for heat pump water heaters. The test procedure for consumer water heaters incorporates by reference current versions of industry standards ASHRAE 41.1, ASHRAE 41.6, ASHRAE 118.2, ASTM D2156, and ASTM E97 and harmonizes various aspects of the test procedure with industry test procedures ASHRAE 118.2–2022 and NEEA Advanced Water Heating Specification v8.0. The effective date of the June 2023 TP Final Rule is July 21, 2023, 30 days after the date of its publication in the **Federal Register.** Changes to the test procedure made by the June 2023 TP Final Rule are mandatory for consumer water heater testing starting December 18, 2023, 180 days after publication. Subsequent references in this NOPR to the ''appendix E test procedure'' refer to the test procedure which will go in effect on July 21, 2023.

DOE received comments in response to the March 2022 Preliminary Analysis regarding the consumer water heater test procedure that were relevant to the test procedure rulemaking.

Cirker provided comments suggesting that, based on personal in-home monitoring of three heat pump water heaters, different designs exhibit different performance (*i.e.,* delivery temperature, delivery capacity, and energy consumption) under winter conditions, when the consumer uses a higher setpoint temperature, has a lower ambient temperature, and a lower supply water temperature. Cirker suggested that DOE include a method to determine the efficiency and first hour rating of heat pump water heaters under cold climate conditions. (Cirker, No. 30 at pp. 1–2)

In the June 2023 TP Final Rule, DOE adopted additional test conditions—including those simulating cold climates—for manufacturers to be able to make voluntary optional representations for heat pump water heaters. 88 FR 40406.

NYSERDA commented that rated storage volume is no longer an appropriate representation of the capacity of a storage water heater volume due to the use of mixing valves and higher tank temperatures, suggesting that first hour rating (''FHR'') be used instead. (NYSERDA, No. 35 at p. 6) DOE agreed that increasing the temperature of the water stored in a water heater above the nominal delivery temperature is a way to increase the capacity of the water heater, as the hotter water can be tempered with cool water using a mixing valve to provide a larger volume of hot water than when the water is stored at the relatively cooler nominal temperature. For water heaters that are capable of storing water at such an elevated temperature, the effective storage volume metric represents a measure of the true storage capacity of the water heater based on the maximum temperature at which it can store water, as compared to storing water at the nominal temperature of 125 degrees Fahrenheit (''°F'') specified in appendix E. DOE agreed, therefore, that rated storage volume alone is not an adequate representation of the storage capacity of water heaters that are capable of heating and storing water at high temperatures (*i.e.,* at a temperature well above the typical setpoint temperature of 125 °F), and established effective storage volume to better represent the storage capacity of such water heaters in the June 2023 TP Final Rule. 88 FR 40406. DOE specified in appendix E that effective storage volume is determined by multiplying the measured storage volume by a scaling factor which represents the ratio of the thermal energy stored in the tank when at its maximum storage temperature as compared to the thermal energy stored in the tank when at the nominal temperature of 125 °F. *Id.*

The appendix E test procedure, as amended by the June 2023 TP Final Rule, does not require water heaters to test in the highest heat mode (*i.e.,* the high temperature test method). In the June 2023 TP Final Rule, DOE deferred the implementation of high temperature testing provisions to this energy conservation standards rulemaking. 88 FR 40406, 40448.

DOE further agrees with NYSERDA that storage volume is not an adequate representation of the storage capacity of water heaters that are capable of heating and storing water at high temperatures (*i.e.,* at a temperature well above the typical setpoint temperature of 125 °F). In the June 2023 TP Final Rule, DOE established effective storage volume as a metric to better represent the storage capacity of such water heaters. 88 FR 40406. Consequently, DOE is now addressing the implementation of effective storage volume provisions in this NOPR. In this NOPR, DOE is proposing that high temperature test provisions be required for electric storage water heaters that have a permanent (*i.e.,* non-temporary) mode or setting to heat and store water above 135 °F and that do not meet the definition of ''heat pump-type'' water heater (*i.e.,* this proposal applies to storage water heaters utilizing only electric resistance technology). Further, these provisions would not apply to water heaters that either store water at an elevated temperature only for a temporary period or to water heaters that are capable of storing at elevated temperatures only in response to instructions from a utility or third-party demand response program. DOE expects that, especially in the case of small electric storage water heaters, these products will be installed at an elevated temperature setpoint with a mixing valve in order to match the performance of larger water heaters. The high temperature test provisions are therefore expected to be representative of the average use cycle of electric resistance water heaters.

DOE's proposal is detailed further in section V.C.1 of this document.

BWC commented in response to the March 2022 Preliminary Analysis regarding product classes for products that do not currently have UEF-based standards, stating that DOE refrain from considering them until the test procedure rulemaking is finalized and DOE determines whether these product classes will be necessary. BWC also noted that a study of the simulated use test completed by Davis Energy Group, Inc. suggests that EF ratings for instantaneous gas-fired water heaters are inflated in comparison to those for gas-fired storage water heaters. BWC acknowledged that this effect should be smaller for UEF ratings, but still urged DOE to consider its potential impact. (BWC, No. 32 at p. 6)

In response to BWC, DOE disagrees that its test procedure provides an unfair advantage to gas-fired instantaneous models over gas-fired storage models. DOE's 24-hour simulated use test, as defined at appendix E, is designed to emulate typical in-field usage patterns for consumer water heaters and includes periods of standby during which no water is being withdrawn from the water heater. Storage water heaters maintain a significant volume of stored water, which loses heat to the cooler surrounding air. This results in the water heater consuming energy to heat the stored water to offset these standby losses, in addition to the energy required to heat the water from the supply water temperature to the setpoint temperature. By contrast, because instantaneous-type water heaters do not typically maintain a significant volume of stored water, the standby losses they experience are generally much lower and do not require additional energy to offset. Instantaneous-type water heaters may therefore achieve higher UEF ratings compared to storage-type water heaters. However, DOE reiterates that this difference in efficiency is not a result of an unfair test procedure, but rather a result of the differences in design between gas-fired storage and gas-fired instantaneous water heaters and is indeed representative of an average use cycle or period of use. See section IV.A.1 of this document for discussion regarding whether storage-type and instantaneous-type product classes should be combined together under uniform standards.

The June 2023 TP Final Rule additionally expanded coverage of the appendix E test procedure to additional consumer water heaters under the scope of coverage of standards. As discussed in that final rule, DOE revised the test procedure to provide additional instructions for testing circulating water heaters and low-temperature water heaters for UEF. 88 FR 40406. A circulating water heater is defined at 10 CFR 430.2 as an instantaneous or heat pump-type water heater that does not have an operational scheme in which the burner, heating element, or compressor initiates and/or terminates heating based on sensing flow; has a water temperature sensor located at the inlet or the outlet of the water heater or in a separate storage tank that is the primary means of initiating and terminating heating; and must be used in combination with a recirculating pump and either a separate storage tank or water circulation loop in order to achieve the water flow and temperature conditions recommended in the manufacturer's installation and operation instructions. A low-temperature water heater is defined at 10 CFR 430.2 as an electric instantaneous water heater that is not a circulating water heater and cannot deliver water at a temperature greater than or equal to the set point temperature specified in section 2.5 of appendix E when supplied with water at the supply water temperature specified in section 2.3 of appendix E and the flow rate specified in section 5.2.2.1 of appendix E.

Treatment of circulating water heaters and low temperature water heaters as potential product classes is discussed in section IV.A.1.a of this document.

In response to the March 2022 Preliminary Analysis, Rinnai provided comments indicating that gas-fired instantaneous water heaters with integrated recirculating pumps may have an additional benefit to water conservation. (Rinnai, No. 55 at pp. 1–2) However, while DOE may consider the energy use associated with increased or decreased water use, DOE does not have the authority to establish water conservation standards for circulating water heaters or instantaneous water heaters. (*See* 42 U.S.C. 6291(6))

C. Technological Feasibility

1. General

In each energy conservation standards rulemaking, DOE conducts a screening analysis based on information gathered on all current technology options and prototype designs that could improve the efficiency of the products or equipment that are the subject of the rulemaking. As the first step in such an analysis, DOE develops a list of technology options for consideration in consultation with manufacturers, design engineers, and other interested parties. DOE then determines which of those means for improving efficiency are technologically feasible. DOE considers technologies incorporated in commercially-available products or in working prototypes to be technologically feasible. Sections 6(b)(3)(i) and 7(b)(1) of appendix A to 10 CFR part 430 subpart C.

After DOE has determined that particular technology options are technologically feasible, it further evaluates each technology option in light of the following additional screening criteria: (1) practicability to manufacture, install, and service; (2) adverse impacts on product utility or availability; (3) adverse impacts on health or safety; and (4) unique-pathway proprietary technologies. Sections 6(b)(3)(ii)–(v) and 7(b)(2)–(5) of appendix A. Section IV.B of this document discusses the results of the screening analysis for consumer water heaters, 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 consumer water heaters using the design parameters for the most efficient products available on the market or in working prototypes. The max-tech levels that DOE determined for this rulemaking are described in section IV.C.1.a of this proposed rule and in chapter 5 of the NOPR TSD.

D. Energy Savings

1. Determination of Savings

For each trial standard level (''TSL''), DOE projected energy savings from application of the TSL to consumer water heaters purchased in the 30-year period that begins in the year of compliance with the proposed standards (2030–2059).[17] The savings are measured over the entire lifetime of consumer water heaters 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'') from potential amended or new standards for consumer water heaters. The NIA spreadsheet model (described in section IV.H of this document) calculates energy savings in terms of site energy, which is the energy directly consumed by products at the locations where they are used. For electricity, DOE reports national energy savings in terms of primary energy savings, which is the savings in the energy that is used to generate and transmit the site electricity. For natural gas, the primary energy savings are considered to be equal to the site energy savings. DOE also calculates NES in terms of FFC energy savings. The FFC metric includes the energy consumed in extracting, processing, and transporting primary fuels (*i.e.,* coal, natural gas, petroleum fuels), and thus presents a more complete picture of the impacts of energy conservation standards.[18] 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.1 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.[19] For example, some covered products and equipment have most of their energy consumption occur during periods of peak energy demand. The impacts of these products on the energy infrastructure can be more pronounced than products with relatively constant demand. Accordingly, DOE evaluates the significance of energy savings on a case-by-case basis, taking into account the significance of cumulative FFC national energy savings, the cumulative FFC emissions reductions, and the need to confront the global climate crisis, among other factors. 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).

E. Economic Justification

1. Specific Criteria

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

An anonymous commenter indicated that the benefits of making water heaters more energy-efficient would likely outweigh the costs. The commenter stated that many households have either

[17] 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.

[18] 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).

[19] 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, 70906).

very old water heaters or water heaters that consume a significant amount of energy, and that energy conservation standards can be helpful in guiding customer choices. (Anonymous, No. 19)

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

d. Lessening of Utility or Performance of Products

In establishing product classes and in evaluating design options and the impact of potential standard levels, DOE evaluates potential standards that would not lessen the utility or performance of the considered products. (42 U.S.C. 6295(o)(2)(B)(i)(IV)) Based on data available to DOE, the standards proposed in this document would not reduce the utility or performance of the products under consideration in this rulemaking.

e. Impact of Any Lessening of Competition

EPCA directs DOE to consider the impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from a proposed standard. (42 U.S.C. 6295(o)(2)(B)(i)(V)) EPCA 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 (''GHGs'') associated with energy production and use. DOE conducts an emissions analysis to estimate how potential standards may affect these emissions, as discussed in section IV.K of this document; the estimated emissions impacts are reported in section V.X of this document. DOE also estimates the economic value of emissions reductions resulting from the considered TSLs, as discussed in section IV.L of this document.

g. Other Factors

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

2. Rebuttable Presumption

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

F. Interested Party Recommendations

As discussed in section II.B.2 of this document, DOE received a Joint Stakeholder Recommendation for amended standards pertaining to electric storage water heaters, gas-fired storage water heaters, and gas-fired instantaneous water heaters. Specifically, the Joint Stakeholder Recommendation recommended that DOE adopt the standards shown in Table III.1 through Table III.3. (Joint Stakeholders, No. 49 at pp. 9–10)

TABLE III.1—JOINT STAKEHOLDER RECOMMENDATION LEVELS FOR ELECTRIC STORAGE WATER HEATERS

<table>
<tr><th rowspan="2">Draw pattern</th><th rowspan="2">First hour rating (FHR)</th><th colspan="4">DOE rated storage volume</th></tr>
<tr><th>≥20 to ≤30 gallons</th><th>>30 to ≤35 gallons</th><th>>35 to ≤55 gallons</th><th>>55 to 120 gallons</th></tr>
<tr><td rowspan="2">Low</td><td rowspan="2">≥18 to <51 gallons</td><td rowspan="2">Current Standard*</td><td>Height ≤36 inches: Current Standard*</td><td rowspan="4">2.3 UEF</td><td rowspan="4">2.5 UEF</td></tr>
<tr><td>Height >36 inches: 2.0 UEF.</td></tr>
<tr><td>Medium</td><td>≥51 to <75 gallons</td><td rowspan="2">2.0 UEF</td><td rowspan="2">2.0 UEF.</td></tr>
<tr><td>High</td><td>≥75 gallons.</td></tr>
</table>

* Current Standard: UEF = 0.9254 − 0.0003 × V_r, where V_r is the DOE rated storage volume.

TABLE III.2—JOINT RECOMMENDATION RECOMMENDED LEVELS FOR GAS-FIRED STORAGE WATER HEATERS

Draw pattern	First hour rating (FHR)	DOE rated storage volume ≥20 to ≤55 gallons
Low	≥18 to <51 gallons	UEF = 0.6451 − 0.0019 * V_r
Medium	≥51 to <75 gallons	UEF = 0.7046 − 0.0017 * V_r
High	≥75 gallons	UEF = 0.7424 − 0.0013 * V_r

Note: V_r = DOE rated storage volume. These recommended levels are for gas-fired storage water heaters including standard, low NO_X, and ultra-low NO_X burners. The levels shown are equivalent to DOE's preliminary TSD Efficiency Level 2 (EL2).

TABLE III.3—JOINT RECOMMENDATION RECOMMENDED LEVELS FOR GAS-FIRED INSTANTANEOUS WATER HEATERS

Draw pattern	Recommended efficiency level
Medium	0.91 UEF
High	0.93 UEF

Note: These recommended levels are for gas-fired instantaneous water heaters with a DOE rated storage volume of <2 gallons and an input rating of >50,000 BTU per hour. The levels shown are equivalent to DOE's preliminary TSD Efficiency Level 2 (EL2).

In support of the recommended levels, the Joint Stakeholders stated that, if adopted, the recommendation would transition the majority of electric water heaters to heat pump technology and make incremental steps to improve gas-fired water heater efficiency. The Joint Stakeholders also stated that the recommended levels would provide significant reductions in national water heating energy use and their associated greenhouse gas emissions, save consumers money on their utility bills, provide manufacturers more business certainty with room to innovate, and offer manufacturers, consumers, and professional installers flexibility for certain applications where heat pump technology is not currently a viable replacement option. (Joint Stakeholders, No. 49 at p. 1 and pp. 5–6)

DOE has included an analysis of the benefits and burdens of the Joint Stakeholder Recommendation as part of its analyses of amended energy conservation standards for this NOPR. The Joint Stakeholder Recommendation is discussed in further detail, as applicable, throughout section IV of this document. Following the submission by the Joint Stakeholders, three other commenters, SWEEP, CEE and NYSERDA, submitted comments in support of the efficiency level proposals recommended by the Joint Stakeholders. (SWEEP, No. 53 at p. 1; CEE, No. 50 at p. 1; NYSERDA, No. 51 at pp. 1–2)

The CA IOUs provided a recommendation similar to the Joint Stakeholder Recommendation, suggesting that all electric storage water heaters between 20 and 120 gallons in rated storage volume would have to meet heat pump standards roughly equivalent to Efficiency Level (''EL'') 2 analyzed in the March 2022 Preliminary Analysis, except for products 20–30 gallons in the low draw pattern (based on FHR). The CA IOUs justified their recommendation by stating that it sought to maximize the share of the future residential water heater market that will be high-efficiency, while allowing less-efficient products to fill applications that are challenging for currently available heat pump water heaters. (CA IOUs, No. 52 at p. 6–7) The CA IOUs' recommendation is shown in Table III.4.

TABLE III.4—CA IOUS RECOMMENDED LEVELS FOR ELECTRIC STORAGE WATER HEATERS

Draw pattern	First hour rating (FHR)	Rated storage volume	
		≥20 to ≤30 gallons	>30 to ≤120 gallons
Low	≥18 to <51 gallons	0.93 UEF	3.30 UEF
Medium	≥51 to <75 gallons	3.35 UEF	
High	≥75 gallons	3.47 UEF	

The Gas Association Commenters submitted a request for DOE to follow the normal notice and comment procedure for proposing standards prior to a final rule, rather than promulgating a direct final rule in response to the Joint Stakeholder Recommendation and the CA IOUs recommendation. The Gas Association Commenters suggested that DOE publish an advance notice of proposed rulemaking (''ANOPR'') prior to a NOPR in order to solicit feedback. The Gas Association Commenters also argued that DOE does not have the grounds for utilizing the direct final rule process based on the provisions in EPCA and relevant precedent. (Gas Association Commenters, No. 54 at pp. 2–3)

To this, DOE notes that it is proposing standards for consumer water heaters and seeking public comment. As for issuing an ANOPR to solicit feedback, DOE has already solicited public comment through the May 2020 RFI and the March 2022 Preliminary Analysis. Further, the March 2022 Preliminary Analysis details the analytical methods and preliminary results DOE has used in this NOPR. As such, DOE does not believe an ANOPR is necessary or appropriate.

NYSERDA agreed with DOE's analysis that supports heat pump water heater (''HPWH'') technology. NYSERDA noted that the HPWH market has seen significant improvement in cost and efficiency in the last decade, and they are pleased to see this reflected through DOE's analysis as part of this rulemaking. (NYSERDA, No. 35 at p.2) NYSERDA also recommended that all products use condensing and heat pump technology as justified and appropriate based on DOE's final analysis. (NYSERDA, No. 35 at p. 6) In response, DOE notes that most energy conservation standard levels proposed for electric storage water heaters in this NOPR effectively require the use of heat pump technology. However, DOE cannot and does not establish standards to explicitly require certain technologies. All standards proposed by DOE must be both technologically feasible and economically justified, and the standards proposed in this NOPR are consistent with that requirement.

Rheem urged DOE to propose and then finalize an EL for gas-fired storage water heaters that requires electricity and is achievable with a Category I venting solution to moderate the installation costs associated with this rulemaking, as well as the next, in anticipation of future electrification efforts. Rheem argued that doing so would ensure that 120 V electrical power already exists at the water heater for the next replacement and provide consumers with the option of choosing a drop-in 120 V heat pump water heater replacement or high efficiency condensing water heater. (Rheem, No. 45 at p. 4) In addition, Rheem stated that it did not recommend amending the standard for gas-fired instantaneous water heaters to EL 3. (Rheem, No. 45 at p. 7) Rinnai recommended that gas-fired storage water heater standards be set at 0.80 UEF [20] because this efficiency level appears to be feasible and could result in significant energy savings because gas-fired storage water heaters may comprise 42 percent of the overall market. Rinnai stated that EL 2 would continue to allow lower efficiency products to be used in the market. (Rinnai, No. 55 at p. 1)

After weighing the benefits and burdens of various potential standard levels, DOE is proposing to amend the standards to those in trial standard level 2, which consists of efficiency level 2 for both gas-fired storage water heaters and gas-fired instantaneous water heaters. Additional discussion of DOE's rationale is discussed in section V.C of this document.

One Gas and the Gas Association Commenters strongly endorse use of non-regulatory alternatives as a means for addressing energy efficiency and greenhouse gas emissions from gas-fired consumer appliances such as the current review of ENERGY STAR for consumer water heaters. One Gas also recognizes that the non-regulatory alternatives available to the Department provide it with the most efficient and effective means of addressing most market failure causes, such as purchase decisions not being made available to consumers inhabiting a dwelling. (ONE Gas, No. 44 at p. 8; Gas Association Commenters, No. 41, attachment 6, at p. 11) A full discussion of the non-regulatory alternatives considered by DOE is presented in chapter 17 of the TSD for this proposed rule. DOE is required to establish amended energy conservation standards for consumer water heaters if an amended standard would result in significant conservation of energy and would be both technologically feasible and economically justified.

BWC strongly discourages DOE from considering regional standards or specifications as part of their analysis. While these are employed in certain parts of the U.S., they encompass non-energy efficiency related elements but do not account for all product types or approach things from a national perspective. (BWC, No.32 at p.6) DOE is not proposing any regional standards in this NOPR.

IV. Methodology and Discussion of Related Comments

This section addresses the analyses DOE has performed for this rulemaking with regard to consumer water heaters. Separate paragraphs 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

[20] In the March 2022 Preliminary Analysis, 0.80 was the UEF value for EL 4 for a representative 48-gallon gas-fired storage water heater in the high draw pattern.

are available on the DOE website for this proposed rulemaking: *www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=32*. Additionally, DOE used output from the latest version of the Energy Information Administration's (''EIA's'') *Annual Energy Outlook* (''*AEO*''), a widely known energy projection for the United States, for the emissions and utility impact analyses.

A. Market and Technology Assessment

DOE develops information in the market and technology assessment that provides an overall picture of the market for the products concerned, including the purpose of the products, the industry structure, manufacturers, market characteristics, and technologies used in the products. This activity includes both quantitative and qualitative assessments, based primarily on publicly-available information. The subjects addressed in the market and technology assessment for this rulemaking include (1) a determination of the scope of the rulemaking and product classes, (2) manufacturers and industry structure, (3) existing efficiency programs, (4) shipments information, (5) market and industry trends; and (6) technologies or design options that could improve the energy efficiency of consumer water heaters. 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.

In the preliminary analysis, DOE sought comment on whether the manufacturer model counts from publicly available databases accurately reflect manufacturer market shares on a model- or sales-weighted basis. In response, AHRI and Rheem indicated that manufacturer model counts in publicly available databases do not accurately reflect manufacturer market shares. (AHRI, No. 31 at p. 16; Rheem, No. 45 at pp. 3–4) AHRI commented that the model count in a certification directory does not reflect sales volume and will provide an inaccurate view of the market. AHRI added that a manufacturer with a large number of models does not necessarily have a larger market share compared to a manufacturer with a smaller number of models. (AHRI, No. 42 at p. 2) DOE agrees with these comments and therefore did not consider database model counts alone to be representative of manufacturer market share in this NOPR's analyses. DOE considered market research [21] as well as market share feedback from confidential interviews with manufacturers to determine more accurate values. Additional details can be found in chapter 3 of the TSD.

During a public meeting held on April 12, 2022, related to this rulemaking, NEEA noted that UEF ratings have increased over the last decade in products ranging from 40 to 80 gallons. (NEEA, No. 31, p. 7–8) DOE agrees that UEF ratings have generally increased over the last decade, and the latest efficiency distribution data were used to inform this NOPR analysis.

1. Product Classes

When evaluating and establishing energy conservation standards, DOE shall 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 the group of covered products has a capacity or other performance-related feature that other products do not have and such feature justifies a different standard. (42 U.S.C. 6295(q)) In making a determination whether a performance-related feature justifies a different standard, DOE must consider such factors as the utility of the feature to the consumer and other factors DOE determines are appropriate. (*Id.*)

EPCA, as amended by the National Appliance Energy Act (NAECA; Pub. L. 100–12), established initial energy conservation standards, expressed as EF, that were based on three product classes differentiated by fuel type: (1) gas-fired, (2) oil-fired, and (3) electric. (42 U.S.C. 6295(e)(1)) These standards applied to consumer water heaters manufactured on or after January 1, 1990.

DOE subsequently amended these EF standards twice, most recently in the April 2010 Final Rule. 75 FR 20112. In the April 2010 Final Rule, DOE further divided consumer water heaters into product classes based on fuel type (gas-fired, oil-fired, or electric), product type (storage, instantaneous, tabletop), storage volume, and input rate.

The Energy Efficiency Improvement Act of 2015 (''EEIA 2015'') (Pub. L. 114–11), enacted on April 30, 2015, added a definition of ''grid-enabled water heater'' and a standard in terms of EF for such products to EPCA's energy conservation standards. (42 U.S.C. 6295(e)(6)(A)(ii)) DOE codified the definition for grid-enabled water heater and the associated energy conservation standards in a final rule published on August 11, 2015. 80 FR 48004.

Most recently, the December 2016 Conversion Factor Final Rule translated the EF-based standards to UEF-based standards for certain classes of consumer water heaters, which are shown in Table IV.1. Although the classes of consumer water heaters with UEF-based standards have limitations on the stored volume and (if applicable) fuel input rate, as discussed in that final rule, the standards established in EPCA do not place any limitation on the storage volume of consumer water heaters and do not define a minimum fuel input rate for gas-fired instantaneous water heaters. Therefore, the original standards established by EPCA in terms of EF remain applicable to all products without UEF-based standards. 81 FR 96204, 96209–96211.

The 36 product classes for which DOE has currently established UEF-based standards are summarized in Table IV.1. The product classes without UEF-based standards, for which EF-based standards from EPCA apply, are shown in Table IV.2.

TABLE IV.1—CONSUMER WATER HEATER PRODUCT CLASSES WITH CURRENT UEF-BASED STANDARDS

Product type	Rated storage volume and input rating (if applicable)	Draw patterns
Gas-Fired Storage Water Heater	≥20 gal and ≤55 gal	Very Small, Low, Medium, High.
Gas-Fired Storage Water Heater	>55 gal and ≤100 gal	Very Small, Low, Medium, High.
Oil-Fired Storage Water Heater	≤50 gal	Very Small, Low, Medium, High.
Electric Storage Water Heater	≥20 gal and ≤55 gal	Very Small Low, Medium, High.
Electric Storage Water Heater	>55 gal and ≤120 gal	Very Small, Low, Medium, High.

[21] Market shares data were found from Statista report *Residential water heater market share by vendor in the United States from 2018 to 2021,* available online at: *www.statista.com/statistics/700257/us-residential-water-heater-market-share/* (Last accessed May 1, 2023).

TABLE IV.1—CONSUMER WATER HEATER PRODUCT CLASSES WITH CURRENT UEF-BASED STANDARDS—Continued

Product type	Rated storage volume and input rating (if applicable)	Draw patterns
Tabletop Water Heater	≥20 gal and ≤120 gal	Very Small, Low, Medium, High.
Instantaneous Gas-Fired Water Heater	<2 gal and >50,000 Btu/h	Very Small, Low, Medium, High.
Instantaneous Electric Water Heater	<2 gal	Very Small, Low, Medium, High.
Grid-Enabled Water Heater	>75 gal	Very Small, Low, Medium, High.

TABLE IV.2—CONSUMER WATER HEATER PRODUCT CLASSES WITHOUT CURRENT UEF-BASED STANDARDS

Product class	Rated storage volume and input rating (if applicable)
Gas-fired Storage	<20 gal.
	>100 gal.
Oil-fired Storage	>50 gal.
Electric Storage	<20 gal.
	>120 gal
Tabletop	<20 gal.
	>120 gal.
Gas-fired Instantaneous	<2 gal and ≤50,000 Btu/h.
	≥2 gal.
Oil-fired Instantaneous	<2 gal.
	≥2 gal.
Electric Instantaneous	≥2 gal.

In the March 2022 Preliminary Analysis, DOE used the conversion factor calculations applied in the December 2016 Conversion Factor Final Rule to translate EPCA's EF-based standards to equivalent UEF-based standards for the product classes in Table IV.2. The methodology and assumptions used for this conversion are described in detail in the preliminary TSD and in the NOPR TSD (see chapter 5). DOE is proposing to adopt UEF-based standards for these classes, which is further discussed in section IV.C.2 of this document.

a. Circulating Water Heater and Low-Temperature Water Heaters

As discussed in section III.B of this document, in the June 2023 TP Final Rule, DOE established definitions for ''circulating water heater'' and ''low temperature water heater'' in 10 CFR 430.2, and also established test procedures to determine the UEF of these types of water heaters. 88 FR 40406. DOE has identified three potential classes of circulating water heater based on fuel type, which are shown in Table IV.3. The input ratings associated with each product class are derived from the instantaneous water heater definitions in EPCA for each fuel type. (42 U.S.C. 6291(27))

TABLE IV.3—PROPOSED CLASSES OF CIRCULATING WATER HEATERS

Product class	Characteristics
Gas-fired Circulating Water Heater	A circulating water heater with a nominal input of 200,000 Btu/h or less; contains no more than one gallon of water per 4,000 Btu/h of input.
Oil-fired Circulating Water Heater	A circulating water heater with a nominal input of 210,000 Btu/h or less; contains no more than one gallon of water per 4,000 Btu/h of input.
Electric Circulating Water Heater	A circulating water heater with an input of 12 kW or less; contains no more than one gallon of water per 4,000 Btu/h of input (including heat pump-only units with power inputs of no more than 24 A at 250 V).

DOE is proposing to add these terms (''gas-fired circulating water heater,'' ''oil-fired circulating water heater,'' and ''electric circulating water heater'') to the definitions found at 10 CFR 430.2.

As discussed in the June 2023 TP Final Rule, DOE has determined that circulating water heaters with input ratings below 200,000 Btu/h (for gas-fired), 210,000 Btu/h (for oil-fired), or 12 kW (for electric) meet the definitional criteria for instantaneous consumer water heaters. As such, these products are subject to the applicable energy conservation standards; however, DOE previously provided an enforcement policy for circulating water heaters.[22] Because an amended test procedure that includes new provisions for testing circulating water heaters was recently finalized in the June 2023 TP Final Rule, DOE is proposing to establish updated UEF standards that reflect the new test method as discussed further in section IV.C.2 of this document. DOE did not consider amended standards for such products as part of this NOPR analysis in order to allow manufacturers time to test their products according to the updated test method and to develop sufficient data upon which to base future rulemaking analysis. As discussed in section V of this document,

[22] Prior to the June 2023 TP Final Rule, DOE became aware of gas-fired instantaneous water heaters meeting the definition of consumer water heaters which operated differently than those DOE had previously considered in test procedure rulemakings. On September 5, 2019, DOE issued an enforcement policy for consumer water heaters meeting the definition of gas-fired ''circulating water heater'' as described in said enforcement policy in which DOE stated that it would not seek civil penalties for failing to certify these products, or if these products failed to comply with applicable standards, on or before December 31, 2021. The June 2023 TP Final Rule has since addressed this issue by establishing test procedures to determine UEF ratings for circulating water heaters.

DOE proposes to update the standards for other types of gas-fired instantaneous water heaters. Therefore, DOE also proposes to establish separate classes for circulating water heaters in order to maintain the standards at their current stringency.

AHRI expressed concern regarding DOE's coverage of gas-fired circulating water heaters as consumer products, stating that most are used in commercial applications. AHRI requested that DOE reinstate the enforcement policy on circulating water heaters, which was issued on September 5, 2019, and expired on December 31, 2021. (AHRI, No. 42 at pp. 5–6)

As discussed, DOE has previously determined that these products are appropriately classified under EPCA as consumer water heaters. In addition, as discussed in the June 2023 TP Final Rule, DOE has identified circulating water heaters compatible with residential applications, and the establishment of a test method to determine the UEF of these products removes the need for any further enforcement policy. 88 FR 40406.

DOE requests comment on its proposed deferral of consideration of amended, more-stringent standards for circulating water heaters.

Regarding low temperature water heaters, DOE notes that they are covered as electric instantaneous water heaters. As discussed in section III.A of this document, DOE is not considering updated standards for electric instantaneous water heaters for this NOPR. Therefore, although low temperature water heaters are tested in a slightly different manner as other electric instantaneous water heaters, DOE is proposing to maintain low temperature water heaters within the broader electric instantaneous water heater product class and is not proposing a separate class for them at this time.

b. Storage-Type and Instantaneous-Type Product Classes

In the March 2022 Preliminary Analysis, DOE addressed comments received in response to the May 2020 RFI that suggested that DOE should consider eliminating the separate product classes for instantaneous water heaters. For the preliminary analysis, DOE analyzed separate classes for instantaneous water heaters, but sought feedback from stakeholders on whether storage-type and instantaneous-type water heaters product classes should be combined. (See section 2.3 of the preliminary TSD.)

In response, AHRI, BWC, and Rheem urged DOE not to combine storage and instantaneous product classes, commenting that this would be inconsistent with EPCA. (AHRI, No. 31 at p. 15; AHRI, No. 42 at p. 2; BWC, No. 32 at p. 1; Rheem, No. 45 at p. 2) AHRI stated that storage and instantaneous water heaters each provide unique utility to consumers due to their smaller footprint, and storage water heaters provide unique utility in that they allow consumers to participate in demand-response programs. AHRI asserted that combining the two product classes could decrease consumer utility if standards were set such that either storage or instantaneous water heaters were precluded from the market. (AHRI, No. 42 at p. 2) BWC requested that DOE not merge the storage and instantaneous product classes of gas-fired water heaters because they have different installation requirements and are useful in different situations. (BWC, No. 32 at p. 1) BWC stated that instantaneous water heaters are typically wall-hung, reducing the required floor space, and models are available for installation outdoors. BWC stated that storage water heaters, unlike instantaneous water heaters, maintain a volume of water available use immediately once a draw commences (whereas instantaneous water heaters take additional time to heat the water). BWC asserted that storage water heaters also provide hot water utility for applications which require large ''dump loads'' such as large tubs or multiple, concurrent, hot water draws by baths, showers, laundry, and/or dishes. Lastly, BWC also noted that storage water heaters can be utilized in demand response programs to store hot water for use when utility rates are high. (*Id.*)

Rheem suggested that combining storage and instantaneous product classes will lead to UEF standards that are not technologically feasible for some volume and input ranges because the standard cannot be lowered. Rheem also stated that combining storage and instantaneous water heaters into the same products class could result in one type of water heater being regulated out of existence or prevent DOE from amending standards to the maximum technologically feasible and economically justified level. (Rheem, No. 45 at p. 2) Rheem stated that the ability to store heated water is a performance-related feature that justifies a separate analysis for storage and instantaneous due to differences in operation, installation, and application. Rheem cited electric instantaneous as an example of a product ideal for hand-washing and low continuous flow point-of-use applications, while electric storage water heaters are better suited for higher flow rates with shorter draws such as to fill a bathtub or supply a shower. Rheem also noted that electric instantaneous water heaters require significant electrical panel capacity to serve an entire home, whereas electric storage water heaters use a much lower panel capacity. Finally, Rheem noted that the ability of storage water heaters to operate in thermal storage programs further differentiates their utility from instantaneous water heaters. (*Id.*)

DOE has tentatively determined that the existing separate product classes for storage and instantaneous water heaters—both electric and gas-fired—should be maintained. Storage and instantaneous water heaters offer distinct utilities to a consumer. For example, instantaneous water heaters provide a continuous supply of hot water, up to the maximum flow rate, while storage water heaters are often better suited to handle large initial demands for hot water as opposed to continuous draws. The ability of an instantaneous water heater to supply hot water continuously is directly attributed to its input rate and storage volume (*i.e.,* the input rate to storage volume ratio). Statutorily, consumer storage water heaters are limited to ratios of no more than 4,000 Btu/h per gallon and consumer instantaneous water heaters are greater than 4,000 Btu/h per gallon. 42 U.S.C. 6291(27)(B). Therefore, instantaneous water heaters possess an inherently distinct capacity to provide a continuous supply of hot water to the consumer. Additionally, storage water heaters have associated standby energy losses that instantaneous water heaters do not. Due to these differences in consumer utility and operational characteristics, DOE has tentatively determined that different product classes and standards for storage and instantaneous water heaters are necessary.

c. Gas-Fired Water Heaters

In response to the March 2022 Preliminary Analysis, several interested parties provided recommendations for the product classes for gas-fired water heaters.

Atmos urged DOE to consider the impact that not distinguishing between condensing and non-condensing water heaters will have on whether Category I venting [23] water heaters remain on the

[23] A Category I vented appliance is defined by the National Fire Protection Association (NFPA) and the American National Standards Institute (ANSI) in chapter 3 of NFPA 54–2021/ANSI Z223.1, the National Fuel Gas Code, as ''an appliance that operates with a nonpositive vent static pressure and

market. (Atmos, No. 38 at p. 5) The Gas Association Commenters urged DOE to reconsider the conclusions reached in the December 2021 Venting Interpretive Final Rule,[24] specifically with regard to gas-fired instantaneous water heaters, for which a condensing-level standard may be economically justifiable. The Gas Association Commenters Indicated that a condensing-level standard would lead to product unavailability for atmospherically vented gas-fired water heaters. (Gas Association Commenters, No. 41 at pp. 3–4)

ONE Gas recommended DOE maintain its breakout of the gas-fired storage water heater analysis in the preliminary TSD by Category I, III, and IV[25] products and consider subdividing analysis of Category I into subcategories that require electric power (such as for induced draft and power damper models) and those that do not, as this split in the analysis would support compliance with 42 U.S.C. 6295(q)(1). ONE Gas also requested that DOE clarify why gas-fired products which require electricity to operate are not considered to ''consume a different kind of energy.'' (ONE Gas, No. 44 at p. 8) The Gas Association Commenters urged DOE to consider separate product classes for gas-fired water heaters that do not require an external electrical power supply, which they claimed could be eliminated by amended energy conservation standards achievable only by condensing products. The Gas Association Commenters added that all products which do not require electricity have a standing pilot and are noncondensing, and hence would become unavailable. These commenters also indicated that such products have a unique utility to be able to operate during outages or entirely off the grid. (Gas Association Commenters, No. 41 at p. 4)

As discussed at the beginning of this section, DOE shall establish separate product classes for a covered product based on: (1) fuel source; and (2) whether a type of product offers a unique capacity or other performance-related feature that justifies a different standard. (*See* 42 U.S.C. 6295(q)(1))

In response to commenters' suggestions that DOE further consider whether to distinguish between non-condensing and condensing water heaters (or associated venting) for the purposes of establishing a separate product class, DOE reiterates its position stated in the March 2022 preliminary analysis that, consistent with the December 2021 Venting Interpretive Final Rule, non-condensing technology does not constitute a performance-related ''feature'' that provides a distinct utility to consumers as prescribed by EPCA at 42 U.S.C. 6295(q)(1). (*See* chapter 2 of the preliminary analysis TSD; 86 FR 73947.) In short, the type of technology (non-condensing or condensing) or venting used by the appliance, does not provide any utility to the consumer that is accessible to the layperson, which is based upon the consumer's operation of or interaction with the appliance. Therefore, there is no difference in the utility derived from the appliance based on these factors. 86 FR 73947, 73951, 73953. As explained in the Venting Interpretive Final Rule, DOE considers any additional costs associated with venting as part of its determination that an energy conservation standard is economically justified. *Id.* at 86 FR 73960. Because neither non-condensing operation, nor atmospheric, category I venting (which is associated with non-condensing operation) meet the requirements to be considered a performance-related ''feature'' as outlined at 42 U.S.C. 6295(q)(1), DOE is not proposing separate product classes specifically to preserve this capability in gas-fired water heaters. DOE similarly finds that other venting categories (*e.g.,* category IV venting) are also not a performance-related feature under EPCA.

Regarding the recommendations that DOE separate product classes based on whether or not a gas-fired water heater uses auxiliary electricity, DOE has long held that use of auxiliary electric power in gas-fired products does not constitute ''consuming a different kind of energy'' from those that do not use auxiliary electric power under EPCA. EPCA defines ''energy'' as meaning electricity, or fossil fuels.[26] (42 U.S.C. 6291(3)) EPCA initially separated water heaters by fuel type into only gas-fired, oil-fired, and electric water heaters product classes. (42 U.S.C. 6295(e)(1)) Although commenters have suggested that products that use both gas and electricity could be thought of as being gas-fired water heaters and electric water heaters, the usage of electricity in gas-fired water heaters is only a means to power auxiliary components and not to heat the water. Therefore, DOE has historically considered these products to be only gas-fired water heaters.

As for whether use of auxiliary electricity constitutes a unique performance-related feature, DOE notes that, in an April 8, 2009 final rule, DOE declined to define separate product classes for gas cooking products that do not require electricity because DOE was unable to identify any unique utility associated with gas cooking products equipped with standing pilot ignition, compared to those with electronic ignition. While DOE considered that the ability to operate in the case of an atypical event such as the loss of line power was of benefit to consumers, DOE determined that battery-powered electronic ignition systems could provide ignition in the absence of line power and noted that such ignition systems already had been implemented in other products including portable gas-fired instantaneous water heaters. As such, consumer water heaters with standing pilot lights are not unique in the ability to operate during outages or entirely off the grid. Thus, DOE has tentatively determined that a separate product class for consumer water heaters with standing pilot lights is not warranted under 42 U.S.C. 6295(q)(1).

d. Electric Storage Water Heaters

In the March 2022 Preliminary Analysis, DOE tentatively determined not to separate heat pump electric storage water heaters from the electric storage water heater product class. DOE noted that to the extent that heat pump electric storage water heaters use electricity to heat, they meet EPCA's definition of an electric storage-type water heater (see 42 U.S.C. 6291(27)(A)) and are subject to the current standards for electric storage water heaters at 10 CFR 430.32(d). (See chapter 2 of the preliminary TSD.) This position is also consistent with the April 2010 Final Rule. In that rule, DOE found that heat pump water electric storage water heaters did not meet the requirements for establishing a separate product class. 75 FR 20112, 20135. As stated previously, DOE establishes separate product classes based on two criteria: (1) fuel source; and (2) whether a type

with a vent gas temperature that avoids excessive condensate production in the vent.''

[24] On December 29, 2021, DOE published a final interpretive rule (''December 2021 Venting Interpretive Final Rule'') reinstating its long-standing interpretation that the heat exchanger technology and associated venting used to supply heated air or hot water is not a performance-related ''feature'' that provides a distinct consumer utility under EPCA. 86 FR 73947.

[25] The National Fuel Gas Code, NFPA 54–2021/ANSI Z223.1, defines a category III vented appliance as ''an appliance that operates with a positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent.'' It defines a category IV vented appliance as ''an appliance that operates with a positive vent static pressure and with a vent gas temperature that can cause excessive condensate production in the vent.''

[26] The definition of ''energy'' also provides that the Secretary may, by rule, include other fuels within the meaning of the term ''energy'' if he determines that such inclusion is necessary or appropriate to carry out the purposes of this chapter. (42 U.S.C. 6291(3))

of product offers a unique capacity or other performance-related feature that justifies a different standard. (*See* 42 U.S.C. 6295(q)(1)) In the April 2010 Final Rule, DOE noted that both heat pump electric storage water heaters and electric resistance storage water heaters use electricity as the fuel source. 75 FR 20112, 20135. As for capacity, DOE observed that heat pump electric storage water heaters were being offered as direct replacements for electric resistance storage water heaters. *Id.* DOE also noted that rated storage volumes and first hour ratings of heat pump electric storage water heaters were comparable to electric resistance storage water heaters. *Id.* Finally, DOE did not identify any other performance-related features that were unique to either heat pump electric storage water heaters or electric resistance storage water heaters. *Id.*

EEI disagreed with DOE's decision in the preliminary analysis not to create a separate product class for heat pump electric storage water heaters and expressed concern over expanding heat pump-level standards to more electric storage water heaters than they currently apply to. (EEI, No. 31 at p. 35)

Cirker also commented that DOE should consider separating out product classes for electric resistance storage water heaters from heat pump electric storage water heaters on the basis of personal experience with three heat pump water heaters installed within the commenter's home exhibiting a wider range of performance characteristics, including, at times, lower delivery capacity. (Cirker, No. 30 at p. 1)

Based on its current market assessment, DOE has tentatively determined that the conclusions reached in the April 2010 Final Rule remain valid. Heat pump electric storage water heaters and electric resistance water heaters use electricity as the fuel source. They both offer similar capacities as evidenced by first hour ratings certified to DOE, which range between 29 gallons and 80 gallons for electric resistance storage water heaters and between 41 gallons and 95 gallons for heat pump electric storage water heaters. Finally, DOE has not identified any unique performance-related features offered by either heat pump electric storage water heaters or electric resistance storage water heaters. As discussed in the Venting Interpretive Final Rule, DOE considers performance-related features to be those aspects of the appliance with which the consumer interacts during operation of the product. 86 FR 73947, 73955.

For consumer water heaters, which are products that traditionally do not receive daily consumer interaction, storage capacity and delivery capacity are the main performance features that impact consumer utility. Water heater capacity reflects that amount of hot water available to the consumer for use, and this also impacts the efficiency of the product. Hence, DOE has currently-established standards which take into account capacity ranges for consumer water heaters. On the other hand, the technology used to heat the water, heat pump or electric resistance, is not something a consumer would interact with during operation of the water heater. As a result, DOE maintains its position from the April 2010 Final Rule and the March 2022 Preliminary Analysis that heat pump electric storage water heaters and electric resistance storage water heaters do not warrant separate product classes.

Plug-In and Split-System Heat Pump Electric Storage Water Heaters

While DOE has tentatively determined that heat pump electric storage water heaters do not warrant their own product class, NYSERDA also recommended that DOE create additional definitions and product classes for plug-in (120 volt (V)/15 ampere (A)) and split-system heat pump electric storage water heaters to allow these products to enter the market and increase market share. (NYSERDA, No. 35 at pp. 6–7) NEEA, ACEEE, and NWPCC also urged DOE to consider plug-in heat pump water heaters in its analysis and to consider whether a separate standard for them would be warranted, given that they are expected to be commercially available by the end of 2022. (NEEA, ACEEE, and NWPCC, No. 47 at p. 7) The CA IOUs requested DOE create a separate product class (or lower efficiency levels if a separate product class is not possible) for split-system heat pump water heaters and plug-in heat pump water heaters because of their unique ability to serve installation scenarios that would be difficult or impossible for unitary (240 V) heat pump water heaters. (CA IOUs, No. 39 at p. 2)

In response to these comments, DOE first notes that it did not consider plug-in heat pump water heaters in the March 2022 Preliminary Analysis as they were not commercially available in the U.S. market at the time. (*See* Chapter 2 of the preliminary TSD). While there are now a limited number of plug-in heat pump water heaters available in the U.S. market, DOE still does not have sufficient information to determine how use of plug-in voltage (120 V) and current (15 A) affects performance and efficiency. As a result, even if DOE were to make a determination that use of plug-in voltage and current constitutes a unique performance-related feature, the Department would be unable to make the necessary finding that a higher or lower efficiency standard is justified for these types of water heaters. DOE may consider establishing a separate product class for plug-in heat pump electric storage water heaters in a future rulemaking.

With respect to establishing a separate product class for split-system heat pump electric storage water heaters, DOE notes the analysis is very similar to what was discussed for heat pump electric storage water heaters. Split-system heat pump water heaters use the same fuel source, electricity, as other electric storage water heaters. DOE also has not identified any unique performance-related features offered by split-system heat pump water heaters that would warrant a separate product class consideration at this time. And, as DOE stated previously, the type of technology used to heat the water, in this case a split-system heat pump, is not something a consumer would interact with during operation of the water heater.

Grid-Enabled Water Heaters

NYSERDA urged DOE to further define grid-enabled water heaters for consistency on connectedness. (NYSERDA, No. 35 at p. 7) In response, DOE notes that grid-enabled water heaters are defined in EPCA. (see 42 U.S.C. 6295(e)(6)(A)(ii)) DOE has not found it necessary at this time to further define connectivity.

Small Electric Storage Water Heaters and Tabletop Water Heaters

Current product classes for electric storage water heaters are based on rated storage volume (capacity) and draw pattern. *See* 10 CFR 430.32(d). There are product classes for electric storage water heaters with storage volumes greater than 20 gallons and less than or equal to 55 gallons, and product classes for electric storage water heaters with storage volumes greater than 55 gallons and less than or equal to 120 gallons. As discussed in section III.F of this document, DOE received a Joint Stakeholder Recommendation for amended water heater standards, that included recommended standard levels for electric storage water heaters. In particular, the Joint Stakeholder Recommendation suggested setting different standards for smaller electric storage water heaters.

In response, DOE notes that the efficiency of an electric storage water heaters is typically increased by adding insulation to the water heater or by incorporating a new technology into the design, such as a heat pump. When implementing these technology options, the water heater's outer dimensions typically are increased to maintain the same internal tank size (and hold the same volume of water). DOE reviewed its existing product classes for electric storage water heaters with storage volumes less than or equal to 55 gallons and greater than 20 gallons to determine whether further subdividing these product classes is warranted. DOE's market data for electric storage water heaters suggests there is a certain category of electric storage water heaters that are limited in their physical size due to the places they are typically installed. Some of these water heaters are commonly referred to as ''lowboy'' water heaters and have restrictions on their physical size to facilitate installation in crawl spaces, in attics, and under staircases, which have finite space constraints that define physical size limitations for the water heater. The physical size limitation of the unit restricts the amount of hot water that can be provided to the household.

In order to determine how to best characterize these ''small water heaters,'' DOE looked at the amount of hot water they produce and their effective storage volumes. DOE found that most ''small electric storage water heaters'' in the market today offer an effective storage volume greater than or equal to 20 gallons and less than or equal to 35 gallons and deliver first-hour ratings less than 51 gallons. Due to their low capacities ''small electric storage water heaters'' fall into the very small or low usage draw patterns.

Thus, DOE tentatively concludes that this restriction is a performance-related feature affecting energy efficiency that would warrant a separate product class. In addition, the physical size limitation constrains the technology options that can be considered to increase the efficiency of these water heaters. For example, the maximum technologically feasible efficiency level for electric storage water heater utilizes heat pump water heater technology. For those water heaters that are physically space-constrained, the max-technology efficiency level must be a split-system heat pump water heater since integrating the heat pump into the top of the tank is physically prohibited by the constraints of the installation. This is discussed further in sections IV.C.1.a and IV.C.1.b of this NOPR.

In this proposed rulemaking, DOE has analyzed splitting the existing 20–55 gallon product classes for electric storage water heaters by establishing new ''small electric storage water heater'' product classes.

The proposed electric storage product classes would be: (1) electric storage water heaters with an effective storage volume greater than or equal to 20 gallons and less than or equal to 35 gallons, with first-hour ratings less than 51 gallons (''small electric storage water heaters''); and (2) electric storage water heaters with an effective storage volume greater than or equal to 20 gallons and less than or equal to 55 gallons (excluding small electric storage water heaters). The electric storage product classes analyzed in this NOPR are summarized below in Table IV.4.

TABLE IV.4—ELECTRIC STORAGE WATER HEATER PRODUCT CLASSES

Current Product Class Structure		
≥20 gallons, ≤55 gallons, All draw patterns		>55 gallons, ≤120 gallons, All draw patterns.
New Product Class Structure Being Considered		
Small Electric Storage Water Heaters ≥20 gallons, ≤35 gallons, Very small and low draw patterns *.	≥20 gallons, ≤55 gallons, All draw patterns, excluding "small electric storage water heaters".	>55 gallons, ≤120 gallons, All draw patterns.

* These products are collectively referred to as "small electric storage water heaters."

Tabletop water heaters, which typically have around 35 gallons of rated storage volume, also have very particular dimensions in order to be used as a kitchen workspace. DOE is not proposing to amend the standards for tabletop water heaters in this rulemaking based on the market assessment for these products (see section IV.C.1.a for details). There are only two basic models of tabletop water heaters on the market currently. Because of the similarities between tabletop water heaters and small electric storage water heaters, DOE is proposing to create alignment between the standards for these types of products. Specifically, in this NOPR, DOE proposes to amend the definition of ''tabletop water heater'' to specify that the tabletop designation of electric storage water heaters is only applicable to products in the very small or low draw pattern. As a result of this proposal (if finalized), any tabletop water heaters in the medium and high draw patterns would henceforth be considered in the broader electric storage water heater product classes. Out of the two basic models of tabletop water heaters certified to DOE, one is in the low draw pattern and will not be affected by the proposal. The other is in the medium draw pattern. DOE expects that this medium draw pattern tabletop model can be redesigned to meet the low draw pattern requirements with limited product conversion cost to the manufacturer.

DOE requests comment on its proposal to limit the tabletop water heater designation to products in the very small and low draw patterns.

2. Technology Options

As described in section III.C.1 of this document, DOE conducts a technology assessment to identify a complete list of technologies for consumer water heaters (''technology options'') with the potential to improve the UEF ratings of products. Section IV.B of this document describes the process by which technology options are screened in a separate screening analysis that aims to determine which technology options could feasibly be adopted based on five screening criteria. Finally, in the engineering analysis (section IV.C of this document), DOE selects the technology options that are most likely to constitute the design pathway to higher efficiency levels in a standards-case scenario (thereafter referred to as ''design options''). Thus, after DOE identifies a comprehensive list of technologies for the technology assessment, the subsequent analysis focuses only on those technologies that are the most likely to be implemented in response to amended standards.

In the preliminary market analysis and technology assessment, DOE identified numerous technology options that would be expected to improve the efficiency of consumer water heaters, as measured by the DOE test procedure. These technology options were presented in chapter 3 of the preliminary TSD. DOE requested feedback on the technology options identified and on whether there are additional technologies available that may improve consumer water heater performance.

In response to the March 2022 Preliminary Analysis, the Joint Advocates requested that DOE evaluate 120 V/15 A heat pump water heaters because their commercial availability is expected to increase throughout 2022. (Joint Advocates, No. 34 at pp. 2–3) Rheem commented that there will be 120 V electric water heaters, including heat pump water heaters, on the market during the 30-year analysis timeframe. (Rheem, No. 45 at p. 4) In response, DOE has included 120 V HPWHs in its technology assessment for electric storage heat pump water heaters in this NOPR. However, as described further in chapter 3 of the NOPR TSD, there are currently very few models of 120 V heat pump water heaters available on the market, and DOE has not analyzed these designs directly in the engineering analysis due to the lack of information on these models and whether these designs would constitute the most cost-effective pathway to improved energy efficiency for electric storage water heaters. DOE's initial findings on the potential efficiency of 120 V heat pump water heaters are detailed in chapter 3 of the NOPR TSD.

DOE requests comment on the outlook for the emergence of 120 V heat pump water heaters, information regarding how their design and operation may differ from 240 V heat pump water heaters, and data on performance characteristics and efficiencies.

Rheem recommended DOE add an inlet damper to the list of technology options but indicated that this technology option may not be suitable for the entire gas-fired storage water heater product class. Rheem stated that it has concerns that the technology may have limitations for some installation applications. (Rheem, No. 45 at p. 3) Based on its independent research and discussions with manufacturers, DOE understands the technology in question to be gas-actuated flue dampers, which are installed at the air intake inlet (hence the term used by the commenter, ''inlet damper''). The Joint Advocates urged DOE to evaluate gas-actuated, non-powered dampers, which require no external power source and instead use a self-powered gas valve to generate the power needed to operate, for gas-fired storage water heaters as a potentially lower-cost alternative to other damper technology options. (Joint Advocates, No. 34 at p. 2) As discussed further in chapter 3 of the NOPR TSD, DOE agrees with Rheem and the Joint Advocates that gas-actuated flue dampers are a viable technology option for gas-fired storage water heaters and has therefore included them in its updated analyses for this NOPR.

AHRI and BWC opposed DOE's inclusion of modulating burners as a technology option for gas-fired storage, oil-fired storage, and gas-fired instantaneous water heaters because modulating burners are, to their knowledge, used only in gas-fired instantaneous water heaters in the consumer market. (AHRI, No. 42 at p. 3; BWC, No. 32 at p. 3) BWC added that adjusting the fuel-to-air ratio is typically done only in commercial applications (with the possible exception of consumer gas-fired instantaneous water heaters) as it is very sophisticated and costly. (BWC, No. 32 at p. 3)

In response to comments from AHRI and BWC, DOE notes that it is technologically feasible to use modulating burners in fossil fuel-fired products, and therefore, it has been included in the list of technology options available for consumer water heaters. However, in the engineering analysis of the March 2022 Preliminary Analysis, which constructs the main design option pathway for efficiency improvements, DOE had tentatively determined that modulating burners were likely to be used as part of the technology pathway for increasing UEF only in instantaneous-type gas-fired water heaters, as commenters have suggested. Accordingly, in this NOPR, as in the March 2022 Preliminary Analysis, DOE has analyzed modulating burners only for gas-fired instantaneous water heaters in the engineering analysis (see section IV.C.1.a of this document for additional discussion).

The technology options found in this NOPR for improving UEF in consumer water heaters, are listed in Table IV.5 and described in chapter 3 of the NOPR TSD.

TABLE IV.5—POTENTIAL TECHNOLOGIES FOR INCREASING EFFICIENCY

Technology option
Heat traps.
Improved insulation:
Increased thickness.
Insulation on tank bottom.
Less conductive tank materials (*e.g.,* plastic).
Foam insulation.
Pipe and fitting insulation.
Advanced insulation types:
Aerogel.
Vacuum panels.
Inert gas-filled panels.
Electronic ignition systems:
Direct spark ignition.
Intermittent pilot ignition.
Hot surface ignition.
Improved burners:
Pulse combustion.
Pressurized combustion.
Side-arm heating.
Two-phase thermosiphon technology.
Modulating burners.
Reduced burner size (slow recovery).
Heat exchanger improvements:
Increased heat exchanger surface area.

TABLE IV.5—POTENTIAL TECHNOLOGIES FOR INCREASING EFFICIENCY—Continued

Technology option
Enhanced flue baffle.
Submerged combustion chamber.
Multiple flues.
Alternative flue geometry (Helical).
U-Tube.
Condensing technology.
Induced-draft (negative vent pressure) heat exchanger.
Direct-fired heat exchange.
Improved venting:
Flue damper:
Externally-powered.
Thermopile-operated (non-powered).
Gas-actuated (non-powered).
Buoyancy-operated (non-powered).
Concentric direct venting.
Power vent.
Improved heat pump water heater components:
Compressor improvements:
Increased capacity.
Increased efficiency.
Variable-speed drive.
Fan improvements:
High-efficiency fan motors.
High-efficiency fan blades.
Expansion device improvements.
Increased evaporator surface area.
Increased condenser surface area.
Gas-fired absorption heat pump water heaters.
Gas-fired adsorption heat pump water heaters.
Carbon dioxide heat pump water heaters.
Thermophotovoltaic and thermoelectric generators.
Improved controls:
Modulating controls.

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 results in the unavailability of any covered product type with performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as products generally available in the United States at the time, it will not be considered further.

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

(5) *Unique-pathway proprietary technologies.* If a technology has proprietary protection and represents a unique pathway to achieving a given efficiency level, it will not be considered further, due to the potential for monopolistic concerns.

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

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

The subsequent sections include 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

The following paragraphs describe the technologies that DOE eliminated for failure to meet one of the following five factors: (1) technological feasibility; (2) practicability to manufacture, install, and service; (3) impacts on equipment utility or equipment availability; (4) adverse impacts on health or safety; and (5) unique-pathway proprietary technologies.

In the preliminary analysis, DOE eliminated the following technology options from further consideration based on the above criteria: advanced insulation types, condensing pulse combustion, side-arm heating, two-phase thermosiphon technology, reduced burner size (slow recovery), direct-fired heat exchange, dual fuel heat pumps, buoyancy-operated flue dampers, gas-fired absorption and adsorption heat pump water heaters, and U-tube flues. Each of these technology options and the reasons for which they were screened out are discussed in detail in the preliminary TSD.

BWC commented that some technology options listed in Table 2.3.3

of the preliminary TSD cannot necessarily be easily implemented in residential products without significant investments. (BWC, No. 32 at p. 2) BWC did not specify which technologies were the subject of their comment.

AHRI suggested DOE's consideration of internationally available technologies as feasible for this rulemaking is inappropriate because internationally available technologies conform to different standards than those used in the United States, which does not guarantee that these technologies can be certified in the United States. (AHRI, No. 42 at p. 3)

As previously discussed, DOE evaluates all technology options identified in the technology assessment, including those that may be internationally available, according to the screening criteria enumerated in sections 6(b)(3) and 7(b) of appendix A to 10 CFR part 430 subpart C. If a specific technology option passes all the screening criteria, it is retained as a design option for the engineering analysis. DOE notes that all of the remaining technology options that were not proposed to be screened out are already available in the United States.

BWC suggested that it is too early for DOE to consider gas-fired heat pump water heaters in its analysis, noting that they are not currently available in the consumer market and the technology has not been demonstrated to be easily and cost-effectively manufactured at large scale to meet the demands of the consumer water heater market. (BWC, No. 32 at p. 3) The Joint Advocates, however, urged DOE to evaluate gas-fired heat pump water heaters as the max-tech level for gas-fired storage water heaters because gas-fired heat pump technology is commercially available in other product types, has been used in some demonstrations for water heaters, and may soon be commercially available for water heaters. (Joint Advocates, No. 34 at p. 2)

In response to these comments, DOE notes that it is not statutorily restricted to technologies that are currently on the market when conducting its analyses and considering standards; however, DOE is required to screen out technologies which are not practicable to manufacture at the scale necessary to serve the relevant market at the time of the projected compliance date of any amended standards (see section 6(b)(3)(i)–(ii) of appendix A and section IV.B of this document). Because there are no commercially available gas-fired heat pump water heaters on the market yet, DOE has no data or information that would suggest that gas-fired heat pump technology will be practicable to manufacture at the necessary scale upon the compliance date expected for this rulemaking. Therefore, DOE proposes to screen out this technology option from further consideration.

AHRI requested that DOE remove millivolt-powered (*i.e.,* thermopile-operated) flue dampers in the screening analysis because they are not used in consumer products. (AHRI, No. 42 at p. 3) Rheem recommended that the thermopile-operated flue damper technology option be screened out due to technological feasibility, agreeing with AHRI that this technology option is not incorporated in commercialized products. (Rheem, No. 45 at p. 3) BWC also urged DOE not to consider millivolt-powered dampers as a technology option for consumer water heaters as they are not used domestically in consumer products. (BWC, No. 32 at p. 2)

DOE reviewed product literature for water heaters which have thermopile-operated flue dampers. These water heaters convert thermal energy from a standing pilot light into electricity to operate a damper, but such thermopiles are found only in commercial water heaters, which typically have substantially higher input rate standing pilot lights. Manufacturers generally agreed during interviews that the standing pilot lights in consumer water heaters are not large enough to power flue dampers. Consequently, DOE screened this design option out because it has tentatively determined that thermopile-operated flue dampers are not technologically feasible for consumer water heaters. (As discussed in section IV.C.1.a of this document, DOE is now considering gas-actuated flue dampers as a design option for reaching EL 2 without use of external electricity, as this technology has been demonstrated in consumer water heaters that are currently on the market.)

2. Remaining Technologies

Through a review of each technology, DOE tentatively concludes that all of the other identified technologies listed in section IV.A.2 of this document met all five screening criteria to be examined further as design options in DOE's NOPR analysis. In summary, DOE did not screen out the following technology options listed in Table IV.6. These technology options are shown from left to right from broader categories to specific design options.

TABLE IV.6—REMAINING TECHNOLOGY OPTIONS AS IDENTIFIED IN THE NOPR ANALYSIS

Technology option
Improved insulation:
Increased thickness.
Insulation on tank bottom.
Less conductive tank materials (*e.g.,* plastic).
Foam insulation.
Pipe and fitting insulation.
Electronic ignition systems:
Direct spark ignition.
Intermittent pilot ignition.
Hot surface ignition.
Burner improvements:
Pressurized combustion.
Modulating burners.
Gas-fired and Oil-fired Heat exchanger improvements:
Increased heat exchanger surface area.
Enhanced flue baffle.
Submerged combustion chamber.
Multiple flues.
Alternative flue geometry (Helical).
Condensing technology.
Induced-draft (negative vent pressure) heat exchanger.
Improved venting:

TABLE IV.6—REMAINING TECHNOLOGY OPTIONS AS IDENTIFIED IN THE NOPR ANALYSIS—Continued

Technology option
Flue damper:
Externally-powered.
Gas-actuated (non-powered).
Power vent.
Concentric direct venting.
Improved heat pump water heater components:
Compressor improvements:
Increased capacity.
Increased efficiency.
Variable-speed drive.
Fan Improvements:
High-efficiency fan motors.
High-efficiency fan blades.
Expansion device improvements.
Increased evaporator surface area.
Increased condenser surface area.
Carbon dioxide (alternative refrigerant) heat pump water heaters.
Improved controls:
Modulating controls.
Heat traps (all types)

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 and do not result in adverse impacts on consumer utility, product availability, health, or safety, unique-pathway proprietary technologies). For additional details, see chapter 4 of the NOPR TSD.

BWC stated that direct vent technology severely limits how much products can be improved due to safety-related combustion requirements. (BWC, No. 32 at p. 2) DOE notes that there are numerous consumer water heaters currently on the market using direct vent technology, which demonstrates that the technology can be used safely. However, though direct vent technology was not screened out, it has been identified as not significantly improving the UEF rating and therefore DOE did not consider it as a design option in its engineering analysis. Section IV.C.1.b of this document and chapter 5 of the TSD have additional details regarding DOE's projected design pathway for improving UEF.

NRECA commented that heat pump water heaters currently do not provide the same functionality as electric resistance water heaters in demand response programs, do not perform as well in certain regions of the country, and have no alternative for consumers without access to natural gas in their homes. NRECA suggested that heat pump water heaters would not be suited for programs in which the water heater is controlled to stop or start operating at different times of the day and sometimes for multiple on/off cycles per day or per hour, because these ''short cycles'' would reduce component lifetimes and reliability. NRECA also noted that heat pump water heaters require a specific minimum area to function properly, and many homes have a water heater located in a closet or small area and do not have the large space needed for the heat pump to operate effectively. (NRECA, No. 33 at p. 2)

The most recent market assessment has found several commercially-available demand-response heat pump water heaters, suggesting that manufacturers are developing ways to implement control strategies in heat pump water heaters which allow them to meet the needs of utility demand-response programs. Additionally, as discussed, heat pump water heaters currently available on the market typically have backup electric resistance elements which may activate during a grid-signaled event if necessary and can allow the water heater to function similarly to an electric resistance water heater when needed. With regards to NRECA's concern about short-cycling, DOE expects that heat pump water heaters would be less likely to undergo shorter recovery periods than electric resistance water heaters. Heat pump water heaters take more time to recover when using only the compressor because the refrigeration cycle requires time to stabilize and begin transferring heat at a high output rate. The condenser coils of heat pump water heaters may also not be in direct contact with the water. By contrast, electric resistance elements are directly submerged in water and are capable of heating water faster because the electrical power is immediately converted into heat output. With respect to NRECA's concerns about space constraints, DOE notes that other options are available to consumers, such as utilizing a louvered door or ducting air to and from the water heater, and these options were considered as part of the installation cost analysis (see section IV.F.2). Finally, DOE agrees that air-source heat pump performance will vary depending on the region of the country due to varying the air conditions at the evaporator. To account for such differences, in the June 2023 TP Final Rule, DOE adopted optional metrics that manufacturers may use to make voluntary representations for heat pump water heaters at a range of alternative ambient and outdoor air conditions. As a result of these considerations, DOE did not screen out heat pump technology as a technology option for improving the UEF of electric storage water heaters.

GEA and Rheem urged DOE to further evaluate the impact of ongoing refrigerant regulations on the viability, availability, and cost of heat pump water heaters. (GEA, No. 46 at p. 2; Rheem, No. 45 at p. 5) BWC urged DOE to consider the fact that alternative refrigerants can be extremely flammable, may have charge limits, operate at high pressures, and are often costly. BWC also noted that there is only one residential heat pump water heater product line on the market today that utilizes CO_2 [27] as a refrigerant. (BWC, No. 32 at pp. 2–3) Southern Company indicated different refrigerants may be in use for heat pump water heaters by the implementation date of this rulemaking and requested that DOE account for their higher prices. (Southern Company, No. 31 at pp. 27–28)

Based on information gathered from manufacturers in confidential interviews after the March 2022 Preliminary Analysis, DOE has tentatively determined that alternative refrigerants with low global warming potentials (''GWP'') will be made available for use in heating products if refrigerant regulations that apply to heat pump water heaters are promulgated by the Environmental Protection Agency (''EPA''). While BWC appeared to be alluding to potential issues with hydrocarbon refrigerants, other more viable options include drop-in replacements, with very similar performance characteristics as R134A (which is a non-flammable hydrofluorocarbon blend), the primary refrigerant used today in heat pump water heaters. Because the future of refrigerant regulations remains uncertain at this time, in this NOPR, DOE has assumed the continued use of R134A for heat pump components. Hence, DOE has not screened out R134A in this analysis. DOE tentatively did not screen out R744 (CO_2) in this analysis because there is no clear evidence that this constitutes a unique-pathway proprietary technology,[28] as BWC appears to suggest. However, as discussed in the engineering analysis, DOE has not assumed the use of R744 systems in order to meet the efficiency levels analyzed for heat pump water heaters because DOE does not expect this to be the most likely design pathway that manufacturers would take.

C. Engineering Analysis

The purpose of the engineering analysis is to establish the relationship between the efficiency and cost of consumer water heaters. 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).

As discussed in section IV.A.1 of this document, certain classes of consumer water heaters currently have UEF-based standards, while for others EPCA's EF-based standards apply. For this NOPR, DOE analyzed amended UEF standards for the product classes that currently have standards in terms of UEF. For the product classes with EF-based standards, DOE developed translated standards in terms of UEF for use in the analysis.

In this NOPR, DOE has analyzed standards with respect to the effective storage volume metric, which is described in section III.B of this document. Compared to rated storage volume and FHR, effective storage volume is a superior descriptor of the thermal energy stored in the hot water of the water heater, which can be made immediately available for consumer use, for the following reasons. The rated storage volume does not account for additional energy that could be stored due to an increase in storage tank temperature. The FHR metric is similar to effective storage volume; however, the FHR test allows the water heater to be energized and actively heating the water; therefore, it is not an appropriate measure of the stored energy. There are two types of water heaters which can cause the system to store more energy than would be otherwise determined by the rated storage volume, as discussed in the June 2023 TP Final Rule: water heaters capable of operating with an elevated tank temperature, and circulating water heaters. In the June 2023 TP Final Rule, DOE established that compliance with the effective storage volume provisions (and, relatedly, high temperature testing method and testing with separate storage tanks for circulating water heaters) would not be required until compliance with amended standards. For circulating water heaters, the effective storage volume of the water heater is determined by the measured storage volume of the separate storage tank used in testing because these types of water heaters are designed to operate with a volume of stored water in the field. 88 FR 40406, 40461–40462. Section V.C.1 of this document discusses the proposed approach to consider efficiency determinations for water heaters tested using the high temperature testing method.

In this NOPR, DOE has initially determined not to propose amended standards for gas-fired storage water heaters (55 gal < V_{eff} ≤ 100 gal), tabletop water heaters (20 gal ≤ V_{eff} ≤ 120 gal), electric instantaneous water heaters (V_{eff} < 2 gal), and grid-enabled water heaters at this time based on the results of the market and technology assessment, screening analysis, interviews with manufacturers, and comments from interested parties. The market assessment indicates that there are no consumer gas-fired storage water heaters certified with storage volumes between 55 gallons and 100 gallons in any draw patterns and that the market has shifted towards smaller storage volumes (between 20 gallons and 55 gallons). The market assessment also shows that there are only two basic models of tabletop water heaters certified at this time, and this segment of the market is not expected to grow. Electric instantaneous water heaters with storage volumes less than 2 gallons have very low standby losses (due to the small storage volume) and have recovery efficiencies of 98 percent. At this time, heat pump technology has not been demonstrated as being technologically feasible for electric instantaneous water heaters (excluding circulating heat pump water heaters, which are designed differently to operate with a large, stored volume of water). Thus, the technological feasibility of improved efficiencies for this product class remains uncertain. Details of these assessments are discussed in chapters 3 and 5 of the NOPR TSD.

In response to the March 2022 Preliminary Analysis, Rheem agreed with DOE that heat pump technology cannot be considered to increase the efficiency of grid-enabled water heaters. Rheem stated that there is an opportunity to increase the efficiency of grid-enabled water heaters with an increase in insulation thickness but noted that the energy savings do not appear to be economically justified at this time. (Rheem, No. 45 at pp. 7–8) BWC, however, commented that the efficiency levels for grid-enabled water heaters are difficult to achieve with the technology options listed in Table ES.3.9 of the preliminary TSD and questioned the feasibility of the efficiency level above baseline. (BWC, No. 32 at p. 2)

Because grid-enabled water heaters are statutorily defined as having electric resistance technology (see 42 U.S.C 6295(e)(6)(A)(ii)), heat pump technology is not applicable as a technology option for these water heaters and DOE has tentatively determined that the only technologically feasible means to further

[27] Commercially referred to as R744.

[28] R744 is also used in some water chiller systems developed by other manufacturers.

improve these products would be to use thicker insulation. However, increased insulation offers diminishing returns for improved UEF, and DOE has tentatively determined that the insulation levels used in some models on the market are the highest that are technologically feasible at this time, and that further increases would not significantly improve UEF. Thus, DOE has not analyzed amended UEF standards for grid-enabled water heaters.

Table IV.7 presents the consumer water heater product classes along with the approach to analyzing them for this NOPR.

TABLE IV.7—ANALYSIS APPROACH BY PRODUCT CLASS

Product category	Distinguishing characteristics (effective storage volume and input rating)	Proposed analysis
Gas-fired Storage Water Heater	<20 gal	Converting EF-based standards to UEF-based standards.
	≥20 gal and ≤55 gal	Amending UEF-based standards.
	>55 gal and ≤100 gal	No amendments proposed.
	>100 gal	Converting EF-based standards to UEF-based standards.
Oil-fired Storage Water Heater	≤50 gal	Amending UEF-based standards.
	>50 gal	Converting EF-based standards to UEF-based standards.
Electric Storage Water Heater	<20 gal	Converting EF-based standards to UEF-based standards.
	≥20 gal and ≤35 gal, FHR <51 gal (Small electric storage water heaters).	Amending UEF-based standards.
	≥20 gal and ≤55 gal, excluding small electric storage water heaters.	Amending UEF-based standards.
	>55 gal and ≤120 gal	Amending UEF-based standards.
	>120 gal	Converting EF-based standards to UEF-based standards.
Tabletop Water Heater	<20 gal	Converting EF-based standards to UEF-based standards.
	≥20 gal and ≤120 gal	No amendments proposed.
Gas-fired Instantaneous Water Heater	<2 gal and ≤50,000 Btu/h	Converting EF-based standards to UEF-based standards.
	<2 gal and >50,000 Btu/h	Amending UEF-based standards.
	≥2 gal and ≤200,000 Btu/h	Converting EF-based standards to UEF-based standards.
Electric Instantaneous Water Heater (including Low-Temperature Water Heaters).	<2 gal	No amendments proposed.
	≥2 gal	Converting EF-based standards to UEF-based standards.
Grid-enabled Water Heater	>75 gal	No amendments proposed.
Gas-fired Circulating Water Heater	≤200,000 Btu/h	Amending UEF-based standards to reflect updates to the test procedure.
Oil-fired Circulating Water Heater	≤210,000 Btu/h	Amending UEF-based standards to reflect updates to the test procedure.
Electric Circulating Water Heater	≤12 kW; for heat pump type units ≤24 A at ≤250 V.	Amending UEF-based standards to reflect updates to the test procedure.

1. Product Classes With Current UEF-Based Standards

For product classes where DOE has analyzed amended UEF-based standards, DOE conducted an efficiency level analysis and a manufacturing cost analysis to generate cost-efficiency relationships that reflect the industry average manufacturing costs associated with each efficiency level analyzed. The following paragraphs of this document summarize the methodology used in these steps.

a. Efficiency Analysis

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

In the March 2022 Preliminary Analysis, DOE developed efficiency levels with a combination of the efficiency-level and design-option approaches. DOE conducted a market analysis of currently available models listed in DOE's Compliance Certification Database (''CCD'') to determine which efficiency levels were most representative of the current distribution of consumer water heaters available on the market. DOE also completed physical teardowns of commercially available units to determine which design options manufacturers may use to achieve certain efficiency levels for each water heater category analyzed. DOE requested comments from stakeholders and conducted interviews with manufacturers concerning these initial efficiency levels, which have been updated in this NOPR based on the feedback DOE received.

The efficiency levels for storage water heater classes presented in the March 2022 Preliminary Analysis are linear equations of UEF as a function of rated storage volume, while for this NOPR DOE has analyzed efficiency levels for UEF that are a function of effective storage volume (with the exception of certain levels which were analyzed in response to the Joint Stakeholder Recommendation). For products with substantial storage volumes, the UEF is expected to decrease with higher volumes because standby losses (*i.e.,* energy lost from the stored water to the surroundings when the water heater is not actively heating water) are related to the temperature of the water stored and the size of the tank.[29] The efficiency levels analyzed in this rulemaking assume that the relationships between standby losses and storage volume for baseline products (*i.e.,* the slopes of the current standards equations) would remain consistent for higher efficiency levels. In other words, the higher efficiency levels are linear equations that are parallel to the current standards. The exception to this is for DOE's analysis of the Joint Stakeholder Recommendation, which included certain efficiency levels that were not specified as a function of storage volume (see Table III.1).

In response to the efficiency levels presented in the March 2022 Preliminary Analysis, NYSERDA stated that reducing standards by rated storage volume is unnecessary and recommended that DOE's proposed standard levels either not change or increase by capacity, as it is more typical of appliance standards and there are models at larger volumes with higher UEFs. (NYSERDA, No. 35 at p. 6) NEEA, ACEEE, and NWPCC urged DOE to consider whether less stringent standards for gas-fired storage water heaters with larger storage volumes are justified, given that smaller gas-fired storage water heaters can meet similar FHRs. (NEEA, ACEEE, and NWPCC, No. 47 at p. 7)

As discussed, larger storage water heaters are more susceptible to standby losses due to the increased surface area of the storage tank when compared to smaller storage water heaters with the same design options. Standards that stay the same do not account for this fact; DOE therefore maintained its current approach and analyzed efficiency levels that are equations that decrease linearly as effective storage volume increases for all levels except those suggested by the Joint Stakeholder Recommendation (because the Joint Stakeholder Recommendation explicitly suggested flat-line standards for electric storage water heaters). Further, DOE understands NYSERDA's reference to ''capacity'' to refer to delivery capacity of the water heater—which is either FHR or Maximum GPM. Draw patterns, which are described in section IV.A.1 of this document, are bins of delivery capacity ranging from very small to high delivery capacity. DOE's current standards already increase in stringency with draw pattern (*see* 10 CFR 430.32(d)), and this increase in stringency was retained in the efficiency level analyses of the March 2022 Preliminary Analysis and this NOPR.

In this NOPR, DOE has revised the efficiency levels analyzed in the March 2022 Preliminary Analysis for electric storage water heaters, gas-fired storage water heaters, and gas-fired instantaneous water heaters. The details of the efficiency level analysis are presented in chapter 5 of the NOPR TSD, and a summary of these updates is discussed here. For electric storage water heaters, DOE has included additional levels for heat pump water heaters based on the standard levels recommended in the Joint Stakeholder Recommendation. For gas-fired storage water heaters, DOE revised its max-tech efficiency levels after conducting an updated market assessment for the NOPR analysis. DOE has tentatively determined that it is possible for gas-fired storage water heaters to surpass the max-tech levels chosen in the March 2022 Preliminary Analysis. Thus, DOE selected revised max-tech efficiency levels for this NOPR based on new product certifications and confidential manufacturer feedback. For gas-fired instantaneous water heaters, DOE analyzed an additional efficiency level for this NOPR that was not evaluated in the March 2022 Preliminary Analysis. In the updated market assessment for this NOPR, DOE observed a greater number of models at the levels specified in the ENERGY STAR v5.0 specification[30] than at the time of the March 2022 Preliminary Analysis; thus, efficiency levels corresponding to the ENERGY STAR v5.0 specification were added. DOE also reduced its max-tech efficiency levels based on feedback from stakeholders and a review of the current market and technologies at the time of this NOPR analysis.

These changes to the efficiency levels are discussed in further detail in the sub-sections that follow.

Baseline Efficiency

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/equipment typical of that class (*e.g.,* capacity, physical size). Generally, a baseline model is one that just meets current energy conservation standards, or, if no standards are in place, the baseline is typically the most common or least efficient unit on the market. For this NOPR, the baseline efficiency levels for product classes with current UEF-based standards are equal to the current energy conservation standards (see Table II.1).

Higher Efficiency Levels

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 the March 2022 Preliminary Analysis, the max-tech efficiency levels generally corresponded to the maximum available efficiency level on the market. DOE also analyzed multiple intermediate efficiency levels between the baseline and max-tech in order to develop the cost-efficiency relationship for each product class. Intermediate efficiency levels were chosen based on the market assessment where there were clear groupings in the market's efficiency distribution. In some cases, efficiency levels were observed for one draw pattern but not the others.

In response to the March 2022 Preliminary Analysis, BWC requested

[29] As discussed in section III.B of this document, the effective storage volume metric accounts for both temperature and tank size, whereas rated storage volume alone only accounts for tank size.

[30] EPA's ENERGY STAR v5.0 specification is available online at: *www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Residential%20Water%20Heaters%20Version%205%20Specification%20and%20Partner%20Commitments.pdf* (Last accessed on April 1, 2023).

DOE clarify how max-tech levels were determined for draw patterns where products do not yet exist. (BWC, No. 32 at p. 2)

In this NOPR, DOE has constructed cost versus efficiency curves for the representative capacities and representative draw patterns which exist on the market today, as opposed to directly analyzing every possible draw pattern. However, DOE is proposing to increase stringency of standards for draw patterns where products do not currently exist in order to match the stringency of standards for draw patterns where products in the same category do exist, in the event that products become available with draw patterns not currently on the market.

For these cases, DOE estimated these max-tech levels using existing relationships between efficiency levels observed in other draw patterns where products do exist. Products in different draw patterns are typically differentiated by rated storage volume and heating capacity (burner input rate, compressor capacity, or element wattage), and the design options used to improve UEF in one draw pattern can generally also be applied to water heaters of the same type in a different draw pattern. For the cases where products at additional intermediate efficiency levels were observed in the market at one draw pattern but not the others, DOE estimated efficiency levels in the other draw patterns based on what was observed for the one available draw pattern. The approach took into account how each product type's efficiency correlates to its delivery capacity (*i.e.,* either FHR or maximum GPM, the delivery capacity metrics assigned for non-flow-activated water heaters and flow-activated water heaters, respectively), recovery efficiency, and technological feasibility of design option implementation. A detailed discussion of efficiency level selection on a product-class by product-class basis is provided in chapter 5 of the NOPR TSD.

The following paragraphs provide additional discussion of the comments received in response to the efficiency levels analyzed in the March 2022 Preliminary Analysis and any updates made to the NOPR efficiency level analysis to address stakeholder concerns. Interested parties provided comments on electric storage water heaters, gas-fired storage water heaters, and gas-fired instantaneous water heaters.

i. Electric Storage Water Heaters

The efficiency levels above the baseline that were analyzed in the March 2022 Preliminary Analysis are shown in Table IV.8.

TABLE IV.8—MARCH 2022 PRELIMINARY ANALYSIS EFFICIENCY LEVELS FOR ELECTRIC STORAGE WATER HEATERS

EL	Draw pattern			
	Very small	Low	Medium	High
Rated Storage Volume (V_r) Greater Than or Equal to 20 Gallons and Less Than or Equal to 55 Gallons				
1	N/A	$0.9381 - 0.0003 \times V_r$	$0.9390 - 0.0002 \times V_r$	$0.9450 - 0.0001 \times V_r$
2	N/A	$3.3048 - 0.0003 \times V_r$	$3.3590 - 0.0002 \times V_r$	$3.4742 - 0.0001 \times V_r$
3	N/A	$3.7048 - 0.0003 \times V_r$	$3.7590 - 0.0002 \times V_r$	$3.8742 - 0.0001 \times V_r$
V_r Greater than 55 Gallons and Less Than or Equal to 120 Gallons				
1	N/A	N/A	$3.4133 - 0.0011 \times V_r$	$3.5380 - 0.0011 \times V_r$
2	N/A	N/A	$3.9633 - 0.0011 \times V_r$	$4.0880 - 0.0011 \times V_r$

EEI expressed concern that some UEF requirements analyzed in the March 2022 Preliminary Analysis are too high for electric resistance water heaters with rated storage volumes less than 55 gallons, stating that there is a large difference between EL 1 and EL 2 in the preliminary analysis and there may be many water heaters between these levels. (EEI, No. 31 at pp. 34–35) NEEA, ACEEE, and NWPCC urged DOE to create a new heat pump efficiency level between the preliminary analysis EL 2 and EL 3 for electric storage water heaters between 20 and 55 gallons, because many such models are currently available between these two efficiency levels. NEEA, ACEEE, and NWPCC specifically recommended a new efficiency level at a UEF of 3.50 for a representative storage volume of 45 gallons in the medium draw pattern. (NEEA, ACEEE, and NWPCC, No. 47 at p. 7) Then, as discussed in section III.F of this document, the Joint Stakeholders recommended that DOE analyze specific efficiency levels for electric storage water heaters, some of which were not evaluated for the preliminary analysis (at 2.0, 2.3, and 2.5 UEF depending on the draw pattern, storage volume and height). (Joint Stakeholders, No. 49 at p. 2)

In this NOPR, DOE has revised EL 1 for electric storage water heaters with effective storage volumes between 20 and 55 gallons (excluding small electric storage water heaters). In the March 2022 Preliminary Analysis, EL 1 represented an incremental improvement in efficiency over the baseline through the implementation of increased insulation thickness to reduce standby losses. However, DOE received feedback from multiple sources indicating that increasing the thickness may not be practical in the manufacturing process because the R-value of polyurethane diminishes when the compound is blown into larger cavities, and the increase in thickness does not offset the increase in water heater surface area (which will increase standby losses). Thus, in this NOPR, DOE considered a different stringency for EL 1 for electric storage water heaters, which would be more representative of the next level up from baseline and would currently be met using heat pump technology. Specifically, DOE considered the efficiency level recommended in the Joint Stakeholder Recommendation as EL 1 for the NOPR, a UEF of 2.30.

On July 18, 2022, EPA published a final draft of the ENERGY STAR v5.0 specifications for water heaters, which went into effect on April 18, 2023. The UEF requirements for ENERGY STAR v5.0 can only be met by heat pump technology. For integrated 240 V heat pump water heaters, the minimum UEF must be 3.30. This stringency generally corresponds to EL 2 in this NOPR analysis. For integrated 120 V heat pump water heaters and split-system heat pump water heaters, the minimum UEF must be 2.20, which is similar to the efficiency level recommended by the Joint Stakeholders.

DOE is aware that ongoing State efforts to decarbonize heating appliances may lead to an increased demand for 120 V heat pump water heaters, which do not need a 240 V electrical connection in order to transition from a gas-fired storage water heater to an electric one. As indicated by comments from interested parties that are discussed in section IV.A.2 of this document, multiple manufacturers are developing 120 V heat pump water heaters, and these products are now close to becoming commercially-available.[31] However, as suggested by ENERGY STAR's less stringent requirement for 120 V and split-system heat pump water heaters, these types of heat pump water heaters may not be able to achieve the same efficiencies as 240 V integrated heat pump water heaters. Reasons for this are discussed further in chapter 3 of the TSD. In its updated market assessment, DOE observed that currently certified 120 V heat pump water heaters can meet the ENERGY STAR v5.0 criteria, and a UEF of 2.20 generally aligns with the lowest heat pump water heaters efficiencies available. DOE has tentatively determined that the efficiency levels proposed by the Joint Stakeholders would not prevent novel 120 V products from entering the market based on the UEF efficiencies these products are reported to attain in CCD and ENERGY STAR certification databases.

Therefore, the redefinition of EL 1 from an electric resistance efficiency level to a low-efficiency heat pump efficiency level reduces the difference in stringency between EL 1 and EL 2, which may address the concern raised by EEI.

For small electric storage water heaters, limitations in split-system heat pump technology result in a lower max-tech efficiency level than for the non-small classes. DOE analyzed one efficiency level above the baseline (which is also the max-tech efficiency level) that corresponds to a UEF of 2.00. This efficiency level was suggested by the Joint Stakeholders. DOE verified that this level was representative of a split-system heat pump small electric storage water heater based on teardown data as well as market data on the performance of other heat pump water heaters on the market today (this is discussed further in chapter 5 of the TSD).

In response to the comment by NEEA, ACEEE, and NWPCC, DOE has not been able to determine whether there are any substantial differences in design options for 45-gallon electric storage water heaters rated at 3.35 UEF versus 3.50 UEF. In this NOPR, DOE has tentatively determined that the use of an electronic expansion valve, electronically commutated fan motors (''ECM'' fans), and appreciable increases in heat exchanger surface areas can allow the majority of the market to achieve a UEF of 3.35 for a 45-gallon product in the medium draw pattern and a UEF of 3.47 for a 55-gallon product in the high draw pattern.

DOE seeks further information that would assist in potentially re-evaluating the stringency of EL 2, especially data regarding the technologies employed in 45-gallon medium draw pattern products at a UEF of 3.50.

NEEA, ACEEE, and NWPCC reiterated that, in establishing the max-tech level, the statute does not require DOE to consider only technologies that are commercially available. Therefore, NEEA, ACEEE, and NWPCC recommended that DOE consider establishing a ''heat pump-only'' level, which would exclude the use of electric resistance elements, as max tech for heat pump water heaters. NEEA, ACEEE, and NWPCC added that the majority of heat pump water heaters already offer a ''heat pump-only mode'' and that this design change would improve in-field efficiency simply through the removal of the resistance element. (NEEA, ACEEE, and NWPCC, No. 47 at pp. 7–8)

In response, DOE notes that its own test data indicate that heat pump water heaters with backup electric resistance elements typically do not use the elements during DOE's 24-hour simulated use test. Therefore, adding an efficiency level that corresponds to a ''heat-pump only'' design option as max tech would not be expected to change the UEF.

AHRI and BWC requested that DOE specifically include ''lowboy''[32] electric storage water heaters in addition to short and tall models in its analysis. (AHRI, No. 42 at p. 4; BWC, No. 32 at pp. 1–2) Rheem expressed concern that lowboy electric storage water heaters were not properly addressed and requested that DOE separately examine lowboy electric storage water heaters. Rheem specifically requested that DOE include low-income consumers in the consumer subgroup analysis with a focus on how the removal of lowboy water heaters through the standards process will affect this group. (Rheem, No. 45 at pp. 5–6) Rheem suggested DOE's provided shipping dimensions for short electric storage water heaters do not align with typical dimensions for lowboy water heaters in medium and high draw patterns for EL 2. Rheem added that, for the low draw pattern, however, the height and diameter DOE provided (when accounting for shipping materials) is within the range of typical dimensions for lowboy water heaters. (Rheem, No. 45 at p. 6)

Lowboy water heaters are suitable for an installation arrangement commonly found in apartments and condominiums. In order to store a volume of water that is similar to the volume of a non-lowboy water heater, lowboy water heaters typically have a much wider aspect ratio as compared to non-lowboy water heaters, while still maintaining diameters that can fit through standard doorways. In the March 2022 Preliminary Analysis, DOE did not analyze lowboy aspect ratios for every draw pattern. Instead, the approach focused on ''tall'' and ''short'' aspect ratios—where ''short'' aspect ratios included some lowboy water heaters but also other mid-height products. In this NOPR, DOE revised its analysis to consider lowboy water heaters as the representative design aspect ratio for small electric storage water heaters. DOE developed efficiency levels and manufacturer production costs (''MPCs'') to specifically reflect lowboy water heaters for that product class given the prevalence of these designs as small electric storage water heaters. (Chapter 3 and Appendix 3A to the NOPR TSD provides additional details on the market distribution of lowboy water heaters.)

Rheem noted that for the medium and high draw patterns, efficiency levels that would require the use of heat pump technology appear to be appropriate for ''short'' and ''tall'' aspect ratios but would not be possible for lowboy water heaters due to the physical limitations of the installation space. Rheem added that there are no commercially available heat pump water heaters in the low draw pattern capable of being installed in space-constrained applications and for direct replacement of lowboy water heaters. (Rheem, No. 45 at pp. 6–7) Rheem suggested that if DOE were to amend the electric storage water heater standards to a level that would require heat pump technology and did not create a separate product class for lowboy water heaters, then replacements would likely be electric instantaneous water heaters, which would not result in efficiency gains and would increase the cost of water heating

[31] EPA's ENERGY STAR qualified product database includes listings for 120 V heat pump water heaters. This database can be accessed online at *www.energystar.gov/productfinder/product/certified-water-heaters/results* (Last accessed on Jan. 24, 2023).

[32] Lowboy water heaters are electric storage water heaters which are typically under 36 inches tall, with fittings considered.

for customers switching from lowboy water heaters. (Rheem, No. 45 at p. 7) The Joint Stakeholders recommended DOE maintain an electric resistance-level standard for electric storage water heaters that are between 30 and 35 gallons in storage volume and under 36 inches in height. (Joint Stakeholders, No. 49 at p. 2)

As discussed in section IV.A.1.d of this NOPR, DOE is considering a separate product class for small electric storage water heaters. DOE recognizes the specific design considerations of small electric storage water heaters and has updated its analyses to account for a unique design option pathway for these water heaters. For this NOPR engineering analysis, DOE considered lowboy designs to be representative models for the small electric storage water heater product class. As Rheem suggests, the typical application of lowboy water heaters may prohibit the use of an integrated heat pump design wherein the heat pump components sit on top of the water tank (these components typically add around 12 inches to the height of a water heater). However, an alternative to integrating the heat pump components into the tank would be a split-system heat pump where the heat pump is located somewhere other than on top of the tank. In its market assessment, and as discussed in the June 2023 TP Final Rule, DOE identified circulating heat pump water heaters designed to be paired with a storage-type water heater in the field (resulting in a split-system heat pump water heater). Details of these products can be found in chapter 3 of the NOPR TSD. DOE expects that split-system heat pump designs could be used in applications with the height restrictions that are currently served by lowboy water heaters because the heat pump componentry can be located remotely from the storage tank. Therefore, in this NOPR engineering analysis, DOE tentatively determined that the design pathways for small electric storage water heaters would use split-system heat pump designs, whereas other electric storage water heaters could achieve higher efficiency levels using integrated heat pump designs. However, DOE's analyses of circulating heat pump water heaters have led the Department to initially determine that such split-system heat pump water heaters may have efficiency limitations due to piping losses, limited heat transfer surface area, and pump operation. Therefore, the max-tech efficiency of a split-system heat pump water heater is expected to be lower than that of an integrated heat pump water heater. Based on its market assessment, only one efficiency level above baseline was analyzed for small electric storage water heaters. There are very few split-system designs on the market today, so DOE requests additional information from commenters on these types of designs and the potential UEFs that can be achieved.

DOE requests comment on the potential design specifications, manufacturing processes, and efficiencies of split-system heat pump water heaters.

ii. Gas-Fired Storage Water Heaters

The higher efficiency levels analyzed in the March 2022 Preliminary Analysis are shown in Table IV.9.

TABLE IV.9—MARCH 2022 PRELIMINARY ANALYSIS EFFICIENCY LEVELS FOR GAS-FIRED STORAGE WATER HEATERS

EL	Draw pattern			
	Very small	Low	Medium	High
1	N/A	$0.6251 - 0.0019 \times V_r$	$0.6646 - 0.0017 \times V_r$	$0.7024 - 0.0013 \times V_r$
2	N/A	$0.6451 - 0.0019 \times V_r$	$0.7046 - 0.0017 \times V_r$	$0.7424 - 0.0013 \times V_r$
3	N/A	$0.6551 - 0.0019 \times V_r$	$0.7146 - 0.0017 \times V_r$	$0.7524 - 0.0013 \times V_r$
4	N/A	$0.7651 - 0.0019 \times V_r$	$0.8146 - 0.0017 \times V_r$	$0.8624 - 0.0013 \times V_r$
5	N/A	$0.8251 - 0.0019 \times V_r$	$0.8746 - 0.0017 \times V_r$	$0.9224 - 0.0013 \times V_r$

NEEA, ACEEE and NWPCC urged DOE to consider gas-fired heat pump water heaters as the basis for the max-tech efficiency level because they are technologically feasible and are expected to be commercially available by 2025. NEEA, ACEEE and NWPCC also added that the statute requires DOE to consider max-tech as the maximum technologically feasible technology that has been shown to achieve high levels of efficiency under field conditions but does not limit DOE to commercially available products. (NEEA, ACEEE, and NWPCC, No. 47 at p. 11)

As discussed in section IV.B.1 of this document, DOE has tentatively determined that gas-fired heat pump water heaters do not meet the screening criteria and as such has screened them out for this NOPR analysis. Consequently, the max-tech efficiency level does not reflect use of gas-fired heat pump water heater technology.

Rheem recommended that EL 3 for gas-fired storage water heaters include the electric flue damper, fan-assist, and power vent technology options and increase the UEF of EL 3 to 0.63, 0.68, and 0.70 for the low, medium, and high draw patterns, respectively. (Rheem, No. 45 at p. 4) In response, DOE determined the efficiency levels for gas-fired storage water heaters based on common design options manufacturers use to increase efficiency and achieve incremental gains in UEF. The UEF levels DOE analyzed for EL 3 for gas-fired storage water heaters correspond with the specified representative effective storage volumes for each draw pattern, which were determined based on the distribution of storage volumes observed in units currently available on the market; DOE notes that Rheem did not specify what storage volumes its suggested UEF levels for EL 3 are based on.

Rheem recommended that DOE remove the thermopile flue damper technology option from EL 2 or replace it with an inlet damper. (Rheem, No. 45 at p. 4) AHRI stated that millivolt-powered dampers are not used in consumer products and questioned the validity of the MPCs developed for EL 2 of gas-fired storage water heaters, given that this efficiency level includes millivolt-powered dampers in its design. (AHRI, No. 42 at p. 3) NEEA, ACEEE, and NWPCC urged DOE to consider gas pressure-actuated non-powered dampers in its list of technology options to reach EL 2 for storage water heaters because they could be a lower cost pathway than the other technologies considered for EL 2. NEEA, ACEEE, and NWPCC added that testing performed by The Gas Technology Institute (''GTI'') indicates the incremental cost of such technology is $38.43. (NEEA, ACEEE, and NWPCC, No. 47 at p. 11)

As discussed previously in section IV.B.1of this document, DOE agrees with these commenters that millivolt and thermopile flue dampers are not applicable to consumer water heaters and has thus screened them out from further analysis in this NOPR. Instead, DOE has implemented the gas-actuated damper technology option for EL 2 for gas-fired storage water heaters.

Additionally, in the March 2022 Preliminary Analysis, DOE presented three different design option pathways to achieve EL 2 for gas-fired storage water heaters. These three pathways account for potential differences in installation requirements, such as the requirement to have electricity supply or a need for induced-draft ventilation to compensate for longer vent lengths. However, in this NOPR, DOE has removed the pathway consisting of an induced-draft ventilation system due to the technological similarities between such an approach and the design options most likely to be implemented for EL 3. Further details of this change are provided in chapter 5 of the NOPR TSD.

iii. Gas-Fired Instantaneous Water Heaters

The higher efficiency levels analyzed in the March 2022 Preliminary Analysis are shown in Table IV.9.

TABLE IV.9—MARCH 2022 PRELIMINARY ANALYSIS EFFICIENCY LEVELS FOR GAS-FIRED INSTANTANEOUS WATER HEATERS

EL	Draw pattern			
	Very small	Low	Medium	High
1	N/A	N/A	0.87	0.89
2	N/A	N/A	0.91	0.93
3	N/A	N/A	0.96	0.97

In response to the March 2022 Preliminary Analysis, the Joint Stakeholders suggested DOE analyze an EL 2 for gas-fired instantaneous water heaters that is the same as was evaluated in the March 2022 Preliminary Analysis. (Joint Stakeholders, No. 49 at p. 2) The efficiency level recommended by the Joint Stakeholders has been analyzed as EL 2 in this NOPR.

Rheem suggested that the UEF levels at EL 3 should be reduced to 0.93 and 0.96 for the medium and high draw patterns, respectively, as these would be more representative of the maximum UEF levels currently available on the market. (Rheem, No. 45 at p. 7)

Based on its review of the CCD, DOE tentatively agrees that the UEF levels suggested by Rheem are more representative of currently available products and notes that it has updated its proposed UEF levels for gas-fired instantaneous water heaters at max-tech to the maximum-available UEF levels found on the market.

In the ENERGY STAR v5.0 specification for water heaters, gas-fired instantaneous water heaters must have UEF greater than or equal to 0.95, provide a maximum GPM rating of at least 2.8 gpm over a 67 °F temperature rise, and meet other warranty and safety criteria to meet the ENERGY STAR v5.0 specification. A maximum GPM rating of 2.8 gpm and above corresponds to the medium and high draw patterns in Table II of the appendix E test procedure. For this NOPR, DOE analyzed a 0.95 UEF efficiency level for the high draw pattern (EL 3), which corresponds to the ENERGY STAR level, as DOE expects that ENERGY STAR will drive a significant portion of the market to this level. However, through DOE's market and technology assessment, supplemented by feedback from confidential manufacturer interviews, the Department has tentatively determined that a UEF of 0.95 is currently not technologically feasible for gas-fired instantaneous water heaters in the medium draw pattern. Through teardown analyses (discussed in chapter 5 of the NOPR TSD), DOE has observed that the efficiency for these products is closely correlated to the heat exchanger surface area. Yet, as the surface area increases, so does the delivery capacity. As a result, the highest-efficiency gas-fired instantaneous water heaters (*i.e.,* those at 0.95 UEF or higher) are in the high draw pattern. Therefore, DOE did not analyze a UEF level of 0.95 for the medium draw pattern. Rather, at EL 3 for the medium draw pattern, DOE analyzed 0.92 UEF, which reflects a more achievable efficiency for this product class and requires the use of analogous technology as for the ENERGY STAR efficiency level of 0.95 UEF for the high draw pattern product class.

Efficiency Levels by Product Class

DOE's NOPR analysis for efficiency levels above baseline is discussed in more detail in chapter 5 of the NOPR TSD. Efficiency levels, including baseline and higher efficiencies, across all product classes are listed in the tables that follow. The efficiency levels which correspond closely to the Joint Stakeholder Recommendation are indicated with ''JSR''.

TABLE IV.10—GAS-FIRED STORAGE: 20 gal ≤V_{eff} ≤55 gal, STANDARD, LOW, AND ULTRA LOW NO_X

Efficiency level	UEF			
	Very small *	Low	Medium	High
0 (Baseline)	0.3456 − (0.0020 × V_{eff})	0.5982 − (0.0019 × V_{eff})	0.6483 − (0.0017 × V_{eff})	0.6920 − (0.0013 × V_{eff})
1	0.3725 − (0.0020 × V_{eff})	0.6251 − (0.0019 × V_{eff})	0.6646 − (0.0017 × V_{eff})	0.7024 − (0.0013 × V_{eff})
2 (JSR)	0.3925 − (0.0020 × V_{eff})	0.6451 − (0.0019 × V_{eff})	0.7046 − (0.0017 × V_{eff})	0.7424 − (0.0013 × V_{eff})
3	0.4025 − (0.0020 × V_{eff})	0.6551 − (0.0019 × V_{eff})	0.7146 − (0.0017 × V_{eff})	0.7524 − (0.0013 × V_{eff})
4	0.5125 − (0.0020 × V_{eff})	0.7651 − (0.0019 × V_{eff})	0.8146 − (0.0017 × V_{eff})	0.8624 − (0.0013 × V_{eff})
5 (Max-Tech)	0.5725 − (0.0020 × V_{eff})	0.8251 − (0.0019 × V_{eff})	0.8746 − (0.0017 × V_{eff})	0.9424 − (0.0013 × V_{eff})

* No products exist in the very small draw pattern at the time of this analysis. DOE applied the differences in efficiency levels from the low draw pattern to define the Efficiency Levels 1 through 5 for the very small draw pattern.

TABLE IV.11—OIL-FIRED STORAGE: V_{eff} ≤50 gal

Efficiency level	UEF			
	Very small *	Low *	Medium *	High
0 (Baseline)	0.2509 − (0.0012 × V_{eff})	0.5330 − (0.0016 × V_{eff})	0.6078 − (0.0016 × V_{eff})	0.6815 − (0.0014 × V_{eff})
1	0.2709 − (0.0012 × V_{eff})	0.5530 − (0.0016 × V_{eff})	0.6278 − (0.0016 × V_{eff})	0.7015 − (0.0014 × V_{eff})
2 (Max-Tech)	0.2909 − (0.0012 × V_{eff})	0.5730 − (0.0016 × V_{eff})	0.6478 − (0.0016 × V_{eff})	0.7215 − (0.0014 × V_{eff})

* No products exist in these draw patterns at the time of this analysis. DOE applied the differences in efficiency levels from the high draw pattern to define the Efficiency Levels 1 and 2 for the other draw patterns.

TABLE IV.12—SMALL ELECTRIC STORAGE: 20 gal ≤V_{eff} ≤35 gal, FHR <51 gal

Efficiency level	UEF	
	Very mmall †	Low
0 (Baseline)	0.8808 − (0.0008 × V_{eff})	0.9254 − (0.0003 × V_{eff})
1 (JSR)	2.00 *	2.00

* DOE applied the Joint Stakeholder Recommendation for low draw pattern units to the very small draw pattern in its analysis.
† No products exist in the very small draw pattern at the time of this analysis.

TABLE IV.13—ELECTRIC STORAGE: 20 gal ≤V_{eff} ≤55 gal, EXCLUDING SMALL ELECTRIC STORAGE

Efficiency level	UEF			
	Very small **	Low	Medium	High
0 (Baseline)	0.8808 − (0.0008 × V_{eff})	0.9254 − (0.0003 × V_{eff})	0.9307 − (0.0002 × V_{eff})	0.9349 − (0.0001 × V_{eff})
1 (JSR)	2.30 *	2.30	2.30	2.30
2	3.2602 − (0.0008 × V_{eff}) †	3.3048 − (0.0003 × V_{eff})	3.3590 − (0.0002 × V_{eff})	3.4742 − (0.0001 × V_{eff})
3 (Max-Tech)	3.6602 − (0.0008 × V_{eff}) †	3.7048 − (0.0003 × V_{eff})	3.7590 − (0.0002 × V_{eff})	3.8742 − (0.0001 × V_{eff})

* DOE applied the Joint Stakeholder Recommendation for low draw pattern units to the very small draw pattern in its analysis.
** No products exist in the very small draw pattern at the time of this analysis.
† DOE applied the differences in efficiency levels from the low draw pattern to define the Efficiency Levels 2 and 3 for the very small draw pattern.

TABLE IV.14—ELECTRIC STORAGE: 55 gal <V_{eff} ≤120 gal

Efficiency Level	UEF			
	Very small **	Low **	Medium	High
0 (Baseline)	1.9236 − (0.0011 × V_{eff})	2.0440 − (0.0011 × V_{eff})	2.1171 − (0.0011 × V_{eff})	2.2418 − (0.0011 × V_{eff})
1 (JSR)	2.50 *	2.50	2.50	2.50
2	3.2198 − (0.0011 × V_{eff}) †	3.3402 − (0.0011 × V_{eff}) †	3.4133 − (0.0011 × V_{eff})	3.5380 − (0.0011 × V_{eff})
3 (Max-Tech)	3.7698 − (0.0011 × V_{eff}) †	3.8902 − (0.0011 × V_{eff}) †	3.9633 − (0.0011 × V_{eff})	4.0880 − (0.0011 × V_{eff})

* DOE applied the Joint Stakeholder Recommendation for low draw pattern units to the very small draw pattern in its analysis.
** Only one product exists in the low draw pattern at the time of this analysis. No products exist in the very small draw pattern at the time of this analysis.
† DOE applied the differences in efficiency levels from the medium draw pattern and high draw pattern to define the Efficiency Levels 2 and 3 for the very small draw pattern and the low draw pattern.

TABLE IV.15—GAS-FIRED INSTANTANEOUS: V_{eff} <2 gal, RATED INPUT >50,000 Btu/h

Efficiency level	UEF			
	Very small *	Low *	Medium	High
0 (Baseline)	0.80	0.81	0.81	0.81
1	† 0.86	† 0.87	0.87	0.89
2 (JSR)	† 0.89	† 0.91	0.91	0.93
3	† 0.90	† 0.92	0.92	0.95
4 (Max-Tech)	† 0.91	† 0.93	0.93	0.96

* Only one brand has commercially-available products in the very small draw pattern and low draw pattern at the time of this analysis.
† DOE applied the differences in efficiency levels from the medium draw pattern to define the Efficiency Levels 1 through 4 for the very small draw pattern and the low draw pattern.

b. Design Options

Based on its teardown analyses and feedback provided by manufacturers in confidential interviews, DOE tentatively determined the technology options that are most likely to constitute the pathway to achieving the efficiency levels assessed. These technology options are referred to as ''design options.'' While manufacturers may achieve a given efficiency level using more than one design strategy, the selected design options reflect what DOE expects to be the most likely approach for the market in general in a standards-case scenario. Further details are provided in chapter 5 of the NOPR TSD.

BWC stated that electric water heaters with 2-inch insulation cavities are used mainly for space-constrained installations and water heaters with 3-inch insulation cavities would be more representative of baseline for non-space-constrained installations. (BWC, No. 32 at p. 2) DOE also acknowledges that 3 inches of insulation is more representative of baseline electric storage water heaters and has therefore updated EL 0 to reflect this.

BWC indicated that gas-fired storage water heaters can achieve the current standards with 1 inch of insulation only if they are designed for space-constrained applications, and in this case, the burner is downsized, resulting in a lower FHR. BWC stated that EL 0 is commonly met with 2 inches of insulation. BWC also noted that some of the specified technology options are only used in certain kinds of installations with specific constraints. (BWC, No. 32 at p. 2) DOE acknowledges that a downsized burner results in a lower FHR, which is why burner derating is screened out as a technology option (see section IV.B.1 of this document and chapter 4 of the NOPR TSD for details). In this NOPR, DOE used the 1-inch insulation design option for baseline gas-fired storage water heaters in the low and medium draw patterns. For the high draw pattern, where the FHR must be higher, DOE has updated the design options for baseline gas-fired storage water heaters to reflect the use of 1.5 inches of insulation based on teardown data.

Table IV.16 through Table IV.20 show the design options at each UEF level analyzed for the NOPR.

TABLE IV.16—DESIGN OPTIONS FOR GAS-FIRED STORAGE: 20 gal ≤V_{eff} ≤55 gal

EL	Standard and low NO_X design options	Ultra-low NO_X design options
0	Standard burner; Standing pilot; 1″ side/1″ top insulation *; Cat I venting (atmospheric); Straight flue.	Ultra-Low NO_X premix burner; Standing pilot; 1″ side/1″ top insulation *; Cat I venting (atmospheric); Straight flue.
1	2″ side/2″ top insulation	2″ side/2″ top insulation.
2A	Cat I venting (gas-actuated flue damper)	Cat I venting (gas-actuated flue damper).
2B	Electronic ignition; Cat I venting (electric flue damper)	Electronic ignition; Cat I venting (electric flue damper).
3	Electronic ignition Cat III venting (power venting) Increased heat exchanger baffling.	Electronic ignition Cat III venting (power venting) Increased heat exchanger baffling.
4	Cat IV venting (power venting) Condensing helical flue	Cat IV venting (power venting) Condensing helical flue.
5	Increased heat exchanger surface area	Increased heat exchanger surface area.

* 1.5″ side/1.5″ top insulation was used for the high draw pattern.

TABLE IV.17—DESIGN OPTIONS FOR OIL-FIRED STORAGE: V_{eff} >50 gal

EL	Design options
0	Single flue heat exchanger; Foam Insulation—1″ side/1.5″ top insulation.
1	Foam Insulation—2″ side/2.5″ top insulation.
2	Multi-flue heat exchanger.

TABLE IV.18—DESIGN OPTIONS FOR SMALL ELECTRIC STORAGE: 20 gal ≤V_{eff} ≤35 gal, FHR <51 gal

EL	Design options
0	3″ side/3″ top insulation; Lowboy aspect ratio (less than 36 inches in height).
1	Split-system R134A rotary compressor; Capillary expansion device; Counterflow condenser design; Tube-and-fin evaporator design; SPM evaporator fan; 2″ side/2″ top insulation.

TABLE IV.19—DESIGN OPTIONS FOR ELECTRIC STORAGE: 20 gal ≤V_{eff} ≤55 gal, EXCLUDING SMALL ELECTRIC STORAGE

EL	Design options
0	3″ side/3″ top insulation; Short aspect ratio for products ≤35 gal or in the low draw pattern, tall aspect ratio for products >35 gal and in the medium or high draw patterns.
1	Integrated R134A rotary compressor; Capillary expansion device; Hotwall condenser; Tube-and-fin evaporator design; SPM evaporator fan; 2″ side/2″ top insulation.
2	Electronic expansion valve; Larger condenser; Larger evaporator; ECM evaporator fan.
3	Larger condenser; Larger evaporator; Insulated sealed system; High efficiency fan blades.

TABLE IV.20—DESIGN OPTIONS FOR ELECTRIC STORAGE: 55 gal ≤V_{eff} ≤120 gal

EL	Design options
0	Integrated R134A rotary compressor; Electronic expansion valve; Hotwall condenser design; Tube-and-fin evaporator design; SPM evaporator fan; 2″ side/2″ top insulation.

TABLE IV.20—DESIGN OPTIONS FOR ELECTRIC STORAGE: 55 gal ≤V_{eff} ≤120 gal—Continued

EL	Design options
1	Larger evaporator.
2	Higher efficiency compressor; Larger condenser; Larger evaporator; ECM evaporator fan.
3	Higher efficiency compressor; Larger condenser; Larger evaporator; High efficiency fan blades.

TABLE IV.21—DESIGN OPTIONS FOR GAS-FIRED INSTANTANEOUS: V_{eff} <2 gal, RATED INPUT >50,000 Btu/h

EL	Design options
0	Step modulating burner; Non-condensing tube-and-fin heat exchanger.
1	Condensing tube heat exchanger.
2	Larger condensing heat exchanger.
3	Fully modulating burner; Larger condensing heat exchanger.
4	Larger condensing heat exchanger.

c. 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 this proposed rulemaking, DOE utilizes a combination of the physical and catalog teardown approaches to develop estimates of the MPC at each UEF efficiency level analyzed. Data from the teardowns were used to create bills of materials (''BOMs'') that capture all of the materials, components, and manufacturing processes necessary to manufacture products that achieve each UEF level. DOE used the BOMs along with publicly available material and component cost data as the basis for estimating the MPCs. DOE refined its cost estimates and its material and component cost data based on feedback received during confidential manufacturer interviews.

DOE received several comments in response to the cost analysis presented in the March 2022 Preliminary Analysis.

BWC expressed concern that DOE's analysis does not reflect this costs, which are very different from costs 2 years ago. BWC added that DOE's analysis also fails to account for future costs and prices. (BWC, No. 32 at p. 3) BWC also commented that some material costs stated in the preliminary TSD were inaccurate compared to both current costs and BWC's estimates of 5-year average costs and requested a confidential interview to provide detailed feedback. (BWC, No. 32 at p. 3) Rheem suggested that gas-fired storage water heater MPCs are underestimated, especially for condensing options. Rheem also suggested that MPCs associated with implementation of heat pump technology across the electric storage product class will be significant and are not fully reflected in DOE's estimates and requested a confidential interview with DOE consultants to provide feedback. (Rheem, No. 45 at pp. 4, 5)

DOE notes that its consultants routinely conduct confidential manufacturer interviews to gather feedback on various analytical inputs, which are then aggregated for use in the analysis. In preparation for this NOPR, DOE's consultants conducted such interviews with manufacturers in which DOE requested and received feedback on the MPCs as estimated in the March 2022 Preliminary Analysis, as well as on the underlying component and material costs. DOE has updated its cost analyses where appropriate, based on this feedback. In addition, due to the volatility of metal prices, DOE uses 5-year average metal prices to minimize the impact of large fluctuations in metal prices. DOE's 5-year average metal cost data have been updated to reflect prices for the most recent 5-year period ending September 2022. For all other material and component prices, DOE used the most recent prices available at the time of the analysis (*i.e.,* September 2022). DOE notes that there have been significant increases in material and component prices in comparison to those observed in September 2021, which were the basis of the MPCs estimated in the March 2022 Preliminary Analysis. As a result, the MPCs presented in this NOPR are higher, consistent with the feedback provided by commenters.

d. Shipping Costs

Shipping costs for storage-type consumer water heater product classes were determined based on the area of floor space occupied by the unit, including packaging. Instantaneous-type consumer water heaters have far less storage volume and have shipping costs based on weight limitations rather than space occupied. Most consumer water heaters cannot be shipped in any orientation other than vertical and are too tall to be double-stacked in a vertical fashion, though some units analyzed by DOE can be double stacked. For those units that can be double-stacked, including gas-fired instantaneous water heaters, lowboy electric storage water heaters, and non-lowboy electric storage water heaters less than or equal to 35 gallons in storage volume, the floor area available effectively doubles, reducing the overall shipping cost compared to taller products. DOE also accounted for electric storage water heaters sold as split-system heat pumps stacking the heat pump assembly atop the tank assembly. DOE research suggests that consumer water heaters are usually shipped together in nearly fully loaded trailers, rather than in less than truckload (''LTL'') configurations, where the consumer water heaters only occupy a portion of the trailer volume. Therefore, shipping costs have been calculated assuming fully loaded trailers; however, DOE applied an assumption that each truckload would only consist of one type of water heater, which may result in a conservative estimate of shipping costs.

To calculate the shipping costs, DOE estimated the cost per trailer based on standard trailer sizes, shipping the products between the middle of the country to the coast, using 2022 as the reference year for prices. Next, DOE estimated the shipped size (including packaging) of products in each product class at each efficiency level and, for each product class and efficiency level, determined the number of units that would fit in a trailer. DOE then calculated the average shipping cost per unit by dividing the cost per trailer load by the number of units that would fit per trailer (either by space limitation for storage-type water heaters or by weight limitation for instantaneous-type water heaters), for each product class and efficiency level.

DOE requests comment on the analysis assumptions used to estimate shipping costs for consumer water heaters.

e. Cost-Efficiency Results

The results of the engineering analysis are reported as cost-efficiency data in the form of MPCs and shipping costs calculated for each efficiency level of each product class for which DOE is proposing amended UEF-based standards. As discussed previously in section IV.C.3 of this NOPR, DOE determined these costs by developing BOMs based on a combination of physical and catalog teardowns and using information in the BOMs along with component and material price data to estimate MPCs. The results of DOE's analysis are listed in Table IV.22 through Table IV.29; see chapter 5 of the NOPR TSD for more details concerning these results.

DOE requests comment on the cost-efficiency results in this engineering analysis.

TABLE IV.22—ENGINEERING ANALYSIS RESULTS FOR GAS-FIRED STORAGE: 20 gal ≤V_{eff} ≤55 gal, STANDARD AND LOW NO_X

EL	UEF				MPC (2022$)	Shipping (2022$)
	Very small	Low 29 gal	Medium 38 gal	High 48 gal		
0	N/A	0.54	0.58	0.63	Low: 175.45, Med: 203.24, High: 236.63.	Low: 29.64, Med: 32.81, High: 49.00.
1	N/A	0.57	0.60	0.64	Low: 196.56, Med: 226.18, High: 249.17.	Low: 32.81, Med: 35.34, High: 51.04.
2A	N/A	0.59	0.64	0.68	Low: 250.46, Med: 280.09, High: 303.08.	Low: 32.81, Med: 35.34, High: 51.04.
2B	N/A	0.59	0.64	0.68	Low: 282.20, Med: 311.57, High: 334.26.	Low: 32.81, Med: 35.34, High: 51.04.
3	N/A	0.60	0.65	0.69	Low: 292.63, Med: 322.71, High: 347.45.	Low: 32.81, Med: 35.34, High: 51.04.
4	N/A	0.71	0.75	0.80	Low: 405.24, Med: 434.10, High: 464.66.	Low: 32.81, Med: 35.34, High: 51.04.
5	N/A	0.77	0.81	0.88	Low: 421.93, Med: 456.34, High: 492.47.	Low: 35.34, Med: 51.04, High: 55.68.

TABLE IV.23—ENGINEERING ANALYSIS RESULTS FOR GAS-FIRED STORAGE: 20 gal ≤V_{eff} ≤55 gal, ULTRA LOW NO_X

EL	UEF				MPC (2022$)	Shipping (2022$)
	Very small	Low 29 gal	Medium 38 gal	High 48 gal		
0	N/A	0.54	0.58	0.63	Low: 257.65, Med: 290.09, High: 329.11.	Low: 29.64, Med: 32.81, High: 49.00.
1	N/A	0.57	0.60	0.64	Low: 279.31, Med: 313.57, High: 341.91.	Low: 32.81, Med: 35.34, High: 51.04.
2A	N/A	0.59	0.64	0.68	Low: 333.21, Med: 367.47, High: 395.81.	Low: 32.81, Med: 35.34, High: 51.04.
2B	N/A	0.59	0.64	0.68	Low: 364.95, Med: 399.04, High: 427.07.	Low: 32.81, Med: 35.34, High: 51.04.
3	N/A	0.60	0.65	0.69	Low: 379.31, Med: 414.41, High: 444.31.	Low: 32.81, Med: 35.34, High: 51.04.
4	N/A	0.71	0.75	0.80	Low: 495.30, Med: 527.85, High: 562.68.	Low: 32.81, Med: 35.34, High: 51.04.
5	N/A	0.77	0.81	0.88	Low: 512.00, Med: 550.08, High: 590.49.	Low: 35.34, Med: 51.04, High: 55.68.

TABLE IV.24—ENGINEERING ANALYSIS RESULTS FOR OIL-FIRED STORAGE: V_{eff} ≤50 gal

EL	UEF				MPC (2022$)	Shipping (2022$)
	Very small	Low	Medium	High 30 gal		
0	N/A	N/A	N/A	0.64	932.84	35.34

TABLE IV.24—ENGINEERING ANALYSIS RESULTS FOR OIL-FIRED STORAGE: V_{eff} ≤50 gal—Continued

EL	UEF				MPC (2022$)	Shipping (2022$)
	Very small	Low	Medium	High 30 gal		
1	N/A	N/A	N/A	0.66	964.62	51.04
2	N/A	N/A	N/A	0.68	1054.22	51.04

TABLE IV.25—ENGINEERING ANALYSIS RESULTS FOR SMALL ELECTRIC STORAGE: 20 gal ≤V_{eff} ≤35 gal, FHR <51 gal

EL	UEF			MPC (2022$) Draw Pattern ($V_{eff}$)	Shipping, (2022$) Draw Pattern ($V_{eff}$)
	Very small	Low 26 gal	Low 35 gal		
0	N/A	0.92	0.91	Low (26): 161.74, Low (35): 183.73	Low (26): 18.56, Low (35): 29.17.
1	N/A	2.00	2.00	Low (26): 500.60, Low (35): 518.84	Low (26): 55.68, Low (35): 58.34.

TABLE IV.26—ENGINEERING ANALYSIS RESULTS FOR ELECTRIC STORAGE: 20 gal ≤V_{eff} ≤55 gal, EXCLUDING SMALL ELECTRIC STORAGE

EL	UEF						MPC (2022$) Draw Pattern ($V_{eff}$)	Shipping (2022$) Draw Pattern ($V_{eff}$)
	Very small	Low 36 gal	Medium 30 gal	Medium 36 gal	Medium 45 gal	High 55 gal		
0	N/A	0.91	0.92	0.92	0.92	0.93	Low (36): 184.99, Med (30): 171.49, Med (36): 189.77, Med (45): 205.75, High (55): 221.86.	Low (36): 49.00, Med (30): 25.52, Med (36): 34.04, Med (45): 35.34, High (55): 53.26.
1	N/A	2.30	2.30	2.30	2.30	2.30	Low (36): 397.67, Med (30): 276.12, Med (36): 400.31, Med (45): 416.25, High (55): 425.70.	Low (36): 49.00, Med (30): 51.04, Med (36): 34.03, Med (45): 35.34, High (55): 53.26.
2	N/A	3.29	3.35	3.35	3.35	3.47	Low (36): 419.64, Med (30): 406.39, Med (36): 422.26, Med (45): 438.79, High (55): 456.64.	Low (36): 49.00, Med (30): 51.04, Med (36): 34.03, Med (45): 35.34, High (55): 53.26.
3	N/A	3.69	3.75	3.75	3.75	3.87	Low (36): 482.54, Med (30): 471.60, Med (36): 486.16, Med (45): 504.95, High (55): 510.83.	Low (36): 49.00, Med (30): 51.04, Med (36): 34.03, Med (45): 35.34, High (55): 53.26.

TABLE IV.28—ENGINEERING ANALYSIS RESULTS FOR ELECTRIC STORAGE: 55 gal <V_{eff} ≤120 gal

EL	UEF				MPC (2022$)	Shipping (2022$)
	Very small	Low	Medium 58 gal	High 80 gal		
0	N/A	N/A	2.05	2.15	Med: 448.22, High: 477.46	Med: 51.04, High: 55.68.
1	N/A	N/A	2.50	2.50	Med: 454.94, High: 482.60	Med: 51.04, High: 55.68.
2	N/A	N/A	3.35	3.45	Med: 476.54, High: 495.66	Med: 51.04, High: 55.68.
3	N/A	N/A	3.90	4.00	Med: 540.27, High: 562.95	Med: 51.04, High: 55.68.

TABLE IV.29—ENGINEERING ANALYSIS RESULTS FOR GAS-FIRED INSTANTANEOUS: V_{eff} <2 gal, RATED INPUT >50,000 Btu/h

EL	UEF				MPC (2022$)	Shipping (2022$)
	Very small	Low	Medium 120,000 Btu/h	High 199,000 Btu/h		
0	N/A	N/A	0.81	0.81	Med: 253.68, High: 276.61	Med: 6.93, High: 11.70.
1	N/A	N/A	0.87	0.89	Med: 374.33, High: 394.00	Med: 10.83, High: 14.54.
2	N/A	N/A	0.91	0.93	Med: 380.81, High: 402.38	Med: 15.60, High: 17.55.
3	N/A	N/A	0.92	0.95	Med: 390.21, High: 410.00	Med: 16.60, High: 17.55.
4	N/A	N/A	0.93	0.96	Med: 396.07, High: 423.26	Med: 15.60, High: 17.55.

2. Product Classes Without Current UEF-Based Standards

In the December 2016 Conversion Factor Final Rule, DOE established that EF-based standards as established by EPCA are applicable to consumer water heaters but would not be enforced until conversion factors and converted standards are adopted. 81 FR 96204, 96209–96211. To convert these EF-based standards to UEF-based standards, DOE first developed conversion factors that convert tested values measured under the DOE test procedure in effect prior to the July 2014 TP Final Rule (which produces the EF metric) to values found under the current DOE test procedure (which produces the UEF metric). DOE then applied these conversion factors to representative baseline models and derived the UEF-based energy conservation standards from the resulting UEF values.

Circulating water heaters are covered by the existing standards for instantaneous water heaters; however these standards have not been enforced for circulating water heaters because of differences in how circulating water heaters operate resulting in difficulty determining UEF ratings under the previously applicable test procedure. Prior to the publication of the June 2023 TP Final Rule, the test procedure did not provide sufficient clarity regarding how these products should be tested, and the June 2023 TP Final Rule established a new method of testing circulating water heaters with separate storage tanks (see section 4.10 of appendix E) to represent how these products are used in the field. As a result of this method of testing, the efficiency ratings for circulating water heaters will reflect the standby losses incurred by the separate storage tank. In order to determine applicable UEF-based standards for circulating water heaters based on use of the newly established test procedure, DOE used the existing UEF-based standards for gas-fired instantaneous water heaters and electric instantaneous water heaters at 10 CFR 430.32(d) as the starting point for gas-fired circulating water heaters and electric circulating water heaters. DOE used the converted UEF-based standards for oil-fired instantaneous water heaters as the starting point for oil-fired circulating water heaters. As discussed previously in section III.C of this document, the effective storage volume of a circulating water heater is equal to the measured storage volume of the separate storage tank used for testing, so to account for these standby losses, DOE is proposing that the standards decrease linearly as a function of this effective storage volume. According to section 4.10 of appendix E, gas-fired circulating water heaters, oil-fired circulating water heaters, and electric resistance circulating water heaters (which would be considered the baseline type of electric circulating water heaters) are to be tested with unfired hot water storage tanks (''UFHWSTs'') with measured volumes between 80 and 120 gallons. DOE has tentatively determined that the relationship between standby losses and storage volume is similar for electric storage water heaters above 55 gallons and for UFHWSTs. Thus, DOE adjusted the UEF-based standards for instantaneous water heaters by applying the linear decreases in the currently applicable standards for electric storage water heaters greater than 55 gallons in rated storage volume to result in the converted standards for circulating water heaters. See chapter 5 of the NOPR TSD for further details describing this analysis.

DOE requests comment on the analytical approach used to determine equivalent baseline standards for circulating water heaters.

The proposed UEF-based standards that were translated from EF-based standards and the updated UEF standards for circulating water heaters that reflect the new test procedure are listed below in Table IV.30. See chapter 5 of the NOPR TSD for more detail concerning how UEF-based standards were determined.

TABLE IV.30—TRANSLATED UEF-BASED ENERGY CONSERVATION STANDARDS FOR PRODUCT CLASSES WITHOUT ESTABLISHED UEF-BASED STANDARDS

Product class	Nominal input	Effective storage volume	Draw pattern	Uniform energy factor
Gas-fired Storage Water Heater	≤75,000 Btu/h	<20 gal	Very Small	$0.2062 - (0.0020 \times V_{eff})$
			Low	$0.4893 - (0.0027 \times V_{eff})$
			Medium	$0.5758 - (0.0023 \times V_{eff})$
			High	$0.6586 - (0.0020 \times V_{eff})$
		>100 gal	Very Small	$0.1482 - (0.0007 \times V_{eff})$
			Low	$0.4342 - (0.0017 \times V_{eff})$
			Medium	$0.5596 - (0.0020 \times V_{eff})$
			High	$0.6658 - (0.0019 \times V_{eff})$
Oil-fired Storage Water Heater	≤105,000 Btu/h	>50 gal	Very Small	$0.1580 - (0.0009 \times V_{eff})$
			Low	$0.4390 - (0.0020 \times V_{eff})$
			Medium	$0.5389 - (0.0021 \times V_{eff})$
			High	$0.6172 - (0.0018 \times V_{eff})$
Electric Storage Water Heaters	≤12 kW	<20 gal	Very Small	$0.5925 - (0.0059 \times V_{eff})$
			Low	$0.8642 - (0.0030 \times V_{eff})$
			Medium	$0.9096 - (0.0020 \times V_{eff})$
			High	$0.9430 - (0.0012 \times V_{eff})$
		>120 gal	Very Small	$0.3574 - (0.0012 \times V_{eff})$
			Low	$0.7897 - (0.0019 \times V_{eff})$
			Medium	$0.8884 - (0.0017 \times V_{eff})$
			High	$0.9575 - (0.0013 \times V_{eff})$
Tabletop Water Heater	≤12 kW	<20 gal	Very Small	$0.5925 - (0.0059 \times V_{eff})$
			Low	$0.8642 - (0.0030 \times V_{eff})$
Instantaneous Gas-fired Water Heater	≤50,000 Btu/h	<2 gal	Very Small	0.64
			Low	0.64
			Medium	0.64
			High	0.64
	≤200,000 Btu/h	≥2 gal	Very Small	$0.2534 - (0.0018 \times V_{eff})$
			Low	$0.5226 - (0.0022 \times V_{eff})$

TABLE IV.30—TRANSLATED UEF-BASED ENERGY CONSERVATION STANDARDS FOR PRODUCT CLASSES WITHOUT ESTABLISHED UEF-BASED STANDARDS—Continued

Product class	Nominal input	Effective storage volume	Draw pattern	Uniform energy factor
			Medium	$0.5919 - (0.0020 \times V_{eff})$
			High	$0.6540 - (0.0017 \times V_{eff})$
Instantaneous Oil-fired Water Heater	≤210,000 Btu/h	<2 gal	Very Small	0.61
			Low	0.61
			Medium	0.61
			High	0.61
		≥2 gal	Very Small	$0.2780 - (0.0022 \times V_{eff})$
			Low	$0.5151 - (0.0023 \times V_{eff})$
			Medium	$0.5687 - (0.0021 \times V_{eff})$
			High	$0.6147 - (0.0017 \times V_{eff})$
Instantaneous Electric Water Heater	≤12 kW	≥2 gal	Very Small	$0.8086 - (0.0050 \times V_{eff})$
			Low	$0.9123 - (0.0020 \times V_{eff})$
			Medium	$0.9252 - (0.0015 \times V_{eff})$
			High	$0.9350 - (0.0011 \times V_{eff})$
Gas-fired Circulating Water Heater	≤200,000 Btu/h	All	Very Small	$0.8000 - (0.0011 \times V_{eff})$
			Low	$0.8100 - (0.0011 \times V_{eff})$
			Medium	$0.8100 - (0.0011 \times V_{eff})$
			High	$0.8100 - (0.0011 \times V_{eff})$
Oil-fired Circulating Water Heater	≤210,000 Btu/h	All	Very Small	$0.6100 - (0.0011 \times V_{eff})$
			Low	$0.6100 - (0.0011 \times V_{eff})$
			Medium	$0.6100 - (0.0011 \times V_{eff})$
			High	$0.6100 - (0.0011 \times V_{eff})$
Electric Circulating Water Heater	≤12 kW; for heat pump type units ≤24 A at ≤250 V.	All	Very Small	$0.9100 - (0.0011 \times V_{eff})$
			Low	$0.9100 - (0.0011 \times V_{eff})$
			Medium	$0.9100 - (0.0011 \times V_{eff})$
			High	$0.9200 - (0.0011 \times V_{eff})$

BWC requested clarification on DOE's methods to convert EF standards to UEF standards without an applicable test procedure to verify that the EF-based standards are appropriate in the first place. (BWC, No. 32 at p. 3) Rheem recommended that technologies used at the baseline for product classes with UEF-based standards also be used for the new volume and input rate ranges being covered. (Rheem, No. 45 at p. 9) BWC also suggested that increasing standards for electric storage water heaters with a volume of less than 20 gallons could preclude many existing models from the market, which BWC added serve a unique utility for very space-constrained installations. (BWC, No. 32 at p. 4)

The Department's detailed methodology for performing the conversion factor analysis on these product classes was provided in chapter 5 of the preliminary TSD and is also described in chapter 5 of the NOPR TSD. In summary, DOE used the conversion parameters from the December 2016 Conversion Factor Final Rule which corresponded to the product types most closely related to the product classes in question. DOE began with the EF-based standards equations prescribed at 42 U.S.C. 6295(e)(1) as a representation of the distribution of baseline-efficiency models in each product class. Considering all of the combinations of rated storage volumes and input rates which could yield baseline-efficiency models in each product class, DOE converted the EF rating to an estimated UEF rating. Once the UEF was determined for every model in this hypothetical population of all possible baseline EF models, DOE determined the most stringent UEF versus rated storage volume relationship (*i.e.,* the smallest-magnitude slope) that would allow the entire population to pass. These relationships were presented in Table 5.15.6 of the preliminary TSD. In this NOPR, DOE additionally assumed that the effective storage volume of each model would be equal to its rated storage volume. Thus, DOE replaced the rated storage volume term in these equations with effective storage volume for the proposed standards for these product classes.

In response to Rheem's suggestion, DOE was unable to clearly determine whether the baseline technologies used in product classes with UEF-based standards also apply to the most similar product classes with EF-based standards, especially in light of BWC's comment indicating that these products may be designed differently for unique applications. Additionally, because the storage volumes and input rates of the product classes with EF-based standards are different from the storage volumes and input rates of the product classes with UEF-based standards, DOE expects that manufacturers may implement different baseline technologies for models that do not have current UEF-based standards. As discussed in section II.B of this document, the current UEF-based standards are the result of two cycles of rulemakings that increased the stringency of the original statutory standards and also the December 2016 Conversion Factor Final Rule (converting the more-stringent EF-based standards into UEF-based standards). For example, in this NOPR, DOE estimates that electric storage water heaters between 20 and 55 gallons might typically use 3 inches of polyurethane foam in order to meet the current UEF standards; however, it is not clear whether this much insulation is being used for much smaller electric storage water heaters—such as those with only 2 gallons of rated storage volume. In some cases, such as oil-fired instantaneous water heaters, there are no current UEF-based standards from which to ascertain any baseline technologies.

In section 5.15 of chapter 5 of the preliminary TSD, DOE discussed that it performed testing of 19 water heater models covering a variety of classes and characteristics to confirm that the UEF energy conservation standards would be achievable by the consumer water heaters available on the market. In response, AHRI, BWC, and Rheem requested a list of the models tested when determining UEF-based standards for products that do not currently have them. (AHRI, No. 42 at p. 5; BWC, No. 32 at p. 3; Rheem, No. 45 at p. 9) To clarify, DOE's testing was limited to models available on the market that fell within these product classes. DOE was able to obtain and perform UEF testing on: 17 electric storage water heaters ranging from 1.8 gallons to 19.9 gallons of rated storage volume (with the average rated storage volume in the sample being approximately 8.7 gallons), 1 electric storage water heater with 158 gallons of rated storage volume, and 1 oil-fired instantaneous water heater with 5.3 gallons of rated storage volume.

Rheem supported DOE establishing realistic UEF-based standards for consumer water heaters currently without them as long as installation flexibility is maintained, but noted its concern that the establishment of these new standards could increase manufacturer burden. (Rheem, No. 45 at p. 9) In response, DOE reiterates that the stringency of these standards is not increasing as a result of the conversion, and therefore, manufacturers should not need to redesign their products to meet the UEF-based standards, if adopted.

DOE seeks comment from interested parties regarding the appropriateness of the converted UEF-based standards presented in Table IV.30 and whether products on the market can meet or exceed the proposed levels. If products are found to generally exceed the proposed levels, the Department requests information and data on the UEF of products within these product classes.

3. Manufacturer Selling Price

To account for manufacturers' non-production costs and profit margin, DOE applies a multiplier (the manufacturer markup) to the MPC. The resulting manufacturer selling price (''MSP'') is the price at which the manufacturer distributes a unit into commerce. DOE developed an average manufacturer markup by examining the annual Securities and Exchange Commission (''SEC'') 10–K reports filed by publicly traded manufacturers that produce consumer water heaters, the manufacturer markups from the April 2010 Final Rule, and feedback from confidential manufacturer interviews. 75 FR 20112. See chapter 12 of the NOPR TSD for additional detail on the manufacturer markup.

D. Markups Analysis

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

For consumer water heaters, the main parties in the distribution chain are: (1) manufacturers, (2) wholesalers or distributors, (3) retailers, (4) plumbing contractors, (5) builders, (6) manufactured home manufacturers, and (7) manufactured home dealers/retailers. See chapter 6 and appendix 6A of the NOPR TSD for a more detailed discussion about parties in the distribution chain.

For this NOPR, DOE characterized how consumer water heater products pass from the manufacturer to residential and commercial consumers [33] by gathering data from several sources, including consultant report (available in appendix 6A of the NOPR TSD), 2022 BRG report,[34] and 2020 Clear Seas Research Water Heater contractor survey [35] to determine the distribution channels and fraction of shipments going through each distribution channel. The distribution channels for replacement or new owner of consumer water heaters in residential applications (not including mobile homes) are characterized as follows: [36]

Manufacturer → Wholesaler → Plumbing Contractor → Consumer
Manufacturer → Retailer → Consumer
Manufacturer → Retailer → Plumbing Contractor → Consumer

For mobile home replacement or new owner applications, there is one additional distribution channel where manufacturers sell to mobile home dealer/retail outlet that then sells to the customer.[37]

Mainly for consumer water heaters in commercial applications, DOE considers an additional distribution channel for which the manufacturer sells the equipment to the wholesaler and then to the consumer through a national account in both replacement and new construction markets.

The new construction distribution channel includes an additional link in the chain—the builder. The distribution channels for consumer water heaters in new construction [38] in residential applications (not including mobile homes) are characterized as follows: [39]

Manufacturer → Wholesaler → Plumbing Contractor → Builder → Consumer
Manufacturer → Wholesaler → Builder → Consumer
Manufacturer → Wholesaler (National Account) → Consumer

For new construction, all mobile home GSWHs and ESWHs are sold as part of mobile homes in a specific distribution chain characterized as follows:

Manufacturer → Mobile Home Manufacturer → Mobile Home Dealer → Consumer

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

[33] DOE estimates that 2 percent of gas-fired storage heaters (GSWHs), 25 percent of oil-fired storage water heaters (OSWHs), 11 percent of electric storage water heaters (ESWHs), and 9 percent of gas-fired instantaneous water heaters (GIWHs) will be shipped to commercial applications in 2030.

[34] BRG Building Solutions, The North American Heating & Cooling Product Markets (2022 Edition) (Available at: *www.brgbuildingsolutions.com/reports-insights*) (Last accessed May 1, 2023).

[35] Clear Seas Research, 2020 Mechanical System—Water Heater (Available at: *https://clearseasresearch.com/reports/industries/mechanical-systems/*) (Last accessed May 1, 2023).

[36] Based on available data, DOE assumed that the consumer water heater goes through the: wholesaler/contractor 50 percent of the time for GSWHs, 90 percent of the time for OSWHs, 45 percent of the time for ESWHs, and 55 percent of the time for GIWHs; directly form the retailer 45 percent of the time for GSWHs, 5 percent of the time for OSWHs, 50 percent of the time for ESWHs, and 40 percent of the time for GIWHs, and retailer/contractor 5 percent of the time for GSWHs, OSWHs, ESWHs, and GIWHs.

[37] Based on available data, DOE assumed that the consumer water heater in mobile homes goes through the: wholesaler/contractor 5 percent of the time for GSWHs, 90 percent of the time for OSWHs, 5 percent of the time for ESWHs, and 55 percent of the time for GIWHs; directly form the retailer 10 percent of the time for GSWHs, 5 percent of the time for OSWHs, 25 percent of the time for ESWHs, and 40 percent of the time for GIWHs; retailer/contractor 5 percent of the time for GSWHs, OSWHs, ESWHs, and GIWHs; and directly through mobile home retailer 80 percent of the time for GSWHs, 0 percent of the time for OSWHs, 65 percent of the time for ESWHs, and 0 percent of the time for GIWHs.

[38] DOE estimates that 10 percent of gas-fired storage heaters (GSWHs), 2 percent of oil-fired storage water heaters (OSWHs), 14 percent of electric storage water heaters (ESWHs), and 32 percent of gas-fired instantaneous water heaters (GIWHs) will be shipped to new construction applications in 2030.

[39] DOE believes that many builders are large enough to have a master plumber and not hire a separate contractor, and assigned about half of water heater shipments to new construction to this channel. DOE estimated that in the new construction market, 90 percent of the residential (not including mobile homes) and 80 percent in commercial applications goes through a wholesalers to builders channel and the rest go through national account distribution channel.

markups are applied to the price of products with baseline efficiency, while incremental markups are applied to the difference in price between baseline and higher-efficiency models (the incremental cost increase). The incremental markup is typically less than the baseline markup and is designed to maintain similar per-unit operating profit before and after new or amended standards.[40]

PHCC stated that they do not believe that the mark-ups and incremental mark-ups of water heaters are similar to consumer electronics or real estate. PHCC believes that mark-ups may be trimmed in competitive bidding situations, but in the typical replacement market, consumers generally take the price of the serviceman who is ready to restore their hot water. Regarding the TSD references to the construction industry not being more profitable now than it has been for decades, PHCC added that this may be true in percentage terms, but as costs have gone up, the real profits have increased. (PHCC, No.40 at p. 2) In contrast, CA IOUs stated that DOE's analysis regarding the incremental cost associated with ELs for electric storage water heaters is consistent with their understanding of the typical markup practices. (CA IOUs, No. 39, p. 2)

The concept of DOE's incremental markup approach is based on a simple notion that an increase in profitability, which is implied by keeping a fixed markup when the product price goes up, is not likely to be viable over time in a business that is reasonably competitive. DOE discusses the consumer electronics and real estate industries as examples of this notion. DOE's analysis necessarily considers a simplified version of the world of water heater manufacturers and contractors: namely, a situation in which nothing changes except for those changes in water heater offerings that occur in response to amended standards.

DOE recognizes that manufacturers and contractors are likely to seek to maintain the same markup on water heaters if the price they pay goes up as a result of appliance standards, but it believes that over time adjustment is likely to occur due to competitive pressures. Other manufacturers and contractors may find that they can gain sales by reducing the markup and maintaining the same per-unit operating profit. Additionally, DOE contends that pricing is more complicated than a simple fixed profit margin.

DOE acknowledges that its approach to estimating manufacturer and contractor markup practices after amended standards take effect is an approximation of real-world practices that are both complex and varying with business conditions. However, DOE continues to maintain that its assumption that standards do not facilitate a sustainable increase in profitability is reasonable. See chapter 6 and appendix 6B of the NOPR TSD for more details about DOE's baseline and incremental markup approach.

To estimate average baseline and incremental markups, DOE relied on several sources, including: (1) form 10–K from U.S. Securities and Exchange Commission (''SEC'') for Home Depot, Lowe's, Wal-Mart, and Costco (for retailers); (2) U.S. Census Bureau 2017 Annual Retail Trade Report for miscellaneous store retailers (NAICS 453) (for online retailers),[41] (3) U.S. Census Bureau 2017 Economic Census data[42] on the residential and commercial building construction industry (for builder, plumbing contractor, mobile home manufacturer, mobile home retailer/dealer); and (4) the U.S. Census Bureau 2017 Annual Wholesale Trade Report data[43] (for wholesalers). DOE assumes that the markups for national account is half of the value of wholesaler markups. In addition, DOE used the 2005 Air Conditioning Contractors of America's (''ACCA'') Financial Analysis on the Heating, Ventilation, Air-Conditioning, and Refrigeration (''HVACR'') contracting industry[44] to disaggregate the mechanical contractor markups into replacement and new construction markets for consumer water heaters used in commercial applications.

In addition to the mark-ups, DOE obtained State and local taxes from data provided by the Sales Tax Clearinghouse.[45] These data represent weighted average taxes that include county and city rates. DOE derived shipment-weighted average tax values for each state considered in the analysis.

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

DOE seeks comments about DOE's approach for distribution channels and markup values.

E. Energy Use Analysis

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

DOE estimated the annual energy consumption of consumer water heaters at specific energy efficiency levels across a range of climate zones, building characteristics, and water heating applications. The annual energy consumption includes the natural gas, liquid petroleum gas (''LPG''), and electricity used by the consumer water heater.

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

1. Building Sample

To determine the field energy use of consumer water heaters used in homes, DOE established a sample of households using consumer water heaters from EIA's 2015 Residential Energy Consumption Survey (''RECS 2015''), which is the most recent such survey that is currently fully available.[46] The

[40] 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.

[41] U.S. Census Bureau, *2017 Annual Retail Trade Report,* available at *www.census.gov/programs-surveys/arts.html* (last accessed May 1, 2023). Note that the 2017 Annual Retail Trade Report is the latest version of the report that includes detailed operating expenses data.

[42] U.S. Census Bureau, *2017 Economic Census Data.* available at *www.census.gov/programs-surveys/economic-census.html* (last accessed May 1, 2023). Note that the 2017 Economic Census Data is the latest version of this data.

[43] U.S. Census Bureau, *2017 Annual Wholesale Trade Report.* available at *www.census.gov/wholesale/index.html* (last accessed May 1, 2023). Note that the 2017 AWTR Census Data is the latest version of this data.

[44] Air Conditioning Contractors of America (''ACCA''), *Financial Analysis for the HVACR Contracting Industry* (2005), available at *www.acca.org/store#/storefront* (last accessed May 1, 2023). Note that the 2005 Financial Analysis for the HVACR Contracting Industry is the latest version of the report and is only used to disaggregate the mechanical contractor markups into replacement and new construction markets.

[45] Sales Tax Clearinghouse Inc., *State Sales Tax Rates Along with Combined Average City and County Rates* (January 8, 2023) (Available at: *www.thestc.com/STrates.stm*) (Last accessed May 1, 2023).

[46] Energy Information Administration (''EIA''), 2015 Residential Energy Consumption Survey

Continued

RECS data provide information on the vintage of the home, as well as water heating energy use in each household. DOE used the household samples not only to determine water heater annual energy consumption, but also as the basis for conducting the LCC and PBP analyses. DOE projected household weights and household characteristics in 2030, the first year of compliance with any amended or new energy conservation standards for consumer water heaters. To characterize future new homes, DOE used a subset of homes in RECS 2015 that were built after 2000.

To determine the field energy use of consumer water heaters used in commercial buildings, DOE established a sample of buildings using consumer water heaters from EIA's 2018 Commercial Building Energy Consumption Survey (''CBECS 2018''), which is the most recent such survey that is currently fully available.[47] See appendix 7A of the NOPR TSD for details about the CBECS 2018 sample.

AHRI, Rheem, and GE Appliances are concerned with the Department using outdated data for the energy use analysis. They stated that it is not a valid assumption that the market has remained unchanged since 2012 or 2015. In the public meeting on April 12, 2022, the Department stated that they will be updating their analysis to use the CBECS 2018 data. AHRI, Rheem, and GE Appliances urged the Department to update its analysis to use the 2020 RECS data as soon as it becomes available. In addition, they recommended that DOE conduct updated surveys, studies, and analysis where the existing data sources are out of date, some by as much as ten years. (AHRI, No. 42 at p. 4; GEA, No. 46 at p. 1; Rheem, No. 45 at p. 8) In addition, NYSERDA also recommends the use of most current RECS 2020 to better reflect today's conditions and use the most recent data available to understand these dynamics due to the lasting impacts from COVID–19 pandemic on consumer water heater usage including the shift in the hours spent outside the home. They also stated that more people in a household leads to more hot water demand, and eventually more efficient energy use. (NYSERDA, No. 35 at pp. 4–5)

For this NOPR, DOE used the most recent data that was available. While conducting the analysis, RECS 2020 was not fully available and did not have energy consumption estimates. DOE did update the sample weighting based on RECS 2020 data. To confirm sample weighting using RECS 2020, DOE also reviewed trends from multiple sources including RECS, CBECS, Home Innovations data, American Home Comfort Survey data, and American Housing Survey (AHS) to determine any changes in occupant density and types of home, changes in the housing stock by region, new construction trends, and changes in the types of water heater used by region and market segment. DOE also compared its energy use model results to multiple studies including NEEA data, RASS data, Pecan Street data, and multiple other water heater studies. DOE has found that its energy use analysis results are similar to these studies. DOE agrees with NYSERDA that as the number of individuals living in households increases, the typically increases hot water use, but DOE has currently no evidence that individuals living in households is increasing over time. Also, DOE is currently tracking potential long-term impacts of COVID–19 pandemic on residential hot water use, but notes that it appears that a significant fraction of the increased hot water use seen during the COVID–19 pandemic has started to reverse as more people return to the workplace. See chapter 7, appendix 7A and appendix 7B of the NOPR TSD for more details about the building sample and distribution of hot water energy use including results comparison.

NEEA, ACEEE, and NWPCC requested that DOE ignore households that use no water in the analysis. They stated that for households with no hot water use, the cost-effectiveness of owning any water heater is, at best, undefined or zero and accordingly, calculating the cost-effectiveness of incrementally increasing the efficiency of a water heater with no water use is undefined. (NEEA, ACEEE, and NWPCC, No. 47 at p. 8) The LCC analysis accounts for occupied homes and buildings using RECS and CBECS. All these homes and buildings in the LCC analysis have at least some hot water use, so no households have zero hot water use.

2. Consumer Water Heater Sizing and Draw Pattern

Calculating hot water use for each sample household requires assigning the water heater a specific tank size (referred to as rated volume). For each household, RECS reports one of three water heater tank sizes (small, medium, or large), as well as the size range in gallons. ''Typical'' water heater sizes, which are those most common for each fuel type, have the minimum energy factor allowed by current energy conservation standards. These ''typical'' storage tank units have the largest market share in their product class (50 gallon for electric, 40 gallon for natural gas and LPG, and 30 gallon for oil). The sizes are referred to as ''standard'' sizes. In addition, DOE accounted for different draw patterns in the test procedure (*i.e.,* low, medium, and high).

In order to disaggregate the selected sampled water heaters into standard sizes and draw patterns, DOE used a variety of sources including RECS historical data on reported tank sizes, input from an expert consultant, and model data from DOE's public Certification Compliance Management System (''CCMS'')[48] and AHRI certification directory[49] together with other publicly available data from manufacturers' catalogs of consumer water heaters. For gas-fired instantaneous water heaters, DOE also used a combination of confidential data provide by AHRI from 2004–2007.[50] For all product classes, disaggregated shipments data by rated volume from BRG Building Solutions 2022 report from 2007 to 2021[51] and disaggregated based on data from U.S. Census Bureau data (2003–2008).[52] Finally to determine the best product type and size for different applications, DOE used manufacturer-produced consumer water heater sizing guidelines and calculators.

BWC stated that the amount of manufacturer models on public databases used in the analysis does not accurately reflect market shares of particular sizes or groups of models. They stated that multiple models with the same or very similar characteristics are likely attributed to manufacturers

(''RECS'') (Available at: *www.eia.gov/consumption/residential/*) (Last accessed May 1, 2023).

[47] U.S. Department of Energy: Energy Information Administration, Commercial Buildings Energy Consumption Survey (2018) (Available at: *www.eia.gov/consumption/commercial/data/2018/index.php?view=microdata*) (Last accessed May 1, 2023).

[48] U.S. Department of Energy-Appliance & Equipment Standards Program. Compliance Certification Management System (CCMS) for Consumer Water Heaters (Downloaded June 1, 2022). (Available at *www.regulations.doe.gov/certification-data/CCMS-4-Water_Heaters.html#q=Product_Group_s%3A%22Water%20Heaters%22*) (Last accessed May 1, 2023).

[49] Air Conditioning Heating and Refrigeration Institute. Consumer's Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment. June 1, 2022. (Available at *www.ahridirectory.org*) (Last accessed May 1, 2023).

[50] AHRI. Confidential Instantaneous Gas-fired Water Heater Shipments Data from 2004–2007 to LBNL. March 3, 2008.

[51] BRG Building Solutions. The North American Heating & Cooling Product Markets (2022 Edition). 2022.

[52] U.S. Census Bureau. Current Industrial Reports for Major Household Appliances 2003–2008. Washington, DC Report No. MA335F.

that have multiple brand names serving different parts of the market or particular customers. (BWC, No. 32 at p. 5). DOE's unique set of consumer water heater models removes models that have the same characteristics and represent multiple brands. DOE's use of this model dataset is only used when shipment or market data is not available. When the model data is used, consultant input or other available sources are used to try to better reflect the market shares of consumer water heaters at different sizes and characteristics. See appendix 7D of the NOPR TSD for more details about the model database.

NEEA, ACEEE, and NWPCC noted that RECS 2015 data shows that many homes have storage water heaters that are likely oversized for the needs of their occupants. NEEA, ACEEE, and NWPCC stated that DOE should consider that such homes may either choose to downsize equipment when replacing a water heater if it is oversized or choose to purchase an oversized water heater in anticipation of a home sale to new owners with greater hot water needs. (NEEA, ACEEE, and NWPCC, No. 47 at p. 9) DOE agrees that consumers could downsize equipment when replacing a water heater if it is oversized or choose to purchase an oversized water heater in anticipation of a home sale to new owners with greater hot water needs. There is limited historical data to quantify historical trends in the number of cases in the no-new-standards case where households might select a smaller or larger water heater, so DOE kept its equipment sizing methodology for the no-new-standards case. For the NOPR analysis, DOE did estimate that due to higher efficiency standards a fraction of consumers could downsize equipment when replacing a water heater if it is oversized to deal with space constraint installation issues or to downsize to smaller water heater options not impacted by standards (such as below 35 gallons for ESWHs in the proposed efficiency level).

NEEA, ACEEE, and NWPCC recommended that DOE should consider turnover in occupancy that may result in different draw profiles throughout the life of a given water heater. (NEEA, ACEEE, and NWPCC, No. 47 at p. 9) DOE agrees that several factors (such as turnover in occupancy and changes in consumer preference over time) may result in changes in the draw profiles and hot water use throughout the life of a given water heater. Currently, DOE could not find any data to quantify historical trends in draw patterns (such as shifts in the average occupancy per water heater). Therefore, DOE contends that on the overall hot water use averages out over the entire sample, since while some households could increase their hot water use analysis, on average a proportional number of households will decrease their hot water use. Therefore, DOE continued to assign the same draw profiles and hot water use throughout the life of a given water heater in the building sample, since on average energy use results would remain the same.

See appendix 7B of the NOPR TSD for more information about DOE's sizing methodology and comparison to available historical data.

3. Consumer Water Heater Energy Use Determination

To calculate the energy use of consumer water heaters, DOE determined the energy consumption associated with water heating and any auxiliary electrical use. In addition, for heat pump water heaters, DOE also accounted for the indirect effects of heat pump water heaters on heating, cooling, and dehumidification systems to compensate for the effects of the heat pump operation.[53] 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. Water heater operating conditions are indicated by the daily hot water draw volume, inlet water temperature, thermostat setting, and air temperature around the water heater (ambient air temperature). To describe energy efficiency characteristics of water heaters, WHAM uses three parameters that also are used in the DOE test procedure: recovery efficiency (*RE*), standby heat-loss coefficient (*UA*), and rated input power (P^{ON}).

The current version of WHAM is appropriate for calculating the energy use of electric resistance storage water heaters. To account for the characteristics of other types of water heaters, energy use must be calculated using modified versions of the WHAM equation. These modified versions are further discussed in chapter 7 and appendix 7B of the NOPR TSD.

The daily hot water draw volume is estimated based on the water heater energy use estimated from RECS 2015 and CBECS 2018. The inlet water temperature is based on weather station temperature data and RECS 2015 ground water temperature data for each household. The consumer water heater thermostat setting is based on multiple sources including contractor survey data and field data. To estimate the air temperature around the water heater (ambient air temperature), DOE assigned the sampled water heaters a water heater installation location including indoors (in the living space, such as an indoor closet), basement, garages, crawlspaces, outdoor closets, attics, etc. (see appendix 7B of this NOPR TSD for the installation fractions for consumer water heaters by installation location). These fractions vary significantly by region and type of home, which matches available survey data. Once the water heater is assigned an installation location, DOE then uses a methodology to determine the surrounding water heater ambient temperature. For example, in indoor locations the temperatures are assumed to be equal to the thermostat temperature. Other locations such as unconditioned attics or unconditioned basements/crawlspaces, outdoor closets, garages could have temperatures that are either lower than 32 deg. or above 100 deg. for a fraction of the year. See appendix 7B and 8D (installation costs) of the NOPR TSD for more details about the installation location methodology and ambient temperature methodology.

ONE Gas and Gas Association Commenters generally supported energy use analysis that is tied to the UEF energy descriptor. Given that DOE and stakeholders went to great lengths to develop and justify the UEF metric upon consumer use assumptions, the resulting consensus behind UEF should serve as the basis for energy use analysis. (One Gas, No. 44, p. 12; Gas Association Commenters, No. 41, Attachment E at p. 15) As explained above, DOE's energy use analysis is based on UEF energy descriptor and test procedure derived parameters (RE, UE, P_{on}). DOE then converts this data to field energy use using modified WHAM equations (see appendix 7B of this NOPR TSD for more details).

4. Heat Pump Water Heater Energy Use Determination

For heat pump water heaters, energy efficiency and consumption are dependent on ambient temperature. To account for this factor, DOE expanded the WHAM to include a heat pump performance adjustment factor. The equation for determining the energy consumption of heat pump water

[53] If the heat pump water heater is installed in a conditioned space and is un-ducted, the cooling byproduct of the heat pump operation could produce a cooling effect that could increase space heating energy use in the heating season and decrease space cooling energy use in the cooling season. In addition, heat pump operation could also produce a dehumidifying effect that could reduce dehumidifier equipment energy use.

heaters is similar to the WHAM equation, but a performance adjustment factor that is a function of the average ambient temperature is applied to adjust *RE.* A heat pump water heater operates either in heat pump or in electric resistance mode. DOE estimated that the electric resistance mode of operation is used 100 percent of the time when the monthly ambient temperature is less than 32 °F or more than 100 °F. A heat pump water heater also operates in the electric resistance mode for part of the time even when the monthly ambient temperature (where the equipment is installed) is between 32 °F and 100 °F, because this product has a slower recovery rate than an electric resistance water heater. DOE determined that, depending on household hot water consumption patterns, the electric resistance mode of operation varies significantly from household to household (on average DOE estimated that electric resistance mode accounts for 10 percent of the heat pump water heater unit's operating time).

NRECA stated that the benefits of using electric hybrid heat pump water heaters in colder climates are significantly less. NRECA stated that the energy savings and costs should be considered region by region, and not averaged nationally, as the impact to individual consumers may vary significantly. (NRECA, No. 33 at p. 3) DOE's energy use model is conducted for a representative sample of households that matches different conditions around the country where the electric water heater is installed as indicated by the RECS and CBECS data. Therefore, the impacts of heat pump water heaters vary for individual consumers. Appendix 7B of the NOPR TSD presents the energy use results for different regions to highlight this aspect of the analysis.

PHCC stated that page 7B–4 of the preliminary analysis TSD has a discussion of heat pump water heaters not operating when ambient temperatures are below 32 °F or above 100 °F and it was unclear what this means. PHCC stated that the TSD infers that the majority of these products will be installed indoors, which would not be in those extreme temperature ranges. (PHCC, No. 40 at p. 2) As previously explained, electric storage water heaters are typically installed in indoors (in the living space, such as an indoor closet), basement, garages, crawlspaces, outdoor closets, attics, *etc.* The installation location fractions vary significantly by region and type of home. Once the water heater is assigned an installation location, DOE then determines the surrounding water heater ambient temperature based on several factors. For example, in indoor locations the temperatures are assumed to be equal to the thermostat temperature. Other locations such as unconditioned attics or unconditioned basements/crawlspaces, outdoor closets, garages could have temperatures that are either lower than 32 °F or above 100 °F for a fraction of the year. For more details on the estimate of water heater ambient temperature, see chapter 7 and appendix 7B of the NOPR TSD.

PHCC stated that DOE's analysis assumes that heat pump water heaters will operate as resistance electric units 10 percent of the time. PHCC believed that given the meager recovery rate typical of heat pump water heaters and their poor performance with cold water below 50 °F, it would seem logical that these products would rely on resistance heat for much more time (30 or perhaps 40 percent of the time). (PHCC, No. 40 at p. 2) DOE notes that the 10 percent value is a national average, which is based on several studies. This value varies significantly by time of year, ambient temperature around water heater, water temperature, installation location and characteristics, hot water usage patterns, etc. For consumer water heaters installed in a location with lower cold water temperatures and lower ambient temperatures, the electric resistance use is closer to 30 percent of the time. For more details see appendix 7B of the NOPR TSD.

Rheem stated that Table 7.4.1 in the preliminary TSD shows that ELs 3 and 4 for electric storage water heaters ≥20 and ≤55 gallons show an increase in fossil-fuel use. Rheem requested clarification on why an electric water heater has fossil-fuel use and why this use is not seen in the >55 to ≤120-gallon range. (Rheem, No. 45 at p. 8) During the winter months, heat pump storage water heaters could impact the space heating load by cooling the surrounding space. Depending on the location of the water heater, this could lead to greater use of the space heating system, which leads to increased fossil fuel energy use for homes that use fossil fuel as the primary space heating source. In the case of >55 gallon sizes, the difference between the baseline and higher efficiency is very small because both are heat pumps. For this NOPR, DOE included the impact for >55 gallon sizes, which shows on average a decrease in cooling impact for higher efficiency HPWHs, due to their fewer compressor operating hours.

NEEA, ACEEE, and NWPCC stated that DOE is likely overestimating the increased space heating system use (and decreased cooling use) due to the impact of heat pump water heater operation in conditioned space. NEEA, ACEEE, and NWPCC pointed out that considerable research by NEEA and others shows that not all the heat extracted from the air (by the heat pump) is subsequently replaced by the space heating system (or counts as an offset to the cooling system) and that, on average, only 65 percent of the heat extracted from the air by the HPWH is replaced by the space heating system. NEEA, ACEEE, and NWPCC provided several references in support of this phenomena. (NEEA, ACEEE, and NWPCC, No. 47 at p. 9) For the preliminary analysis, DOE estimated that two-thirds of heat extracted from the air by the HPWH is replaced by the space conditioning system. DOE reviewed its analysis methodology and assumptions based on the references provided. Based on this data, DOE was able to confirm the estimate.

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

☐ The LCC is the total consumer expense of an appliance or product over the life of that product, consisting of total installed cost (manufacturer selling price, distribution chain markups, sales tax, and installation costs) plus operating costs (expenses for energy 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 consumer water heaters in the absence of new or amended energy conservation standards. In contrast, the PBP for a given efficiency level is measured relative to the baseline product.

For each considered efficiency level in each product class, DOE calculated the LCC and PBP for a nationally representative set of housing units and commercial buildings. As stated previously, DOE developed household and commercial building samples from RECS 2015 and CBECS 2018. For each sample household and commercial building, DOE determined the energy consumption for the consumer water heaters and the appropriate energy price. By developing a representative sample of households and commercial buildings, the analysis captured the variability in energy consumption and energy prices associated with the use of consumer water heaters.

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

BWC was concerned about numerous references that are outdated surveys and other data sources of which some sources are 17 years old. BWC stated that today's costs to consumers and manufacturers are significantly beyond what they were a few years ago, which can give the impression that certain Efficiency Levels can be justified. BWC strongly recommended DOE contract surveys or studies on their own to obtain the information necessary to properly inform their major regulatory policy decisions. (BWC, No. 32 at p. 5) DOE always tries to use the most up-to-date data. For this analysis, DOE reviewed all its references and updated them to the latest available as highlighted throughout this NOPR document and the associated TSD. DOE also hired a contractor to supplement and/or validate its review for today's costs and market conditions.

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 consumer water heaters user samples. For this rulemaking, the Monte Carlo approach is implemented in MS Excel together with the Crystal Ball™ add-on.[54] The model calculated the LCC for products at each efficiency level for 10,000 water heater installations in housing and commercial building units per simulation run. The analytical results include a distribution of 10,000 data points showing the range of LCC savings for a given efficiency level relative to the no-new-standards case efficiency distribution. In performing an iteration of the Monte Carlo simulation for a given consumer, product efficiency is chosen based on its probability. If the chosen product efficiency is greater than or equal to the efficiency of the standard level under consideration, the LCC calculation reveals that a consumer is not impacted by the standard level. By accounting for consumers who already purchase more-efficient products, DOE avoids overstating the potential benefits from increasing product efficiency.

DOE calculated the LCC and PBP for consumers of consumer water heaters as if each were to purchase a new product in the expected first full year of required compliance with new or amended standards. Amended standards would apply to consumer water heaters manufactured 5 years after the date on which any new or amended standard is published. (42 U.S.C. 6295(g)(10)(B)) At this time, DOE estimates issuance of a final rule in 2024. Therefore, for purposes of its analysis, DOE used 2030 as the first full year of compliance with any amended standards for consumer water heaters.

NEEA, ACEEE, and NWPCC requested that DOE publish the LCC of HPWHs binned by occupancy and average daily water draw. NEEA, ACEEE, and NWPCC stated that DOE's draw profiles derived from RECS 2015 exhibit a wide variance in water consumption even among homes with the same occupancy resulting in net cost for households with very low water usage and the proposed approach will allow for a better assessment. (NEEA, ACEEE, and NWPCC, No. 47 at p. 8) DOE provides additional LCC results binned by occupancy and average daily water draw in appendix 8G.

Table IV. summarizes the approach and data DOE used to derive inputs to the LCC and PBP calculations. The paragraphs 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 RSMeans. Assumed no change with efficiency level.
Annual Energy Use	Total annual energy use based on the average daily hot water use, derived from the building samples. Variability: Based on the RECS 2015 and CBECS 2018.
Energy Prices	Natural Gas: Based on EIA's Natural Gas Navigator data for 2022. Electricity: Based on EIA's Form 861 data for 2022. Propane and Fuel Oil: Based on EIA's State Energy Data System ("SEDS") for 2021. Variability: Regional energy prices determined for 50 states and District of Columbia for residential and commercial applications. Marginal prices used for natural gas, propane, and electricity prices.
Energy Price Trends	Based on *AEO2023* price projections.
Repair and Maintenance Costs	Based on RSMeans 2023 data and other sources. Assumed variation in cost by efficiency.
Product Lifetime	Based on shipments data, multi-year RECS, American Housing Survey, American Home Comfort Survey data.

[54] 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 May 1, 2023).

TABLE IV.31—SUMMARY OF INPUTS AND METHODS FOR THE LCC AND PBP ANALYSIS *—Continued

Inputs	Source/method
Discount Rates	Residential: 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. Commercial: Calculated as the weighted average cost of capital for businesses purchasing NWGFs. Primary data source was Damodaran Online.
Compliance Date	2030.

* 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.

1. Product Cost

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

PHCC review of just one nationally noted online plumbing wholesale source found that the cost of various types of water heaters to be near or even exceed the TSD projected installed cost of water heaters. (PHCC, No. 40 at p. 1) DOE updated its MPC values from the engineering analysis and the markups to the latest available values. Overall the water heater retail prices increased. DOE compared its estimated retail prices to available current retail prices and found that the prices are comparable to DOE's estimates (see Appendix 6A of this NOPR TSD).

BWC requested DOE elaborate on how it has arrived at its installation cost estimates for EL 2, which included thermopile flue dampers as an associated design option, considering that thermopile flue dampers are not commercially available for the consumer water heater market. (BWC, No. 32 at p. 2) In response, as previously discussed in the screening analysis section, IV.B.1, of this NOPR, DOE has removed this design option from all proposed efficiency levels and updated cost estimates.

Examination of historical price data for certain appliances and equipment that have been subject to energy conservation standards indicates that the assumption of constant real prices may, in many cases, overestimate long-term trends in appliance and equipment prices. Economic literature and historical data suggest that the real costs of these products may in fact trend downward over time according to ''learning'' or ''experience'' curves.[55]

In the experience curve method, the real cost of production is related to the cumulative production or ''experience'' with a manufactured product. This experience is usually measured in terms of cumulative production. As experience (production) accumulates, the cost of producing the next unit decreases. The percentage reduction in cost that occurs with each doubling of cumulative production is known as the learning rate. In typical experience curve formulations, the learning rate parameter is derived using two historical data series: cumulative production and price (or cost). DOE obtained historical PPI data for water heating equipment from 1950–1961, 1968–1973, and 1977–2022 for electric consumer water heaters and from 1967–1973 and 1977–2022 for all other consumer water heaters from the Bureau of Labor Statistics' (BLS).[56] The PPI data reflect nominal prices, adjusted for product quality changes. An inflation-adjusted (deflated) price index for heating equipment manufacturing was calculated by dividing the PPI series by the implicit price deflator for Gross Domestic Product Chained Price Index.

From 1950 to 2006, the deflated price index for consumer water heaters was mostly decreasing, or staying flat. Since then, the index has risen, primarily due to rising prices of copper, aluminum, and steel products which are the major raw material used in water heating equipment. The rising prices for copper and steel products were attributed to a series of global events, from strong demand from China and other emerging economies to the recent severe delay in commodity shipping due to the COVID–19 pandemic. Given the slowdown in global economic activity in recent years and the lingering impact from the global pandemic, DOE believes that the extent to which the trends of the past five years will continue is very uncertain. DOE also assumes that any current supply chain constraints are short-lived and will not persist to the first year of compliance. Therefore, DOE decided to use constant prices as the default price assumption to project future consumer water heater prices. Thus, projected prices for the LCC and PBP analysis are equal to the 2022 values for each efficiency level in each product class. DOE welcomes comment on the use of a constant price trend.

CA IOUs stated that the current difference in pricing between electric resistance water heater and HPWHs reflects HPWH's current small share of the electric storage water heater market. They believe that the potential for future increases in HPWH sales volumes will lower prices. CA IOUs encouraged DOE to reflect this potential through the inclusion of price learning in its Life Cycle Cost analyses. (CA IOUs, No. 39 at p. 2) The MPCs estimated by DOE account for economies of scale for HPWHs if they are a standard and the sales volume sales is much larger.

CA IOUs stated that in comparing condensing technologies in commercial residential-duty gas and consumer storage water heaters analysis, they believe that DOE has significantly underestimated the learning price trend for consumer storage water heaters. Because the incremental MPC for condensing design options is lower in commercial residential duty water analysis compared to consumer water heaters analysis, even though they would expect the opposite to be true due to commercial residential duty larger size. (CA IOUs, No. 52 at pp. 5–6) NYSERDA commented that DOE should adopt price learning for condensing technology in its LCC analyses for consumer storage water heaters. (NYSERDA, No. 51 at p. 2) NYSERDA also recommends DOE to conduct a sensitivity analysis for different technology price scenarios. (NYSERDA, No. 35 at p. 3) Joint Advocates encouraged DOE to investigate how the analysis could reflect price learning associated with

[55] Desroches, L.-B., K. Garbesi, C. Kantner, R. Van Buskirk, and H.-C. Yang. Incorporating Experience Curves in Appliance Standards Analysis. *Energy Policy.* 2013. 52 pp. 402–416; Weiss, M., M. Junginger, M. K. Patel, and K. Blok. A Review of Experience Curve Analyses for Energy Demand Technologies. *Technological Forecasting and Social Change.* 2010. 77(3): pp. 411–428.

[56] Series ID PCU33522033522081 and PCU33522833522083; see *www.bls.gov/ppi/.*

heat pump and condensing technology. Joint Advocates expected that the price trends associated with heat pump and condensing technologies will be significantly different than the overall price trends of water heaters. In particular, components used in heat pump water heaters, such as compressors and heat exchangers, are similar to those used in other air conditioning and heat pump equipment. Joint Advocates noted that in the rulemakings for space cooling heat pumps and room air conditioners DOE applied price trends similar to central air conditioners which utilize similar components. (Joint Advocates, No. 34, p. 3)

DOE acknowledges that the prices of higher efficiency technologies (such as heat pump or condensing technology options) may not change at the same rate and using a trend for all water heaters to represent the price trend of higher efficiency water heaters may underestimate the future decline in the cost of higher efficiency water heaters. However, DOE could not find detailed data that would allow for a price trend projection for higher efficiency water heaters that may differ from baseline water heaters. Thus, for this NOPR, it used the same price trend projection for all water heaters. Although DOE was not able to find information or data regarding price trends related to different water heater technologies, DOE is aware of alternative approaches to estimating learning rates.[57] For this analysis, DOE included a scenario where HPWH and condensing technology had a separate learning curve, which is similar to HVAC equipment.

2. Installation Cost

The installation cost is the cost to the consumer of installing the consumer water heater, in addition to the cost of the water heater itself. The cost of installation covers all labor, overhead, and material costs associated with the replacement of an existing water heater or the installation of a water heater in a new home, as well as delivery of the new water heater, removal of the existing water heater, and any applicable permit fees. Higher-efficiency water heaters may require one to incur additional installation costs.

DOE's analysis of installation costs estimated specific installation costs for each sample household based on building characteristics given in RECS 2015 and CBECS 2018. For this NOPR, DOE used 2023 RSMeans data for the installation cost estimates, including labor costs.[58] [59] [60] [61] DOE's analysis of installation costs accounted for regional differences in labor costs by aggregating city-level labor rates from RSMeans into 50 U.S. States and the District of Columbia to match RECS 2015 data and CBECS 2018 data.

a. Basic Installation Costs and Inputs

First, DOE estimated basic installation costs that are applicable to all consumer water heaters, in replacement, new owner, and new home or building installations. These costs include putting in place and setting up the consumer water heater, gas piping and/or electrical hookup, permits, water piping, removal of the existing consumer water heater, and removal or disposal fees.

PHCC stated that the values for products, materials, and labor used in the preliminary analysis TSD do not seem to be aligned with the current market. PHCC's review of just one nationally noted online plumbing wholesale source found that the cost of various types of water heaters to be near or even exceed the TSD projected installed cost of water heaters. PHCC found that the cost of many of the miscellaneous products listed in the TSD analysis are understated as well (expansion tanks, water heater stands, relief valves, pipe and fittings, etc.). (PHCC, No. 40 at p. 1) DOE updated its MPC values from the engineering analysis and the markups to the latest available values. Overall the water heater retail prices increased. DOE compared its estimated retail prices to available current retail prices and found that the prices are comparable to DOE's estimates (see Appendix 6A of this NOPR TSD). DOE updated the components cost with data from RS Means 2023 and found them comparable to multiple other sources (see Appendix 7D of this NOPR TSD).

BWC states that there are a number of labor and material costs that are mischaracterized. (BWC, No. 32 at p.6) BWC did not provide any details, so DOE was unable to determine what they believe is mischaracterized. However, DOE welcomes specific suggestions as to how it might improve its maintenance and repair methodology.

PHCC observed that the TSD indicates plumbers charge approximately $64 per hour for residential work and $89 for commercial work yet the analysis uses $60 per hour. PHCC's opinion is that these values are very low. Further, PHCC noted that in several instances DOE relies on information from sources in the HVAC industry which are not plumbing professionals and that there are differences between the two industries. (PHCC, No. 40 at p. 2) PHCC also pointed out that there are errors and confusing statements in the preliminary analysis TSD appendix 8C and requested clarification of these issues. (PHCC, No. 40 at p. 3) In regard to the plumbers' hourly rates, the consultant report uses a $60 per hour average labor hour for illustration purposes based on actual rates in a few locations. DOE's analysis uses plumbing labor rates based on RS Means data that vary by state and market segment (residential or commercial). In addition, DOE assigned a higher labor rate for "emergency" replacements in residential applications. For mobile home installations, DOE also assigned lower labor rates based on consultant input on the labor rates that might be used in the mobile homes market. For the NOPR analysis, DOE updated labor rates using the latest RSMeans 2023 available. DOE also significantly updated its installation cost appendix (appendix 8D of the NOPR TSD) to correct inconsistencies noted by stakeholders.

PHCC stated that the materials needed for the installation that DOE included seem somewhat random. For example, 3 feet of pipe is allowed for hot and cold-water pipe drops, which is fine if the heater is located under the mains but there may be a need for branch piping to get to a location. In addition, PHCC stated that electrical requirements should be included, and there is no mention of seismic bracing as required in numerous jurisdictions. (PHCC, No. 40 at p. 4) The fixed pipe lengths and materials costs that are listed in the consultant report, are for typical installations for illustrative purposes. In DOE's analysis, the pipe lengths vary based on a distribution of pipe lengths. DOE's analysis also includes a variety of installation costs that are encountered in the field to meet different electrical

[57] Taylor, M. and K. S. Fujita, Accounting for Technological Change in Regulatory Impact Analyses: The Learning Curve Technique, Lawrence Berkeley National Laboratory, Report No. LBNL–6195E (2013) (Available at: *eta-publications.lbl.gov/sites/default/files/lbnl-6195e_.pdf*) (Last accessed May 1, 2023).

[58] RSMeans Company Inc., *RSMeans Mechanical Cost Data.* Kingston, MA (2023) (Available at: *www.rsmeans.com/products/books/2022-cost-data-books*) (Last accessed May 1, 2023).

[59] RSMeans Company Inc., *RSMeans Residential Repair & Remodeling Cost Data. Kingston,* MA (2023) (Available at: *www.rsmeans.com/products/books/2022-cost-data-books*) (Last accessed May 1, 2023).

[60] RSMeans Company Inc., *RSMeans Plumbing Cost Data.* Kingston, MA (2023) (Available at: *www.rsmeans.com/products/books/2022-cost-data-books*) (Last accessed May 1, 2023).

[61] RSMeans Company Inc., *RSMeans Electrical Cost Data.* Kingston, MA (2023) (Available at: *www.rsmeans.com/products/books/2022-cost-data-books*) (Last accessed May 1, 2023).

requirements and code requirements (for example, seismic bracing in all California installations). For the NOPR, DOE expanded the material requirements for different installation situations (see appendix 8D of the NOPR TSD for more details).

PHCC noted that the installation time of 2.08 hours is low however no breakdown for the various installation items is provided. (PHCC, No. 40 at p. 4) The 2.08 hours refers to the consultant report average typical hours to install and set into place a water heater for illustrative purposes, while in DOE's analysis this value varies based on the installation characteristics. (see appendix 8D of the NOPR TSD).

PHCC noted that the direct vent installations have lower cost than a conventional system due to the vent material, but the installation of these units is more complex. (PHCC, No. 40 at p. 4) For the NOPR, DOE expanded the distribution of values associated with setting in place a water heater in several installation situations including differences in installation costs for direct vent compared to conventional system venting (see appendix 8D of the NOPR TSD).

PHCC noted that a trip charge is included for service contractors to cover some travel and office overhead related to the job, but the water heater installations additionally require some miscellaneous materials and some special tooling as well as the costs for vehicles and fuel. These additional costs are not recognized as part of the trip charge. (PHCC, No. 40 at p. 4) Based on the consultant report, DOE's analysis included additional miscellaneous materials as a line item.

PHCC stated that not all water meters have check valves. For systems that have check valves, the water heater expansion tank is necessary. The expansion tank should also be replaced at a changeout of a water heater, which adds additional installation costs. (PHCC, No. 40 at p. 4) DOE agrees that not all water heaters have check valves. DOE's analysis accounts for replacement of the expansion tank when the water heater is replaced. For the preliminary analysis, DOE estimated that 5% of water heater installations would require an expansion tank. For the NOPR, reviewed available data and the updated consultant report, but found no source to justify a lower or higher fraction. DOE also notes that the check valve installation cost is the same for baseline and higher efficiency equipment.

b. Gas-Fired and Oil-Fired Water Heater Installation Costs

For gas-fired and oil-fired water heater installations, DOE included a number of additional costs (''adders'') for a fraction of the sample households. Most of these additional cost adders are associated with installing higher efficiency consumer water heater designs in replacement installations.

For replacement installations, DOE conducted a detailed analysis of installation costs when a baseline (or minimum efficiency) consumer water heater is replaced with higher efficiency design options, with particular attention to space constraint issues (associated with larger dimensions for certain higher efficiency consumer water heaters), venting issues, and condensate withdrawal (for power vented and condensing gas-fired water heaters). Due to the larger dimensions of higher efficiency storage water heaters, installation adders included removing and replacing door jambs (to be able to fit the larger sized water heater) or adding tempering valves for increasing set-point temperatures to install a smaller sized storage water heater that produces the same hot water output. For non-condensing gas-fired and oil-fired water heaters, additional costs included updating flue vent connectors, vent resizing, and chimney relining. For non-condensing power vented and condensing gas-fired water heaters, additional costs included adding a new flue vent, combustion air vent for direct vent installations, concealing vent pipes for indoor installations, addressing an orphaned furnace (by updating flue vent connectors, vent resizing, or chimney relining), and condensate removal. Freeze protection is accounted for in the cost of condensate removal for a fraction of condensing gas-fired water heaters installed in non-conditioned spaces.

DOE also included installation adders for new owner and new construction installations. For non-condensing gas-fired and oil-fired water heaters, a new flue vent and accounting for other commonly vented heating appliances are the only adders. For power vented and condensing gas-fired water heaters, the adders include new flue vent, combustion air vent for direct vent installations, and condensate removal.

Atmos, One Gas, and Gas Association Commenters stated that DOE should more accurately consider the variability and uncertainty around installation costs of water heaters, particularly in water heater replacement applications requiring a shift in venting systems from atmospheric venting to power venting, and the consequences of venting to other appliances. (Atmos, No. 38 at p. 3; One Gas, No. 44 at p. 6 ; Gas Association Commenters, No. 41, Attachment E at p. 8) PHCC stated that in terms of gas venting it has long maintained that the conversion to condensing products is not always an acceptable option. PHCC pointed out that there are some installations where vent lengths could exceed the manufacturer's recommendation. (PHCC, No. 40 at p. 3) CA IOUs stated that in comparing condensing technologies in Commercial residential-duty gas and consumer storage water heaters analysis, they believe that DOE has significantly overestimated the installation for consumer storage water heaters. Because the incremental installation cost for condensing design options is lower in commercial residential duty water analysis compared to consumer water heaters analysis, even though they would expect the opposite to be true due to commercial residential duty larger size. (CA IOUs, No. 52 at pp. 5–6)

In the case of replacing an atmospheric GSWH with a power vent or condensing GSWH, DOE's installation model carefully considers different vent installation configurations (or situations). This includes adding costs for varying length of new PVC piping, piping going through multiple walls, patching and concealing vent piping in living areas, and addressing the vent termination requirements. These costs could range from relatively small amount in the case of close to the wall GSWH with side wall venting to complex venting installation. DOE believes that the range of values captures the variability that is likely to occur in the field.

PHCC acknowledged that DOE suggests that alternate methods exist or are in development, but noted that it would be preferable to have fully vetted proven technology in place before hanging hopes on this. (PHCC, No. 40 at p. 3) DOE's analysis considers an alternative venting option that is currently on the market for commonly-vented non-condensing and condensing equipment, but did not include in its reference case analysis since it has limited field data associated with this technology. DOE is considering whether to include the alternative venting options in its installation model and/or conduct a sensitivity analysis with alternative venting options and invites stakeholder input on its approach.

See appendix 8D of the NOPR TSD for further details about flue venting cost model and the alternative venting option.

Atmos, One Gas, and Gas Association Commenters stated that DOE's analysis ignores consumers who do not live in single-family households who may need a water heater replacement. Atmos stated that DOE should consider the impacts on multifamily housing households whose water heaters vent atmospherically into a common vent shared with other households, because one household's water heater replacement may, due to the unavailability of models of atmospherically vented water heaters, compromise proper venting of other households' water heaters because the atmospheric venting system is likely to now be oversized. (Atmos, No. 38, p. 4; One Gas, No. 44 at p. 6; Gas Association Commenters, No. 41, Attachment 6 at pp. 8–9) DOE's preliminary analysis accounted for water heater installations (or replacements) in all residential building types including single-family (detached); single-family (attached), multi-family, and mobile homes. DOE also considers separate installation costs for commercial buildings. For the NOPR analysis DOE refined its installation model so that it could better account for impacts of installations in multi-family and mobile home installations, including common vent installations in multifamily buildings. See appendix 8D of the NOPR TSD for disaggregated installation costs by building type.

c. Condensate Withdrawal for Higher Efficiency Design Options

For the preliminary analysis, DOE assumed that 12.5 percent of condensing gas-fired water heaters and HPWHs in replacement situations required a condensate pump. For new construction, DOE assumed that a condensate pump would not be required since the building would be designed with the drains located nearby. PHCC stated that it is not a code requirement to have a drain near the water heater, and many times this drain is not there. PHCC has concerns that in the case of new construction, DOE does not contemplate condensate pumps and electric outlets for certain water heaters. In reality, these should be included, if the builder did not anticipate that these products would be at additional cost. (PHCC, No. 40 at pp. 3–4) Based on the input of an expert consultant, if a higher efficiency water heater that requires condensate withdrawal is selected for a project it is unlikely that a condensate pump with be required, since the plumbing plan will likely include a drain nearby to deal with the condensate. Similarly, the electrical plan will be adjusted so that the appropriate electrical outlet requirements are included. DOE believes these are very minor requirements to have in a construction plan, particularly with a long lead time to the first year of compliance. DOE did not change its approach for the NOPR analysis.

d. Heat Pump Water Heater Installation Costs

For heat pump water heater installations, DOE included a number of adders for a fraction of the sample households. Most of these adders are associated with installing heat pump water heater designs in replacement installations.

For replacement installations, DOE conducted a detailed analysis of installation costs when a baseline consumer water heater is replaced with higher efficiency designs, with particular attention to space constraint issues (associated with larger dimensions for heat pump water heaters compared to electric resistance water heaters), condensate withdrawal, and ductwork for heat pump water heaters installed in conditioned spaces. To address the larger dimensions of heat pump water heaters, installation adders included removing and replacing door jambs (to be able to fit the larger sized water heater), adding a tempering valve for increasing set-point temperatures to allow for a smaller-sized storage water heater that produces the same hot water output, or relocating water heater. Freeze protection is accounted for in the cost of condensate removal for a fraction of heat pump water heaters installed in non-conditioned spaces. DOE also included condensate removal installation adders for new owner and new construction HPWH installations.

PHCC stated that the preliminary TSD's assumption that changing to a heat pump would only add, on average, 1 hour of labor is too low. Additional handling, drain work, re-piping, and programming of controls will require additional time. (PHCC, No. 40 at p. 4) The average additional labor varies by installation. In the preliminary analysis, the average additional labor hours is about 2 hours, which matches available field data. For the NOPR, DOE kept the same assumptions and methodological approach.

NRECA stated that heat pump water heaters are required to maintain a specific minimum area around the heat pump water heater to function per manufacturer design specifications. They added that many homes, especially older housing stock or manufactured homes, do not allow for such a large space to house a water heater, and others would require home retrofits. NRECA concluded that heat pump water heaters are simply not practical in many of these cases. (NRECA, No. 33 at pp. 2–3) EEI stated that non-ducted HPWH require at least 700 cubic feet of space to operate properly and achieve efficiency levels presented in the technical support document. (EEI, No. 43 at p. 2) In contrast, NEEA, ACEEE, and NWPCC pointed to current research which indicates that HPWHs can be installed in much smaller spaces than manufacturer literature specifies. Specifically, under testing with a draw profile similar to the DOE-specified medium draw profile, compared to performance at OEM-specified minimums, reducing room volume to 450 ft^3 reduces COP by less than 10 percent, and reducing room volume to 200 ft^3 reduces COP by less than one-third. They noted that remedies that have been successfully applied (adding small vents to the door, using a louvered door, installing passive ventilation grilles in the wall, and simple ducting to an adjacent room) are inexpensive and require little labor. (NEEA, ACEEE, and NWPCC, No. 47 at p. 5)

To be conservative in its analysis, DOE accounted for the airflow requirements as specified in manufacturer installation manuals in its installation cost model. The additional costs of adding louvered doors, venting, or relocating a water heater are included for a fraction of installations, mainly for HPWHs installed in indoor locations. See appendix 8D of the NOPR TSD for more details.

NRECA and EEI pointed to field studies from NREL, Fortis BC, and SMUD [62] that provide a range of actual costs for installing heat pump water heaters when replacing electric resistance water heaters in space constrained areas such as closets where walls, ceilings, and doors must be removed and replaced or ductwork needs to be added. NRECA stated that DOE should update its analysis with real world information on the costs of such installations as it moves forward. (NRECA, No. 33 at pp. 3–4; EEI, No. 43 at p. 2)

NEEA, ACEEE, and NWPCC pointed to a survey of more than 100 installers in the NW and SE regions to understand issues associated with HPWH installations. Survey respondents indicated an average of less than two

[62] See *www.nrel.gov/docs/fy16osti/64904.pdf*; *energy350.com/wp-content/uploads/2018/11/CO2-Integrated-Heat-Pump-Water-Heater-Performance-Report-FINAL.pdf*; and *www.smud.org/-/media/Documents/Corporate/About-Us/Reports-and-Documents/2018/HPWH-Field-Testing-Report-1-6-2016.ashx*.

additional labor hours to install a HPWH compared with a conventional electric resistance product. Informed by this survey, NEEA believed that DOE's estimates for the likelihood of installation challenges and the associated additional labor hours are within reason. (NEEA, ACEEE, and NWPCC, No. 47, pp. 4–5) NYSERDA and Joint Advocates stated that DOE's HPWH installation cost estimates are robust and reasonable. (NYSERDA, No. 35 at p. 2; Joint Advocates, No. 34 at pp. 3–4) Joint Advocates stated that NEEA has experienced limited challenges with installation. In a survey of consumers who had received a utility rebate for a HPWH, NEEA found that 72 percent of professionally installed water heaters were installed in half a day or less, which appears to be in line with DOE's estimated installation time for HPWHs. The study found that only 15 percent of professionally installed HPWHs encountered some form of challenge (usually minor) during the installation process and only three percent of installations had to install ducting. Joint Advocates stated that the limited installation challenges are further corroborated by a recent study conducted by CLEAResult that evaluated 15 HPWHs installed in manufactured homes. (Joint Advocates, No. 47, pp. 4–5) NEEA, ACEEE, and NWPCC stated that NEEA's regional experience with more than 100,000 heat pump water heaters installed in the Northwest shows limited installation challenges and broad consumer satisfaction. (NEEA, ACEEE, and NWPCC, No. 47 at p. 3)

DOE carefully reviewed the studies provided by stakeholders. DOE found that the NREL study, Fortis BC, Canadian study, and NEEA study results were consistent with DOE's installation model. DOE conducted a literature review and found that other studies in other regions (outside of California, Canada, Northeast) have similar results to DOE's analysis. See Appendix 8D of the NOPR TSD for more details of the literature review and comparison results.

CA IOUs also stated that currently available HPWH products are unable to serve some ''space-constrained'' [63] applications currently served by electric resistance storage water heaters. They noted that while the eventual development of HPWH products that can serve many of these space-constrained applications is possible, the current HPWH market is dominated by integrated models in a standard configuration (CA IOUs, No. 52 at pp. 6–7) AHRI, Rheem, and GE Appliances stated that DOE disregarded lowboy electric storage water heaters, which are space constrained products that are the only means for some consumers to meet their hot water needs. They stated that to comply with the current standards, these products have already reached the maximum size feasible for these space constrained applications, and there is no room available for these products to incorporate heat pump technologies or physically expand to accommodate additional insulation. They requested the Department to update its analysis to include lowboy electric storage water heaters, similar to what was done for short and tall ratio water heaters. (AHRI, No. 20 at p. 5; GEA, No. 46 at p. 1; Rheem, No. 45 at p. 4) PHCC stated that taller heaters will not fit in undercounter cabinets and that rough-in piping locations or building elements may also prevent taller units. PHCC added that instead of the space constraint option solutions listed, consumers likely will settle for a smaller capacity water heater rather than make extensive modifications to their buildings. (PHCC, No. 40 at p. 3) DOE did extensive revisions to its installation cost model to include installations of low-boy water heaters, which DOE estimated to be around 11 percent of the total 20 to 55 gallon electric storage water heater market. DOE assessed that many of these installations would require significant installation costs in order to install a HPWH. DOE notes that at the proposed standard, most models currently serving the small electric water heater market will remain available.

PHCC stated that DOE's analysis suggested that door frames be removed and re-installed to allow larger storage water heater design options (such as HPWH) products to be installed. PHCC believed that this is against the plumbing code for most jurisdictions in the U.S., which prescribe that structural elements or finished surfaces are not to be removed to service water heaters. (PHCC, No. 40 at p. 3) For the NOPR, to account for locations where plumbing codes might limit or ban this practice, DOE reduced the fraction of installations removing and re-installing door jambs. In these situations, the model selects an alternative installation, such as using a tempering valve, moving the water heater to a new location, or installing a split-system heat pump water heater. All relevant costs for these installations are accounted for in the analysis.

PHCC questioned DOE's suggestion that smaller heaters can be installed with elevated storage temperatures and the use of a mixing valve can then reduce the supply water temperature, noting that this is a costly and maintenance-intensive solution and there is concern for inadvertent scalding situations with elevated temperatures. (PHCC, No. 40 at p. 3) In contrast, CA IOUs stated that Thermostatic mixing valves that allow the storage temperature to be set above 125 °F are relatively inexpensive, widely available, and required by the plumbing code in at least one state. (CA IOUs, No. 52 at pp. 8)

DOE has found that for some applications mixing valves are currently being used in order to have higher hot water temperature for dishwashers or clothes washers, to provide more hot water capacity, and to reduce bacterial growth, while making sure the delivered water is within a safe range. In other cases, this approach is starting to be used more often to increase available hot water.[64] Some water heaters have internal mixing valves that are meant to increase available hot water. In some cases, mixing valves could be used to address the increased hot water needs when the number of people in the household increases without replacing the entire water heater. DOE's updated test procedure includes a method to test water heaters in the highest storage tank temperature mode, which would be more representative for these types of installations. This is discussed more in section V.D.1. DOE's analysis in this NOPR accounts for a fraction of installations that might choose this approach.

3. Annual Energy Consumption

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

Higher-efficiency water heaters reduce the operating costs for a consumer, which can lead to greater use of the water heater. A direct rebound effect occurs when a product that is made more efficient is used more intensively, such that the expected energy savings from the efficiency improvement may not fully materialize. At the same time, consumers benefit

[63] CA IOUs define ''space-constrained'' as applications that include ''small closets, crawlspaces, and other locations where electric resistance storage water heaters function well, but HPWH either cannot physically fit, or do not have access to an adequate ambient air supply.'' (CA IOUs, No. 52 at p. 6).

[64] See *www.geappliances.com/appliance/GE-Smart-50-Gallon-Electric-Water-Heater-with-Flexible-Capacity-GE50S10BMM.*

from increased utilization of products due to rebound. Although some households may increase their water heater use in response to increased efficiency, DOE does not include the rebound effect in the LCC analysis because the increased utilization of the water heater provides value to the consumer. DOE does include rebound in the NIA for a conservative estimate of national energy savings and the corresponding impact to consumer NPV. See section IV.H of this document and chapter 10 of the NOPR TSD for more details.

4. Energy Prices

Because marginal energy prices more accurately capture 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 energy prices. Therefore, DOE applied average energy prices for the energy use of the product purchased in the no-new-standards case, and marginal energy prices for the incremental change in energy use associated with the other efficiency levels considered.

DOE derived average monthly marginal residential and commercial electricity, natural gas, and LPG prices for each state using data from EIA.[65] [66] [67] DOE calculated marginal monthly regional energy prices by: (1) first estimating an average annual price for each region; (2) multiplying by monthly energy price factors, and (3) multiplying by seasonal marginal price factors for electricity, natural gas, and LPG. The analysis used historical data up to 2022 for residential and commercial natural gas and electricity prices and historical data up to 2021 for LPG and fuel oil prices. Further details may be found in chapter 8 of the NOPR TSD.

GEAG is concerned with DOE's approach in the preliminary TSD at section 2.8.2.1 that conflates marginal energy prices with marginal energy rates. CEAG states that DOE's method of averaging inflates consumer savings estimates. GEAG recommends another method instead (called CMER) which is described in a paper from Spire to the NAS peer review committee. GEAG would like to see the CMER method used as a reality/spot check until DOE gets accustomed to it. (GEAG, No. 36 at p. 3)

DOE is currently reviewing the CMER method proposed by GEAG. In the past, stakeholders have proposed alternative methods and data to estimate marginal natural gas prices. For example, DOE compared marginal price factors developed by DOE from the EIA data to develop seasonal marginal price factors for 23 gas tariffs provided by the Gas Technology Institute for the 2016 residential boilers energy conservation standards rulemaking.[68] DOE found that the winter price factors used by DOE are generally comparable to those computed from the tariff data, indicating that DOE's marginal price estimates are reasonable at average usage levels. The summer price factors are also generally comparable. Of the 23 tariffs analyzed, eight have multiple tiers, and of these eight, six have ascending rates and two have descending rates. The tariff-based marginal factors use an average of the two tiers as the commodity price. A full tariff-based analysis would require information about the household's total baseline gas usage (to establish which tier the consumer is in), and a weight factor for each tariff that determines how many customers are served by that utility on that tariff. These data are generally not available in the public domain. DOE's use of EIA State-level data effectively averages overall consumer sales in each State, and so incorporates information from all utilities. DOE's approach is, therefore, more representative of a large group of consumers with diverse baseline gas usage levels than an approach that uses only tariffs.

DOE notes that within a State, there could be significant variation in the marginal price factors, including differences between rural and urban rates. In order to take this to account, DOE developed marginal price factors for each individual household using RECS 2015 billing data. These data are then normalized to match the average State marginal price factors, which are equivalent to a consumption-weighted average marginal price across all households in the State. DOE's methodology allows energy prices to vary by sector, region and season. For more details on the comparative analysis and updated marginal price analysis, see appendix 8E of this NOPR TSD.

To estimate energy prices in future years, DOE multiplied the 2022 energy prices by the projection of annual average price changes for each of the 50 U.S. states and District of Columbia from the Reference case in *AEO2023,* which has an end year of 2050. [69] To estimate price trends after 2050, DOE used the average annual growth rate in prices from 2046 to 2050 based on the methods used in the 2022 Life-Cycle Costing Manual for the Federal Energy Management Program (''FEMP'').[70]

Joint Advocates believe that the current DOE approach may be significantly underestimating future natural gas prices. Joint Advocates note that the national electrification trends will result in decline in gas customers and/or consumption, which will result in an increase in gas prices for the remaining customers. (Joint Advocates, No. 34 at p. 3) NRDC and RMI also stated that customer exit from the gas system associated with electrification will tend to increase rates for remaining gas customers, because the fixed costs of the gas system will be spread over a smaller number of users. NRDC and RMI urge DOE to take into account the potential for such increases in average gas rates. (NRDC and RMI, No. 37 at p. 1)

Because the effects of widespread electrification are very uncertain at this point, DOE prefers to rely on the latest AEO price forecasts in its analysis. DOE notes that if future natural gas prices end up higher than DOE estimates due to electrification, the economic justification for the standards proposed for gas-fired water heaters in this NOPR would become stronger still.

The CA IOUs proposed a methodology for developing adjustment factors for EIA natural gas price forecasts. The approach adjusts the most recent natural gas price forecast based on historical trends in forecast accuracy, thus narrowing the difference between forecasted and actual prices. CA IOUs also recommend that DOE also incorporate scenario analyses in its LCC calculations to consider the future impact of these factors on the retail

[65] U.S. Department of Energy-Energy Information Administration, Form EIA–861M (formerly EIA–826) detailed data (2022) (Available at: *www.eia.gov/electricity/data/eia861m/*) (Last accessed May 1, 2023).

[66] U.S. Department of Energy-Energy Information Administration, Natural Gas Navigator (2022) (Available at: *www.eia.gov/naturalgas/data.php*) (Last accessed May 1, 2023).

[67] U.S. Department of Energy-Energy Information Administration, State Energy Data System (''SEDS'') (2021) (Available at: *www.eia.gov/state/seds/*) (Last accessed May 1, 2023).

[68] GTI provided a reference located in the docket of DOE's 2016 rulemaking to develop energy conservation standards for residential boilers. (Docket No. EERE–2012–BT–STD–0047–0068) (Available at: *www.regulations.gov/document/EERE-2012-BT-STD-0047-0068*) (Last accessed May 1, 2023).

[69] EIA. *Annual Energy Outlook 2023 with Projections to 2050.* Washington, DC. Available at *www.eia.gov/forecasts/aeo/* (last accessed May 1, 2023).

[70] Lavappa, Priya D. and J. D. Kneifel. Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis—2022 Annual Supplement to NIST Handbook 135. National Institute of Standards and Technology (NIST). NISTIR 85–3273–37, available at *www.nist.gov/publications/energy-price-indices-and-discount-factors-life-cycle-cost-analysis-2022-annual* (last accessed May 1, 2023).

price of natural gas. (CA IOU, No. 52 at pp. 2–5) NYSERDA also encouraged DOE to improve the accuracy of natural gas retail price forecasts by using the CA IOUs approach. (NYSERDA, No. 51 at p. 2)

Atmos recommends that the Department modify its current use of single forecasts of consumer energy prices with forecast adjustments of plus and minus five percent to account for forecasting errors, and then run the analysis under these three price forecast trends. One Gas suggests for parity with forecasts of electricity prices, error factors of plus or minus 6% in forecast prices appear as reasonable alternative price trends for natural gas and propane, as well as a systematic adjustment in the AEO 2021 natural gas price out to 2050 and beyond on the order of 15%. Further, Atmos and One Gas stated that the EIA data has diminishing accuracy and reliability in out years of the forecast period. (Atmos, No. 38 at p. 5; One Gas, No. 44 at pp. 9–10; Gas Association Commenters, No. 41, Attachment 6 at p. 12)

DOE's analysis uses price forecasts from the latest AEO reference case and includes sensitivity analysis using high and low economic growth scenarios. DOE is currently evaluating the use of other price forecast scenarios (such as high/low oil gas supply, high/low oil price, high/low renewables cost) as well as the approaches suggested by the stakeholders. DOE uses other inputs from the AEO analysis and DOE contends that it is important for it to maintain consistency with EIA in DOE's inputs and energy prices.

5. Maintenance and Repair Costs

Repair costs are associated with repairing or replacing product components that have failed in an appliance; maintenance costs are associated with maintaining the operation of the product. Typically, small incremental increases in product efficiency produce no, or only minor, changes in repair and maintenance costs compared to baseline efficiency products. DOE included additional maintenance and repair costs for higher efficiency consumer water heaters (including maintenance costs associated with condensate withdrawal, heat pump component filter cleaning, and deliming of the heat exchanger and repair costs associated with electronic ignition, controls, and blowers for fan-assisted designs, compressor, evaporator fan) based on 2023 RSMeans data.[71] DOE accounted for regional differences in labor costs by using RSMeans regional cost factors.

BWC states that there are a number of labor and material maintenance and repair costs that are mischaracterized. (BWC, No. 32 at p. 6) BWC did not provide any details, so DOE was unable to determine what they believe is mischaracterized. However, DOE welcomes specific suggestions as to how it might improve its maintenance and repair methodology, including accounting for the value of time spent by consumers performing regular maintenance (*e.g.,* cleaning heat pump air filters).

The methodology and data sources are described in detail in appendix 8F of the NOPR TSD.

6. Product Lifetime

Product lifetime is the age at which an appliance is retired from service. DOE conducted an analysis of water heater lifetimes based on the methodology described in a journal paper.[72] For this analysis, DOE relied on RECS 1990, 1993, 2001, 2005, 2009, 2015, and 2020.[73] DOE also used the U.S. Census's biennial American Housing Survey (''AHS''), from 1974–2021, which surveys all housing, noting the presence of a range of appliances.[74] DOE used the appliance age data from these surveys, as well as the historical water heater shipments, to generate an estimate of the survival function. The survival function provides a lifetime range from minimum to maximum, as well as an average lifetime. DOE estimates the average product lifetime to be around 15 years for storage water heaters and around 20 years for instantaneous water heaters. DOE is considering whether to conduct a sensitivity analysis with higher and lower lifetimes for all water heater product classes and invites stakeholder input on its approach.

7. Discount Rates

In the calculation of LCC, DOE applies discount rates appropriate to households to estimate the present value of future operating cost savings. DOE estimated a distribution of discount rates for consumer water heaters 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.[75] 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 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[76] (''SCF'') starting in 1995 and ending in 2019. Using the SCF and other sources, DOE developed a distribution of rates for each type of debt and asset

[71] RSMeans Company, Inc., *RS Means Facilities Repair and Maintenance* (2023), available at *www.rsmeans.com/* (last accessed May 1, 2023).

[72] Lutz, J., A. Hopkins, V. Letschert, V. Franco, and A. Sturges, Using national survey data to estimate lifetimes of residential appliances, *HVAC&R Research* (2011) 17(5): pp. 28 (Available at: *www.tandfonline.com/doi/abs/10.1080/10789669.2011.558166*) (Last accessed May 1, 2023).

[73] U.S. Department of Energy: Energy Information Administration, *Residential Energy Consumption Survey (''RECS''),* Multiple Years (1990, 1993, 1997, 2001, 2005, 2009, 2015, and 2020) (Available at: *www.eia.gov/consumption/residential/*) (Last accessed May 1, 2023).

[74] 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, 2019, and 2021) (Available at: *www.census.gov/programs-surveys/ahs/*) (Last accessed April 1, 2023).

[75] 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.

[76] 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*) (last accessed May 1, 2023). The Federal Reserve Board is currently processing the 2022 Survey of Consumer Finances, which is expected to be fully available in late 2023.

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 market share of each product class, is 4.1 percent. See chapter 8 of the NOPR TSD for further details on the development of consumer discount rates.

To establish commercial discount rates for the small fraction of consumer water heaters installed in commercial buildings, DOE estimated the weighted-average cost of capital using data from Damodaran Online.[77] The weighted-average cost of capital is commonly used to estimate the present value of cash flows to be derived from a typical company project or investment. Most companies use both debt and equity capital to fund investments, so their cost of capital is the weighted average of the cost to the firm of equity and debt financing. DOE estimated the cost of equity using the capital asset pricing model, which assumes that the cost of equity for a particular company is proportional to the systematic risk faced by that company. DOE's commercial discount rate approach is based on the methodology described in a LBNL report, and the distribution varies by business activity.[78] The average rate for consumer water heaters used in commercial applications in this NOPR analysis, across all business activity and weighted by the market share of each product class, is 6.9 percent.

See chapter 8 of this NOPR TSD for further details on the development of consumer and commercial 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). This approach reflects the fact that some consumers may purchase products with efficiencies greater than the baseline levels.

To estimate the energy efficiency distribution of consumer water heaters for 2030, DOE used available shipments data by efficiency including in previous AHRI submitted historical shipment data,[79] ENERGY STAR unit shipments data,[80] and data from a 2022 BRG Building Solutions report. [81] To cover gaps in the available shipments data, DOE used DOE's public CCMS model database [82] and AHRI certification directory.[83]

NEEA, ACEEE, and NWPCC provided the market data regarding the market share of HPWHs in the northwest. The high percentage of installations in new homes has been driven by building codes combined with utility incentives, bulk pricing, and a workforce that has quickly become adept at installing HPWHs. (NEEA, ACEEE, and NWPCC, No. 47 at p. 3) Based on the provided data, DOE was able to refine the assignment of HPWHs in the Northwest for replacements and new construction.

The estimated market shares for the no-new-standards case for consumer water heaters are shown in Table IV.28. See chapter 8 of the NOPR TSD for further information on the derivation of the efficiency distributions.

TABLE IV.27—NO-NEW-STANDARDS CASE ENERGY EFFICIENCY DISTRIBUTIONS IN 2030 FOR CONSUMER WATER HEATERS

Efficiency level	Draw pattern					
	Low		Medium		High	
	UEF*	Market Share (%)	UEF*	Market Share (%)	UEF*	Market Share (%)
Gas-Fired Storage Water Heaters, ≥20 gal and ≤55 gal						
0	0.54	63.7	0.58	57.1	0.63	54.3
1	0.57	15.3	0.60	21.3	0.64	22.8
2	0.59	6.0	0.64	4.4	0.68	4.7
3	0.60	12.1	0.65	14.8	0.69	15.7
4	0.71	2.8	0.75	0.9	0.80	1.0
5	0.77	0.0	0.81	1.5	0.88	1.5
Oil-Fired Storage Water Heaters, ≤50 gal						
0					0.64	66.4
1					0.66	16.5
2					0.68	17.2
Small Electric Storage Water Heaters, ≥20 gal and ≤35 gal and FHR <51 gal						
0	0.91/0.92**	99.0				

[77] Damodaran Online, Data Page: Costs of Capital by Industry Sector (2021) (Available at: *pages.stern.nyu.edu/~adamodar/*) (Last accessed May 1, 2023).

[78] Fujita, S., Commercial, Industrial, and Institutional Discount Rate Estimation for Efficiency Standards Analysis: Sector-Level Data 1998–2018 (Available at: *ees.lbl.gov/publications/commercial-industrial-and*) (Last accessed May 1, 2023).

[79] AHRI. Confidential Instantaneous Gas-fired Water Heater Shipments Data from 2004–2007 to LBNL. March 3, 2008; AHRI. Gas-fired and Electric Storage Water Heater Shipments Data to DOE. March 11, 2008; AHRI. Gas-fired Storage Heater Shipments Data to DOE. March 18, 2009.

[80] ENERGY STAR. Unit Shipments data 2010–2021. multiple reports. (Available at: *www.energystar.gov/partner_resources/products_partner_resources/brand_owner_resources/unit_shipment_data*) (Last accessed May 1, 2023).

[81] BRG Building Solutions. The North American Heating & Cooling Product Markets (2022 Edition). 2022.

[82] U.S. Department of Energy-Appliance & Equipment Standards Program. Compliance Certification Management System (CCMS) for Consumer Water Heaters (Downloaded June 1, 2022). (Available at *www.regulations.doe.gov/certification-data/CCMS-4-Water_Heaters.html#q=Product_Group_s%3A%22Water%20Heaters%22*) (Last accessed May 1, 2023).

[83] Air Conditioning Heating and Refrigeration Institute. Consumer's Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment. June 1, 2022. (Available at *www.ahridirectory.org*) (Last accessed May 1, 2023).

TABLE IV.27—NO-NEW-STANDARDS CASE ENERGY EFFICIENCY DISTRIBUTIONS IN 2030 FOR CONSUMER WATER HEATERS—Continued

Efficiency level	Draw pattern					
	Low		Medium		High	
	UEF*	Market Share (%)	UEF*	Market Share (%)	UEF*	Market Share (%)
1	2.00	1.0				
Electric Storage Water Heaters, ≥20 gal and ≤55 gal, excluding Small ESWHs						
0	0.91	87.8	0.92	86.9	0.93	84.2
1	2.30	0.9	2.30	0.6	2.30	0.7
2	3.29	7.3	3.35	8.2	3.47	11.0
3	3.69	4.0	3.75	4.3	3.87	4.1
Electric Storage Water Heaters, >55 gal and ≤120 gal						
0			2.05	2.6	2.15	3.0
1			2.50	11.2	2.50	11.4
2			3.35	74.6	3.45	73.8
3			3.90	11.7	4.00	11.8
Gas-Fired Instantaneous Water Heaters, <2 gal and >50,000 Btu/h						
0			0.81	30.7	0.81	29.7
1			0.87	8.1	0.89	7.6
2			0.91	47.3	0.93	46.6
3			0.92	5.6	0.95	7.2
4			0.93	8.3	0.97	9.0

* UEF at the representative rated capacity.
** 0.91 UEF at 30 gallon effective volume and 0.92 UEF at 35 gallon effective volume.

The LCC Monte Carlo simulations draw from the efficiency distributions and randomly assign an efficiency to the water heater purchased by each sample household in the no-new-standards case according to these distributions.

Finally, DOE considered the 2019 AHCS survey,[84] which includes questions to recent purchasers of HVAC equipment regarding the perceived efficiency of their equipment (Standard, High, and Super High Efficiency), as well as questions related to various household and demographic characteristics. DOE did not find similar data for consumer water heaters, but believes that the HVAC data could be applicable to other larger appliances such as consumer water heaters. From these data, DOE found that households with larger square footage exhibited a higher fraction of High- or Super-High efficiency equipment installed. DOE used the AHCS data to adjust its water heater efficiency distributions as follows: (1) the market share of higher efficiency equipment for households under 1,500 sq. ft. was decreased by 5 percentage points; and (2) the market share of condensing equipment for households above 2,500 sq. ft. was increased by 5 percentage points.

ONE Gas and Gas Association Commenters stated that no attempts appear to have been made to address consumer choice and trade-offs (NAS Report RECOMMENDATION 4–3), and instead assignment of consumer purchase decisions again appears to be continuing to use a random assignment of consumers across the design options. One Gas further stated that the consumer choice and decision making is not accounted for in rational economic terms among the options of: (1) savings that could be demonstrated among the choices of a baseline water heater against the proposed efficiency levels (EL) or (2) savings that could accrue from continuing to own a baseline product versus purchasing an EL-rated product (NAS Report RECOMMENDATION 4–5). (ONE Gas, No. 44 at p. 6; Gas Association Commenters, No. 41, attachment 6, p. 8) Atmos also stated that consistent with NAS Recommendation 4–5, DOE should account for consumer choice in rational economic terms, including the: (1) savings that could be demonstrated among the choices of a baseline water heater against the proposed TSLs or (2) savings that could accrue from continuing to own a baseline product versus purchasing TSL efficiency products. These savings are crucial for estimating the benefits of appliance replacement programs that governments and utilities may consider, and such savings analyses will better illuminate potential consumer impacts. Atmos also stated that consistent with NAS Recommendation 4–13, DOE should assume that consumers will behave rationally and purchase the model that produces the most life-cycle cost savings. Atmos pointed out that DOE selected the minimum efficiency water heater as the baseline model, but this model will not produce the most life-cycle cost savings in all cases. Atmos stated that DOE should not rely on a one-size-fits-all assumption, as doing so underestimates costs to consumers and overestimates purported benefits of energy efficiency standards. (Atmos, No. 38 at p. 3)

Atmos stated that DOE's use of a random assignment of consumers across design options instead of assigning base-case efficiencies with discretion, results in an inaccurate overstatement of energy efficiency standards' potential to produce economic benefits for consumers and is contrary to NAS Recommendation 4–3, which states that the agency ''should collect data on consumer choices in appliance markets and estimate a discrete choice model of consumer behavior to quantify the

[84] Decision Analysts, 2019 American Home Comfort Studies (Available at: *www.decisionanalyst.com/Syndicated/HomeComfort/*) (Last accessed May 1, 2023).

trade-offs that consumers face from changes in appliance performance.'' Atmos stated that, at a minimum, DOE should provide further explanation of its efforts to account for correlated variables in the life-cycle cost analysis. (Atmos, No. 38 at p. 2) Further, Atmos urged DOE to assign base-case efficiencies with discretion, rather than random assignment. Atmos disagrees with DOE that the current method of efficiency assignment, which is in part random, ''is a better representation of actual behavior in the field compared to assigning water heater efficiency based solely on imputed cost-effectiveness.'' Atmos stated that, at minimum, as recommended in the NAS report ''DOE should place greater emphasis on providing an argument for the plausibility and magnitude of any market failure related to the energy efficiency gap in their analyses.'' (Atmos, No. 38 at p. 4) Atmos urged DOE to consider assigning base-case efficiencies with discretion, rather than randomly, and suggested DOE place greater emphasis on explaining the plausibility and magnitude of any market failure related to the energy efficiency gap in its analyses. (Atmos, No. 19 at pp. 4–5)

ONE Gas and Gas Association Commenters also stated that the Department appears to have not undertaken measures to address stakeholder concerns related to past issues of random assignment of consumers to appliance purchase decisions in the base case life cycle cost analysis. Further, ONE Gas stated that DOE has never presented analysis that justifies linkages between market failure and random purchase behavior and pointed out that there is no evidence that the recommendations of the National Academies of Sciences (NAS) report to improve its coverage of market failure in relation to the setting of appliance minimum efficiency standards is implemented in DOE's analysis. (ONE Gas, No. 44 at pp.4–5; Gas Association Commenters, #41, attachment 6 at p. 6) ONE Gas and Gas Association Commenters recommended that to address the issues in consumer base case definition, the Department should modify the LCC spreadsheet by using either of the two methods suggested by the gas industry—Correlated Consumer Attributes Approach or Rational Consumer Economic Choice Approach. Under a Correlated Consumer Attribute Approach, the Department would use the functionality of the Monte Carlo software to avoid presumed non-rational economic decision making by implementing simulation correlations of these variables and develop base case conditions that better approximate consumer decision making. Under the Rational Consumer Economic Choice Approach would calculate for each simulated consumer the most life cycle cost efficient alternative among available water heating products and assign that as the base case over which improvements provided by higher efficiency options would be evaluated. (ONE Gas, No. 44 at p. 5; Gas Association Commenters, No. 41, attachment 6 at p. 7)

Gas Association Commenters stated that DOE must consider whether and to what extent there are market failures that significantly impede economically beneficial investments in higher-efficiency products, citing to *Am. Pub. Gas Ass'n* v. *United States Dep't of Energy,* 22 F4th 1018 (D.C. Cir. 2022) and a Consensus Study Report by the National Academies of Sciences. The Gas Association Commenters also stated that DOE's attempts to dismiss prior comment on this issue (see TSD at 2–58—2–59) are non-responsive. Gas Association Commenters also stated that DOE's LCC analysis completely ignores the fact that—in the absence of new standards—purchasers tend to make the most economically attractive efficiency investments and decline those with the most substantial net costs. Gas Association Commenters stated that DOE's analysis ''assigns'' even the most economically attractive and highest net-cost efficiency investment outcomes to the base case for analysis randomly, as though purchasers never consider the economics of potential efficiency investments regardless of the economic stakes involved. Further, Gas Association Commenters stated that because there is no basis to suggest that standards are needed to ensure that consumers will choose more efficient products when those products have lower initial costs, DOE should assign such cases to the base case for analysis rather than assigning them to the base or standard cases randomly. (Gas Association Commenters, No. 41, attachment 1 at p. 5)

Gas Association Commenters requested that DOE should assign all cases in which a purchaser would fail to invest in a more efficient product that would pay for itself within a year, to the base case for analysis rather than assigning them randomly. They stated that this would provide a useful screening test to determine whether there is any reasonable possibility that new standards could produce net LCC benefits for consumers. Gas Association Commenters further requested that DOE report the resulting change in the average LCC outcome before it proceeds with further standards development activity. Gas Association Commenters also stated that if there are market failures that could cause purchasers facing higher initial costs to forego economically beneficial efficiency investments, DOE should: (1) identify the specific nature and impact of any market failures allegedly interfering with sound economic decision-making on the part of purchasers of consumer water heaters; and (2) disclose the evidence DOE relied upon to support its assessment of such market failures. Additionally, to enable interested parties to understand and review DOE's analysis of any market failure impacts, Gas Association Commenters requested DOE (3) disclose the range and distribution of the most economically beneficial individual LCC outcomes in both its base case and rule outcome case; (4) explain its justification for the distribution of those outcomes; (5) disclose the range and distribution of the highest net cost individual LCC outcomes in both its base case and rule outcome case; and (6) explain its justification for the distribution of those outcomes. (Gas Association Commenters, No. 41, attachment 1 at pp. 6–7)

While DOE acknowledges that economic factors may play a role when consumers, commercial building owners, or builders decide on what type of water heater to install, assignment of water heater 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 below. While this literature is not specific to water heaters, DOE maintains that the method of assignment, which is in part random, is a reasonable approach, one that simulates behavior in the water heater market, where market failures and other consumer preferences result in purchasing decisions not being perfectly aligned with economic interests, more realistically than relying only on apparent cost-effectiveness criteria derived from the limited information in CBECS or RECS. DOE further emphasizes that its approach does not assume that all purchasers of water heater make economically irrational decisions (*i.e.,* the lack of a correlation is not the same as a negative correlation). As part of the random assignment, some homes or buildings with large hot water use will be assigned higher efficiency water heaters, and some homes or buildings with particularly low hot water use will be assigned baseline water heaters, which aligns with the available data. By using this approach, DOE acknowledges the variety of market failures and other consumer behaviors present in the water heater market. This approach 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.[85] There are also several behavioral factors that can influence the purchasing decisions of complicated multi-attribute products, such as water heaters. For example, consumers (or decision makers in an organization) are highly influenced by choice architecture, defined as the framing of the decision, the surrounding circumstances of the purchase, the alternatives available, and how they're presented for any given choice scenario.[86] 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.[87] Thaler, who won the Nobel Prize in Economics in 2017 for his contributions to behavioral economics, and Sunstein point out that these behavioral factors are strongest when the decisions are complex and infrequent, when feedback on the decision is muted and slow, and when there is a high degree of information asymmetry.[88] These characteristics describe almost all purchasing situations of appliances and equipment, including water heaters. The installation of a new or replacement water heater is done infrequently, as evidenced by the mean lifetime for water heaters. Additionally, it would take at least one full water heating season for any impacts on operating costs to be fully apparent. Further, if the purchaser of the water heater is not the entity paying the energy costs (*e.g.,* a building owner and tenant), there may be little to no feedback on the purchase. Additionally, there are systematic market failures that are likely to contribute further complexity to how products are chosen by consumers, as explained in the following paragraphs.

The first of these market failures—the split-incentive or principal-agent problem—is likely to affect water heaters more than many other types of appliances. 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 water heater to install, whereas the renter is responsible for paying energy bills. In the LCC sample, a significant fraction of households with a water heater are renters. These fractions are significantly higher for low-income households (see section IV.I of this document). In new construction, builders influence the type of water heater used in many homes but do not pay operating costs. Finally, contractors install a large share of water heaters in replacement situations, and they can exert a high degree of influence over the type of water heater purchased.

In addition to the split-incentive problem, there are other market failures that are likely to affect the choice of water heater efficiency made by consumers. For example, emergency replacements of essential equipment such as water heaters are strongly biased toward like-for-like replacement (*i.e.,* replacing the non-functioning equipment with a similar or identical product). Time is a constraining factor during emergency replacements and it may not be possible to consider the full range of available options on the market, as a new product choice may take more time to install than is practical. The consideration of alternative product options is far more likely for planned replacements and installations in new construction.

Additionally, Davis and Metcalf[89] conducted an experiment demonstrating that the nature of the information available to consumers from EnergyGuide labels posted on air conditioning equipment results in an inefficient allocation of energy efficiency across households with different usage levels. Their findings indicate that households are likely to make decisions regarding the efficiency of the climate control equipment of their homes that do not result in the highest net present value for their specific usage pattern (*i.e.,* their decision is based on imperfect information and, therefore, is not necessarily optimal).

In part because of the way information is presented, and in part because of the way consumers process information, there is also a market failure consisting of a systematic bias in the perception of equipment energy usage, which can affect consumer choices. Attari, Krantz, and Weber[90] show that consumers tend to underestimate the energy use of large energy-intensive appliances, but overestimate the energy use of small appliances. Therefore, it is likely that consumers systematically underestimate the energy use associated with water heater, resulting in less cost-effective water heater purchases.

These market failures affect a sizeable share of the consumer population. A study by Houde[91] 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.

Although consumer water heaters are predominantly installed in the

[85] 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 May 1, 2023).

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

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

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

[89] 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 May 1, 2023).

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

[91] 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 May 1, 2023).

residential sector, some are also installed in commercial buildings (slightly less than 10 percent of projected shipments; see chapter 9 of the NOPR TSD). There are market failures relevant to consumer water heaters installed in commercial applications as well. It is often assumed that because commercial and industrial customers are businesses that have trained or experienced individuals making decisions regarding investments in cost-saving measures, some of the commonly observed market failures present in the general population of residential customers should not be as prevalent in a commercial setting. However, there are many characteristics of organizational structure and historic circumstance in commercial settings that can lead to underinvestment in energy efficiency.

First, a recognized problem in commercial settings is the principal-agent problem, where the building owner (or building developer) selects the equipment and the tenant (or subsequent building owner) pays for energy costs.[92] [93] Indeed, more than a quarter of commercial buildings in the CBECS 2018 sample are occupied at least in part by a tenant, not the building owner (indicating that, in DOE's experience, the building owner likely is not responsible for paying energy costs). Additionally, some commercial buildings have multiple tenants. There are other similar misaligned incentives embedded in the organizational structure within a given firm or business that can impact the choice of a water heater. For example, if one department or individual within an organization is responsible for capital expenditures (and therefore equipment selection) while a separate department or individual is responsible for paying the energy bills, a market failure similar to the principal-agent problem can result.[94] Additionally, managers may have other responsibilities and often have other incentives besides operating cost minimization, such as satisfying shareholder expectations, which can sometimes be focused on short-term returns.[95] Decision-making related to commercial buildings is highly complex and involves gathering information from and for a variety of different market actors. It is common to see conflicting goals across various actors within the same organization as well as information asymmetries between market actors in the energy efficiency context in commercial building construction.[96]

Second, the nature of the organizational structure and design can influence priorities for capital budgeting, resulting in choices that do not necessarily maximize profitability.[97] Even factors as simple as unmotivated staff or lack of priority-setting and/or a lack of a long-term energy strategy can have a sizable effect on the likelihood that an energy efficient investment will be undertaken.[98] U.S. tax rules for commercial buildings may incentivize lower capital expenditures, since capital costs must be depreciated over many years, whereas operating costs can be fully deducted from taxable income or passed through directly to building tenants.[99]

Third, there are asymmetric information and other potential market failures in financial markets in general, which can affect decisions by firms with regard to their choice among alternative investment options, with energy efficiency being one such option.[100] Asymmetric information in financial markets is particularly pronounced with regard to energy efficiency investments.[101] There is a dearth of information about risk and volatility related to energy efficiency investments, and energy efficiency investment metrics may not be as visible to investment managers,[102] which can bias firms towards more certain or familiar options. This market failure results not because the returns from energy efficiency as an investment are inherently riskier, but because information about the risk itself tends

[92] Vernon, D., and Meier, A. (2012). ''Identification and quantification of principal-agent problems affecting energy efficiency investments and use decisions in the trucking industry,'' *Energy Policy,* 49, 266–273.

[93] Blum, H. and Sathaye, J. (2010). ''Quantitative Analysis of the Principal-Agent Problem in Commercial Buildings in the U.S.: Focus on Central Space Heating and Cooling,'' Lawrence Berkeley National Laboratory, LBNL–3557E. (Available at: *escholarship.org/uc/item/6p1525mg*) (Last accessed May 1, 2023).

[94] Prindle, B., Sathaye, J., Murtishaw, S., Crossley, D., Watt, G., Hughes, J., and de Visser, E. (2007). ''Quantifying the effects of market failures in the end-use of energy,'' Final Draft Report Prepared for International Energy Agency. (Available from International Energy Agency, Head of Publications Service, 9 rue de la Federation, 75739 Paris, Cedex 15 France).

[95] Bushee, B.J. (1998). ''The influence of institutional investors on myopic R&D investment behavior,'' *Accounting Review,* 305–333. DeCanio, S.J. (1993). ''Barriers Within Firms to Energy Efficient Investments,'' *Energy Policy,* 21(9), 906–914. (explaining the connection between short-termism and underinvestment in energy efficiency).

[96] International Energy Agency (IEA). (2007). Mind the Gap: Quantifying Principal-Agent Problems in Energy Efficiency. OECD Pub. (Available at: *www.iea.org/reports/mind-the-gap*) (Last accessed May 1, 2023).

[97] DeCanio, S.J. (1994). ''Agency and control problems in US corporations: the case of energy-efficient investment projects,'' *Journal of the Economics of Business,* 1(1), 105–124.

Stole, L.A., and Zwiebel, J. (1996). ''Organizational design and technology choice under intrafirm bargaining,'' *The American Economic Review,* 195–222.

[98] Rohdin, P., and Thollander, P. (2006). ''Barriers to and driving forces for energy efficiency in the non-energy intensive manufacturing industry in Sweden,'' *Energy,* 31(12), 1836–1844.

Takahashi, M and Asano, H (2007). ''Energy Use Affected by Principal-Agent Problem in Japanese Commercial Office Space Leasing,'' In *Quantifying the Effects of Market Failures in the End-Use of Energy.* American Council for an Energy-Efficient Economy. February 2007.

Visser, E and Harmelink, M (2007). ''The Case of Energy Use in Commercial Offices in the Netherlands,'' In *Quantifying the Effects of Market Failures in the End-Use of Energy.* American Council for an Energy-Efficient Economy. February 2007.

Bjorndalen, J. and Bugge, J. (2007). ''Market Barriers Related to Commercial Office Space Leasing in Norway,'' In *Quantifying the Effects of Market Failures in the End-Use of Energy.* American Council for an Energy-Efficient Economy. February 2007.

Schleich, J. (2009). ''Barriers to energy efficiency: A comparison across the German commercial and services sector,'' *Ecological Economics,* 68(7), 2150–2159.

Muthulingam, S., et al. (2013). ''Energy Efficiency in Small and Medium-Sized Manufacturing Firms,'' *Manufacturing & Service Operations Management,* 15(4), 596–612. (Finding that manager inattention contributed to the non-adoption of energy efficiency initiatives).

Boyd, G.A., Curtis, E.M. (2014). ''Evidence of an 'energy management gap' in US manufacturing: Spillovers from firm management practices to energy efficiency,'' *Journal of Environmental Economics and Management,* 68(3), 463–479.

[99] Lovins, A. (1992). Energy-Efficient Buildings: Institutional Barriers and Opportunities. (Available at: *rmi.org/insight/energy-efficient-buildings-institutional-barriers-and-opportunities/*) (Last accessed May 1, 2023).

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Cummins, J.G., Hassett, K.A., Hubbard, R.G., Hall, R.E., and Caballero, R.J. (1994). ''A reconsideration of investment behavior using tax reforms as natural experiments,'' *Brookings Papers on Economic Activity,* 1994(2), 1–74.

DeCanio, S.J., and Watkins, W.E. (1998). ''Investment in energy efficiency: do the characteristics of firms matter?'' *Review of Economics and Statistics,* 80(1), 95–107.

Hubbard R.G. and Kashyap A. (1992). ''Internal Net Worth and the Investment Process: An Application to U.S. Agriculture,'' *Journal of Political Economy,* 100, 506–534.

[101] Mills, E., Kromer, S., Weiss, G., and Mathew, P.A. (2006). ''From volatility to value: analysing and managing financial and performance risk in energy savings projects,'' *Energy Policy,* 34(2), 188–199.

Jollands, N., Waide, P., Ellis, M., Onoda, T., Laustsen, J., Tanaka, K., and Meier, A. (2010). ''The 25 IEA energy efficiency policy recommendations to the G8 Gleneagles Plan of Action,'' *Energy Policy,* 38(11), 6409–6418.

[102] Reed, J.H., Johnson, K., Riggert, J., and Oh, A. D. (2004). ''Who plays and who decides: The structure and operation of the commercial building market,'' U.S. Department of Energy Office of Building Technology, State and Community Programs. (Available at: *www1.eere.energy.gov/buildings/publications/pdfs/commercial_initiative/who_plays_who_decides.pdf*) (Last accessed May 1, 2023).

not to be available in the same way it is for other types of investment, like stocks or bonds. In some cases energy efficiency is not a formal investment category used by financial managers, and if there is a formal category for energy efficiency within the investment portfolio options assessed by financial managers, they are seen as weakly strategic and not seen as likely to increase competitive advantage.[103] This information asymmetry extends to commercial investors, lenders, and real-estate financing, which is biased against new and perhaps unfamiliar technology (even though it may be economically beneficial).[104] Another market failure known as the first-mover disadvantage can exacerbate this bias against adopting new technologies, as the successful integration of new technology in a particular context by one actor generates information about cost-savings, and other actors in the market can then benefit from that information by following suit; yet because the first to adopt a new technology bears the risk but cannot keep to themselves all the informational benefits, firms may inefficiently underinvest in new technologies.[105]

In sum, the commercial and industrial sectors face many market failures that can result in an under-investment in energy efficiency. This means that discount rates implied by hurdle rates[106] and required payback periods of many firms are higher than the appropriate cost of capital for the investment.[107] The preceding arguments for the existence of market failures in the commercial and industrial sectors are corroborated by empirical evidence. One study in particular showed evidence of substantial gains in energy efficiency that could have been achieved without negative repercussions on profitability, but the investments had not been undertaken by firms.[108] The study found that multiple organizational and institutional factors caused firms to require shorter payback periods and higher returns than the cost of capital for alternative investments of similar risk. Another study demonstrated similar results with firms requiring very short payback periods of 1–2 years in order to adopt energy-saving projects, implying hurdle rates of 50 to 100 percent, despite the potential economic benefits.[109] A number of other case studies similarly demonstrate the existence of market failures preventing the adoption of energy-efficient technologies in a variety of commercial sectors around the world, including office buildings,[110] supermarkets,[111] and the electric motor market.[112]

The existence of market failures in the residential and commercial sectors is well supported by the economics literature and by a number of case studies. If DOE developed an efficiency distribution that assigned water heater efficiency in the no-new-standards case solely according to energy use or economic considerations such as life-cycle cost or payback period, the resulting distribution of efficiencies within the building 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 water heater market. Further, even if a specific household/building/organization is not subject to the market failures above, the purchasing decision of water heater efficiency can be highly complex and influenced by a number of factors not captured by the building characteristics available in the RECS or CBECS samples. These factors can lead to households or building owners choosing a water heater efficiency that deviates from the efficiency predicted using only energy use or economic considerations such as life-cycle cost or payback period (as calculated using the information from RECS 2015 or CBECS 2018). However, DOE intends to investigate this issue further, and it welcomes suggestions as to how it might improve its assignment of water heater efficiency in its analyses.

DOE further notes that, in the case of gas-fired storage and electric storage water heaters (≤55 gal), the distribution of efficiency in the current market is heavily weighted toward baseline efficiency or efficiency at EL 1. Most consumers are assigned EL 0 or EL 1 in accordance with the market data. As a result, any variation to DOE's efficiency assignment methodology will not produce substantially differing results than presented in this NOPR, as most consumers will continue to be assigned the same efficiency regardless of the details of the methodology.

In response to the Gas Association Commenters regarding the disclosure of results, DOE reiterates that the full results of all trials in the LCC are made available to all interested parties. These results include the most economically beneficial individual LCC outcomes and highest net cost individual LCC outcomes.

9. Accounting for Product Switching Under Potential Standards

For the preliminary analysis, DOE did not account for the product switching under potential standards. For this NOPR, DOE maintained the same approach and did not include any product switching in its analysis. DOE assumes that any product switching as a result of the proposed standards is likely to be minimal.

In the hypothetical case of a consumer switching from a gas-fired water heater to an electric storage water heater, there are likely additional installation costs necessary to add an electrical connection. In some cases, it may be possible to install a 120 V heat pump storage water heater with minimal additional installation costs, particularly if there is a standard electrical outlet nearby already. In most cases, however, a standard 240 V electrical storage water heater would be installed. To do so, the consumer would need to add a 240 V circuit to either an existing electrical panel or upgrade the entire panel. Panel upgrade costs are significant and can be approximately $1,000–$2,000 for 100 to 200 amp

[103] Cooremans, C. (2012). ''Investment in energy efficiency: do the characteristics of investments matter?'' *Energy Efficiency,* 5(4), 497–518.

[104] Lovins 1992, op. cit.

The Atmospheric Fund. (2017). Money on the table: Why investors miss out on the energy efficiency market. (Available at: *taf.ca/publications/money-table-investors-energy-efficiency-market/*) (Last accessed May 1, 2023).

[105] Blumstein, C. and Taylor, M. (2013). Rethinking the Energy-Efficiency Gap: Producers, Intermediaries, and Innovation. Energy Institute at Haas Working Paper 243. (Available at: *haas.berkeley.edu/wp-content/uploads/WP243.pdf*) (Last accessed May 1, 2023).

[106] A hurdle rate is the minimum rate of return on a project or investment required by an organization or investor. It is determined by assessing capital costs, operating costs, and an estimate of risks and opportunities.

[107] DeCanio 1994, op. cit.

[108] DeCanio, S.J. (1998). ''The Efficiency Paradox: Bureaucratic and Organizational Barriers to Profitable Energy-Saving Investments,'' *Energy Policy,* 26(5), 441–454.

[109] Andersen, S.T., and Newell, R.G. (2004). ''Information programs for technology adoption: the case of energy-efficiency audits,'' *Resource and Energy Economics,* 26, 27–50.

[110] Prindle 2007, op. cit.

Howarth, R.B., Haddad, B.M., and Paton, B. (2000). ''The economics of energy efficiency: insights from voluntary participation programs,'' *Energy Policy,* 28, 477–486.

[111] Klemick, H., Kopits, E., Wolverton, A. (2017). ''Potential Barriers to Improving Energy Efficiency in Commercial Buildings: The Case of Supermarket Refrigeration,'' *Journal of Benefit-Cost Analysis,* 8(1), 115–145.

[112] de Almeida, E.L.F. (1998). ''Energy efficiency and the limits of market forces: The example of the electric motor market in France'', *Energy Policy,* 26(8), 643–653.

Xenergy, Inc. (1998). United States Industrial Electric Motor Systems Market Opportunity Assessment. (Available at: *www.energy.gov/sites/default/files/2014/04/f15/mtrmkt.pdf*) (Last accessed April 1, 2023).

electrical panels.[113] Older homes and homes with gas-fired space heating (*e.g.,* homes with gas furnaces) are more likely to need an electrical panel upgrade in order to install an electric storage water heater, given the relatively modest electrical needs of the home at the time of construction. Given the significant additional installation costs, DOE estimates that very few consumers would switch from gas-fired water heaters to electric storage water heaters as a result of an energy conservation standard, especially at the proposed standard at TSL 2. This is especially true in the case of an emergency replacement where time is a critical factor. When a water heater fails, consumers typically have limited time to make a decision on which new water heater the consumer is going to choose to purchase and rely upon replacing the water heater with one that is similar to the one that failed. Consumers are unlikely to invest in switching fuels to water heater that utilizes a different fuel source in the emergency replacement scenario.

In the hypothetical case of a consumer switching from an electric storage water heater to a gas-fired water heater, there are, similarly, additional installation costs necessary to add a gas connection. Based on RECS 2020, DOE estimates that only 25 percent of homes with an electric storage water heater currently use natural gas and an additional 25 percent reported that natural gas is available in the neighborhood. Therefore, the option to switch to a gas-fired water heater is not available to half of consumers and for another 25 percent, it would be very expensive to bring in a natural gas connection from the street level to the home. An additional 10 percent of homes use LPG, but the fuel costs are much more expensive than natural gas and requires significant gas line connection upgrades to connect the LPG tank to the water heater. Even in homes with an existing gas connection, new venting would need to be installed for either gas-fired storage water heaters or gas-fired instantaneous water heaters. The average total installed costs for either gas-fired option, including all the necessary venting and additional gas lines in the home, are larger than replacing the electrical storage water heater with a standards-compliant model (at the proposed level). As a result, DOE estimates that very few consumers would switch from electric storage water heaters to gas-fired water heaters as a result of an energy conservation standard, particularly in the case of an emergency replacement.

Lastly, in the hypothetical case of a consumer switching from a gas-fired storage water heater to a gas-fired instantaneous water heater or vice-versa, there are additional installation costs necessary as well. The vast majority of gas-fired storage water heaters utilize non-condensing technology that utilizes Category I type B metal vent material, whereas switching to gas-fired instantaneous water heaters would require condensing technology that utilizes Category IV venting material at the efficiency levels proposed in this rule. Replacing the venting system would result in significant installation costs. Furthermore, given the significantly higher Btu/h input required for instantaneous water heaters, it may be necessary to upgrade the gas line feeding the water heater to a larger diameter. This is especially true if the line also services a gas furnace. Upgrading a gas line could add approximately $1,000 in extra costs or more. For the proposed standards for gas-fired storage water heaters and gas-fired instantaneous water heaters, the difference in installation costs between the baseline equipment and higher efficiency option is typically much less than the potential switching costs. As a result, DOE estimates that very few consumers would switch from gas-fired storage water heaters to gas-fired instantaneous water heaters or vice versa as a result of an energy conservation standard, particularly in the case of an emergency replacement.

NYSERDA recommends DOE include a Discrete Choice Model (DCM) to understand technology switching in the LCC. DCMs would help predict the likelihood of a customer choosing one product over another, based on their preferences (such as price, first cost, or life cycle cost). (NYSERDA, No.35 at p. 5) As noted previously, DOE did not include product switching in its analysis as this is likely to be a minimal effect. As a result, DOE did not require a DCM to model this switching for the LCC analysis. As described in the shipments analysis (IV.G.1.a), DOE used the LCC spreadsheet to estimate potential shipments impacts due to downsizing of electric storage water heaters in the various proposed TSLs based on a consumer choice model.

PHHC stated that in the case of switching from gas to electric resistance, the additional electrical costs would add significantly to the installation cost. (PHCC, No.40 at p. 3) DOE agrees that when switching from gas to electric storage water heaters, the additional electrical costs could be significant and include replacement of the entire electrical panel. As a result, and as noted previously, DOE did not include product switching in its analysis as this is likely to be a minimal effect.

Rheem stated that if DOE were to amend the electric storage water heater standards to a level that would require heat pump technology for lowboy water heaters, replacements would likely be electric instantaneous water heaters, as gas-fired is not an option due to venting and heat pump technology cannot fit in the confined space. Rheem stated that electric instantaneous water heaters use electric resistance technology and have comparable UEF values to lowboy water heaters, so DOE won't realize actual efficiency gains for these types of water heaters. Further, Rheem stated that replacing a lowboy water heater with an electric instantaneous water heater would likely require a costly electrical panel upgrade and significantly increase energy use during peak grid energy use times, and both issues will significantly increase the cost of water heating for the low-income households that typically rely on lowboy water heaters. (Rheem, No. 45 at p. 7)

DOE agrees that replacing small electric resistance water heaters (including lowboy water heaters) can be challenging for standards cases that would require a heat pump water heater standard. DOE notes that the proposed standard does not require an efficiency equivalent to a heat pump water heater for very small and low draw pattern electric storage water heaters below 35 gallons, which is the majority of the lowboy market. As described in the shipments analysis (IV.G.1.a), DOE used took into account various consumer choice options for lowboy water heaters and other challenging installation situations, including using a smaller electric storage water heater and a ''booster'' instantaneous water heater.[114]

DOE welcomes comment on the likelihood of consumers switching products in response to amended standards.

10. 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

[113] For example, see: *www.homeadvisor.com/cost/electrical/upgrade-an-electrical-panel/#upgrade* (last accessed May 1, 2023).

[114] See Rheem's booster instantaneous water heater, which can increase the availability of hot water for storage tank water heaters: *https://www.rheem.com/innovations/innovation_residential/water-heater-booster/*.

that the increased total installed cost is not recovered in reduced operating expenses.

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

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

G. Shipments Analysis

DOE uses projections of annual product shipments to calculate the national impacts of potential amended or new energy conservation standards on energy use, NPV, and future manufacturer cash flows.[115] The shipments model takes an accounting approach, tracking market shares of each product class and the vintage of units in the stock. Stock accounting uses product shipments as inputs to estimate the age distribution of in-service product stocks for all years. The age distribution of in-service product stocks is a key input to calculations of both the NES and NPV, because operating costs for any year depend on the age distribution of the stock.

DOE developed shipment projections based on historical data and an analysis of key market drivers for each product. DOE estimated consumer water heater shipments by projecting shipments in three market segments: (1) replacement of existing consumer water heaters; (2) new housing; and (3) new owners in buildings that did not previously have a consumer water heater or existing water heater owners that are adding an additional consumer water heater.[116]

To project water heater replacement shipments, DOE developed retirement functions from water heater lifetime estimates and applied them to the existing products in the housing stock, which are tracked by vintage. DOE calculated replacement shipments using historical shipments and the lifetime estimates. Annual historical shipments sources are: (1) Appliance Magazine;[117] (2) Air-Conditioning, Heating, and Refrigeration Institute (AHRI) website;[118] (3) multiple AHRI data submittals;[119] (4) BRG Building Solutions 2022 report; (5) ENERGY STAR unit shipments data;[120] (6) Oil Heating Magazine;[121] and 2010 Heating Products Final Rule. In addition, DOE adjusted replacement shipments by taking into account demolitions, using the estimated changes to the housing stock from *AEO2023*.

To project shipments to the new housing market, DOE used the AEO2023 housing starts and commercial building floor space projections to estimate future numbers of new homes and commercial building floor space. DOE then used data from U.S. Census Characteristics of New Housing,[122] [123] Home Innovation Research Labs Annual Builder Practices Survey,[124] RECS 2020, AHS 2021, and CBECS 2018 to estimate new construction water heater saturations by consumer water heater product class.

DOE estimated shipments to the new owners market based on the residual shipments from the calculated replacement and new construction shipments compared to historical shipments in the last 5 years (2018–2022 for this NOPR). DOE compared this with data from Decision Analysts' 2002 to 2022 American Home Comfort Study[125] and 2022 BRG data, which showed similar historical fractions of new owners. DOE assumed that the new owner fraction in 2030 would be equal to the 10-year average of the historical data (2013–2022) and then decrease to zero by the end of the analysis period (2059). If the resulting fraction of new owners is negative, DOE assumed that it was primarily due to equipment switching or non-replacement and added this number to replacements (thus reducing the replacements value).

BWC stated that there are several elements from the 2010 Final Rule that never materialized as DOE expected following its effective date in 2015. Given this, BWC recommend DOE perform a lookback analysis to better understand why things didn't materialize as expected based on the 2010 Final Rule. BWC stated that this will allow the current rulemakings process and analysis to be better informed, adjusted appropriately, and ideally be more representative of the anticipated outcome. (BWC, No.32 at p. 6) BWC did not clarify which elements of the 2010 final rule did not materialize, but DOE believes this comment mainly relates to the lower fraction of shipments of gas-fired and electric storage water heaters above 55 gallons after the 2015 standards, relative to DOE's projection. For this analysis, DOE examined why the shipments did not materialize as expected in the 2010 Final Rule analysis, which is included as part of appendix 9A of the NOPR TSD. This lookback analysis was then used to better estimate projected shipments by water heater size for the present analysis. Based on this analysis, which showed a significant number of consumers opted to install one or more smaller water heaters, DOE developed the consumer choice model for estimating the impacts of proposed

[115] 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.

[116] The new owners primarily consist of households that add or switch to a different water heater option during a major remodel. Because DOE calculates new owners as the residual between its shipments model compared to historical shipments, new owners also include shipments that switch away from water heater product class to another.

[117] Appliance Magazine. *Appliance Historical Statistical Review: 1954–2012.* 2014. UBM Canon.

[118] Air-Conditioning, Heating, and Refrigeration Institute. Water Heaters Historical Data. (Available at: *www.ahrinet.org/resources/statistics/historical-data/residential-storage-water-heaters-historical-data*) (Last accessed May 1, 2023).

[119] AHRI. Confidential Instantaneous Gas-fired Water Heater Shipments Data from 2004–2007 to LBNL. March 3, 2008; AHRI. Oil-fired Storage Water Heater (30/32 gallons) Shipments Data provided to DOE. 2008.

[120] ENERGY STAR. Unit Shipments data 2010–2021. multiple reports. (Available at: *www.energystar.gov/partner_resources/products_partner_resources/brand_owner_resources/unit_shipment_data*) (Last accessed May 1, 2023).

[121] Oil Heating Magazine. Merchandising News: Monthly Data on Water Heaters Installed by Dealers 1997–2007. 2007.

[122] U.S. Census. Characteristics of New Housing from 1999–2022 (Available at: *www.census.gov/construction/chars/*) (Last accessed May 1, 2023).

[123] U.S. Census. Characteristics of New Housing (Multi-Family Units) from 1973–2022 (Available at: *www.census.gov/construction/chars/mfu.html*) (Last accessed May 1, 2023).

[124] Home Innovation Research Labs (independent subsidiary of the National Association of Home Builders (''NAHB''). Annual Builder Practices Survey (2015–2019) (Available at: *www.homeinnovation.com/trends_and_reports/data/new_construction*) (Last accessed May 1, 2023).

[125] Decision Analysts, 2002, 2004, 2006, 2008, 2010, 2013, 2016, 2019, and 2022 American Home Comfort Study (Available at: *www.decisionanalyst.com/Syndicated/HomeComfort/*) (Last accessed May 1, 2023).

standards on shipments as shown in IV.G.1.a.

BWC is concerned with the projected water heater shipments by product category in the preliminary analysis, as it shows a significant increase in gas-fired instantaneous water heaters shipments. They stated that these projections do not appear to account for how state and local policies will impact the shipments of different water heater types; *i.e.,* California, one of the largest markets for gas-fired instantaneous water heaters, has modified Title 24, its building code, to disincentivize their use. They stated that this is also true of various pieces of state legislation and proposed actions by the California Air Resources Board, as well as several Air Districts (*e.g.,* South Coast Air Quality Management District; Bay Area Air Quality Management District). (BWC, No. 32 at p.5) AHRI requested that DOE evaluate the impact of regional efforts to bring gas water heater emissions below ultra-low NO_X levels. (AHRI, No. 31 at pp. 20–21)

For the NOPR, DOE accounted for the 2022 update to Title 24 in California[126] and also the decision of the California Public Utilities Commission to entirely eliminate ratepayer subsidies for the extension of new gas lines beginning in July 2023. Together, these policies are expected to lead to the phase-out of gas-fired water heaters in new single-family homes. The California Air Resources Board has adopted a 2022 State Strategy for the State Implementation Plan that would effectively ban sales of new gas-fired space heaters and water heaters beginning in 2030.[127] However, because a final decision on a rule would not happen until 2025, DOE did not include this policy in its analysis for the NOPR.

AHRI, Rheem and GEA are concerned with the shipment projections that DOE has outlined in the preliminary TSD because of the lack of consideration related to the ongoing decarbonization and electrification efforts. They stated that many states and cities are moving towards a ''ban'' on gas products altogether (*e.g.,* California Title 24, CARB, SCAQMD, BAAQMD, and New York City) that is likely to impact water heater shipments by product class, efficiency, and especially fuel type, and yet DOE's analysis shows a steady increase in gas appliance sales. AHRI stated that it does not appear that the Department took these policies into account when performing their analysis. (AHRI, No. 42 at p. 3; GEA, No. 46 at p. 1; Rheem, No. 45 at p. 3) NYSERDA also stated that DOE's shipment analysis is not predicting an appropriate future increase in electric water heater sales and disagrees with DOE's analysis showing the number of electric water heaters, including HPWHs, remaining steady in DOE's predictions. NYSERDA stated that New York is among many jurisdictions with deep decarbonization or carbon neutral buildings goals, with timelines ranging from 2032 to 2050 and it expects that these goals will dramatically increase the market for electric water heaters while decreasing overall demand for fossil fuel water heaters. NYSERDA recommends that DOE reflect existing policies that are heavily pushing electrification of space and water heating and increase the number of electric WHs projected to be shipped between approximately 2030 and 2050. (NYSERDA, No. 35 at pp.2–3) EEI suggested that DOE complete a sensitivity analysis based on successfully establishing a zero-carbon energy grid by 2035. (EEI, No. 31 at pp. 48–49)

For the preliminary analysis, assumptions regarding future policies encouraging electrification of households and electric water heating were speculative at that time, so such policies were not incorporated into the shipments projection.

DOE agrees that ongoing electrification policies at the Federal, State, and local levels are likely to encourage installation of electric water heaters in new homes and adoption of electric water heaters in homes that currently use gas-fired water heaters. For example, the Inflation Reduction Act includes incentives for heat pump water heaters and electrical panel upgrades. However, there are many uncertainties about the timing and impact of these policies that make it difficult to fully account for their likely impact on gas and electric water heater market shares in the time frame for this analysis (*i.e.,* 2030 through 2059). Nonetheless, DOE has modified some of its projections to attempt to account for impacts that seem most likely in the relevant time frame. The assumptions are described in chapter 9 and appendix 9A of the NOPR TSD. The changes result in a decrease in gas-fired storage and instantaneous water heater shipments in the no-new-standards case in 2030 compared to the preliminary analysis. DOE acknowledges that electrification policies may result in a larger decrease in shipments of gas-fired water heaters than projected in this NOPR, especially if stronger policies are adopted in coming years. However, this would occur in the no-new amended standards case and thus would only reduce the energy savings estimated in this proposed rule. For example, if incentives and rebates shifted 5 percent of shipments in the no-new amended standards case from gas-fired storage water heaters to heat pump electric storage water heaters, then the energy savings estimated for gas-fired storage water heaters in this proposed rule would decline by approximately 5 percent. The estimated consumer impacts are likely to be similar, however, except that the percentage of consumers with no impact at a given efficiency level would increase. DOE notes that the economic justification for the proposed rule would not change if DOE included the impact of incentives and rebates in the no-new-standards case, even if the absolute magnitude of the savings were to decline.

DOE requests comments on its approach for taking into account electrification efforts in its shipments analysis.

1. Impact of Potential Standards on Shipments

a. Impact of Consumer Choice for Electric Storage Water Heaters

DOE applied a consumer choice model to estimate the impact on electric storage water heaters shipments in the case of a heat pump water heater standard. As noted previously (IV.F.9), DOE did not include other product switching (*e.g.,* using different fuels) in its analysis as this is likely to be a minimal effect. This is especially true in the case of an emergency replacement.

DOE accounted for the potential of consumers selecting one or more smaller electric storage water heaters with or without a ''booster'' instantaneous water heater instead of replacing a larger electric storage water heater with a heat pump water heater.[128] DOE analyzed two main scenarios for a heat pump standard: (1) When electric storage water heaters, ≥20 gal and ≤55 gal, excluding small ESWHs could potentially downsize to the small electric storage water heater product class, due to a heat pump standard to electric storage water heaters, ≥20 gal

[126] The 2022 update includes heat pumps as a performance standard baseline for water or space heating in single-family homes, and space heating in multi-family homes. Builders will need to either include one high-efficiency heat pump in new constructions or subject those buildings to more stringent energy efficiency standards.

[127] *https://ww2.arb.ca.gov/resources/documents/2022-state-strategy-state-implementation-plan-2022-state-sip-strategy#:~:text=The%202022%20State%20SIP%20Strategy,all%20nonattainment%20areas%20across%20California.*

[128] See Rheem's booster instantaneous water heater, which can increase the availability of hot water for storage tank water heaters: *https://www.rheem.com/innovations/innovation_residential/water-heater-booster/.*

and ≤55 gal, excluding small ESWHs only; (2) Heat pump water heater standard for all ESWH product classes, where ESWHs could potentially downsize to very small water heaters. DOE identified households from the electric consumer water heater sample that might downsize at each of the considered standard levels based on water heater sizing criteria and matching to the different consumer choice options that would result in no loss of utility. DOE assigned an effective volume and draw pattern to sampled consumer water heaters based on data from RECS 2015 and CBECS 2018. DOE selected the households or buildings that would downsize based on the fact that the consumer would have a financial incentive to downsize in the short term (*e.g.,* lower first cost), even though in some cases downsizing might not be advantageous in the long run compared to installing a heat pump water heater. Table IV.28 and Table IV.29 show the resulting estimated shipment market share impacted for each scenario.

TABLE IV.28—CONSUMER CHOICE RESULTS FOR ELECTRIC STORAGE WATER HEATERS

[Assuming heat pump standard for electric storage water heaters, ≥20 gal and ≤55 gal, excluding small ESWHs only]

Consumer choice options	Efficiency level, market share impacted (%)			
	0	1	2	3
Not Switching	100.0	78.2	78.5	75.3
Small ESWH	0.0	11.4	11.4	13.3
Small ESWH + Booster	0.0	7.7	7.5	8.2
Two Small ESWH	0.0	2.8	2.6	3.2

TABLE IV.29—CONSUMER CHOICE RESULTS FOR ELECTRIC STORAGE WATER HEATERS

[Assuming heat pump standard for all electric storage water heater product classes]

Consumer choice options	Efficiency level, market share impacted (%)			
	0	1	2	3
Small Electric Storage Water Heaters, ≥20 gal and ≤35 gal and FHR <51 gal				
Not Switching	100.0	23.0	....	....
Very Small ESWH + One Booster	0.0	74.1	....	....
Two Very Small ESWH	0.0	2.8	....	....
Two Very Small ESWH + One Booster	0.0	0.1	....	....
Electric Storage Water Heaters, ≥20 gal and ≤55 gal, excluding Small ESWHs				
Not Switching	100.0	90.4	90.6	89.4
Very Small ESWH + One Booster	0.0	4.7	4.7	5.5
Two Very Small ESWH	0.0	3.2	3.1	3.4
Two Very Small ESWH + One Booster	0.0	1.6	1.5	1.8

The shipments model considers the switching that might occur in each year of the analysis period (2030–2059). To do so, DOE estimated the switching in the first year of the analysis period (2030), using data on willingness to pay, in the LCC analysis and derived trends from 2030 to 2059. The shipments model also tracks the number of additional consumer water heaters shipped in each year. See appendix 9A of this NOPR TSD for further details regarding how DOE estimated switching between various electric water heater options.

b. Impact of Repair vs. Replace

For this NOPR, DOE estimated a fraction of consumer water heater replacement installations that choose to repair their equipment, rather than replace their equipment in the new standards case. The approach captures not only a decrease in consumer water heater replacement shipments, but also the energy use from continuing to use the existing consumer water heater and the cost of the repair. DOE assumes that the demand for water heating is inelastic and, therefore, that no household or commercial building will forgo either repairing or replacing their equipment (either with a new consumer water heater or a suitable water heating alternative).

For details on DOE's shipments analysis, consumer choice and the repair option, see chapter 9 of the final rule TSD.

H. National Impact Analysis

The NIA assesses the national energy savings (''NES'') and the NPV from a national perspective of total consumer costs and savings that would be expected to result from new or amended standards at specific efficiency levels.[129] (''Consumer'' in this context refers to consumers of the product being regulated.) DOE calculates the NES and NPV for the potential standard levels considered based on projections of annual product shipments, along with the annual energy consumption and total installed cost data from the energy use and LCC analyses. For the present analysis, DOE projected the energy savings, operating cost savings, product costs, and NPV of consumer benefits over the lifetime of consumer water heaters sold from 2030 through 2059.

DOE evaluates the impacts of new or amended standards by comparing a case without such standards with standards-case projections. The no-new-standards case characterizes energy use and consumer costs for each product class in the absence of new or amended energy conservation standards. For this projection, DOE considers historical trends in efficiency and various forces that are likely to affect the mix of efficiencies over time. DOE compares

[129] The NIA accounts for impacts in the 50 states and U.S. territories.

the no-new-standards case with projections characterizing the market for each product class if DOE adopted new or amended standards at specific energy efficiency levels (*i.e.,* the TSLs or standards cases) for that class. For the standards cases, DOE considers how a given standard would likely affect the market shares of products with efficiencies greater than the standard.

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

Table IV.29 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—SUMMARY OF INPUTS AND METHODS FOR THE NATIONAL IMPACT ANALYSIS

Inputs	Method
Shipments	Annual shipments from shipments model.
Compliance Date of Standard	2030.
Efficiency Trends	No-new-standards case: Based on historical data. Standards cases: Roll-up in the compliance year and then DOE estimated growth in shipment-weighted efficiency in all the standards cases.
Annual Energy Consumption per Unit	Annual weighted-average values are a function of energy use at each TSL.
Total Installed Cost per Unit	Annual weighted-average values are a function of cost at each TSL. Incorporates projection of future product prices based on historical data.
Annual Energy Cost per Unit	Annual weighted-average values as a function of the annual energy consumption per unit and energy prices.
Repair and Maintenance Cost per Unit	Annual values do not change with efficiency level.
Energy Price Trends	*AEO2023* projections (to 2050) and extrapolation thereafter.
Energy Site-to-Primary and FFC Conversion	A time-series conversion factor based on *AEO2023.*
Discount Rate	3 percent and 7 percent.
Present Year	2023.

NEEA, ACEEE, and NWPCC stated that DOE's NIA and NPV results align with NEEA's research and experience that HPWHs and improved gas water heaters are cost-effective and deliver significant benefits to consumers. (NEEA, ACEEE, and NWPCC, No. 47 at p. 3)

1. Product Efficiency Trends

A key component of the NIA is the trend in energy efficiency projected for the no-new-standards case and each of the standards cases. Section IV.F.8 of this document describes how DOE developed an energy efficiency distribution for the no-new-standards case (which yields a shipment-weighted average efficiency) for each of the considered product classes for the year of anticipated compliance with an amended or new standard. To project the trend in efficiency absent amended standards for consumer water heaters over the entire shipments projection period, DOE used available historical shipments data and manufacturer input. The approach is further described in chapter 10 of the NOPR TSD.

For the standards cases, DOE used a ''roll-up'' scenario to establish the shipment-weighted efficiency for the year that standards are assumed to become effective (2030). 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.

To develop standards case efficiency trends after 2030, DOE used historical shipment data and on current consumer water heater model availability by efficiency level (see chapter 8). DOE estimated growth in shipment-weighted efficiency by assuming that the implementation of ENERGY STAR's performance criteria and other incentives would gradually increase the market shares of higher efficiency water heaters meeting ENERGY STAR® requirements such as EL 3 and above for gas-fired storage water heaters, EL 2 and above for electric storage water heaters (≥20 gal V_{eff} ≤55 gal), and EL 1 and above for gas-fired instantaneous water heaters. DOE also took into account increased incentives for higher efficiency equipment and electrification efforts. For oil-fired storage water heaters and electric storage water heaters (>55 gal V_{eff} ≤120 gal), DOE assumed a constant market share throughout the analysis period (2030–2059).

DOE requests comments on its approach for developing efficiency trends after 2030, and solicits input on how of the Inflation Reduction Act could affect future uptake of higher efficiency water heaters.

2. National Energy Savings

The national energy savings analysis involves a comparison of national energy consumption of the considered products between each potential standards case (''TSL'') and the case with no new or amended energy conservation standards. DOE calculated the national energy consumption by multiplying the number of units (stock) of each product (by vintage or age) by the unit energy consumption (also by vintage). DOE calculated annual NES based on the difference in national energy consumption for the no-new standards case and for each higher efficiency standard case. DOE estimated energy consumption and savings based on site energy and converted the electricity consumption and savings to primary energy (*i.e.,* the energy consumed by power plants to generate site electricity) using annual conversion factors derived from *AEO2023.* Cumulative energy savings are the sum of the NES for each year over the timeframe of the analysis.

Use of higher-efficiency products is sometimes associated with a direct rebound effect, which refers to an increase in utilization of the product due to the increase in efficiency. DOE examined a 2009 review of empirical estimates of the rebound effect for various energy-using products.[130] This review concluded that the econometric and quasi-experimental studies suggest a mean value for the direct rebound

[130] Steven Sorrell, *et al.,* Empirical Estimates of the Direct Rebound Effect: A Review, 37 *Energy Policy* 1356–71 (2009) (Available at *www.sciencedirect.com/science/article/pii/S0301421508007131*) (Last accessed May 1, 2023).

effect for household water heating of around 10 percent. DOE also examined a 2012 ACEEE paper [131] and a 2013 paper by Thomas and Azevedo.[132] Both of these publications examined the same studies that were reviewed by Sorrell, as well as Greening *et al.*,[133] and identified methodological problems with some of the studies. The studies believed to be most reliable by Thomas and Azevedo show a direct rebound effect for water heating products in the 1-percent to 15-percent range, while Nadel concludes that a more likely range is 1 to 12 percent, with rebound effects sometimes higher for low-income households who could not afford to adequately heat their homes prior to weatherization. DOE applied a rebound effect of 10 percent for consumer water heaters used in residential applications based on studies of other residential products and the value used for consumer water heaters in the 2010 Final Rule for Heating Products, and 0 percent for consumer water heaters in commercial applications, which also matches EIA's National Energy Modeling System (''NEMS'') for residential and commercial water heating and is consistent with other recent energy conservation standards rulemakings.[134] [135] [136] [137] The calculated NES at each efficiency level is therefore reduced by 10 percent in residential applications. DOE also included the rebound effect in the NPV analysis by accounting for the additional net benefit from increased consumer water heaters usage, as described in section IV.H.3 of this document.

DOE requests comments on its approach and value of the rebound effect for consumer water heaters.

In 2011, in response to the recommendations of a committee on ''Point-of-Use and Full-Fuel-Cycle Measurement Approaches to Energy Efficiency Standards'' appointed by the National Academy of Sciences, DOE announced its intention to use FFC measures of energy use and greenhouse gas and other emissions in the national impact analyses and emissions analyses included in future energy conservation standards rulemakings. 76 FR 51281 (Aug. 18, 2011). After evaluating the approaches discussed in the August 18, 2011 notice, DOE published a statement of amended policy in which DOE explained its determination that EIA's National Energy Modeling System (''NEMS'') is the most appropriate tool for its FFC analysis and its intention to use NEMS for that purpose. 77 FR 49701 (Aug. 17, 2012). NEMS is a public domain, multi-sector, partial equilibrium model of the U.S. energy sector [138] that EIA uses to prepare its *Annual Energy Outlook.* The FFC factors incorporate losses in production and delivery in the case of natural gas (including fugitive emissions) and additional energy used to produce and deliver the various fuels used by power plants. The approach used for deriving FFC measures of energy use and emissions is described in appendix 10B of the NOPR TSD.

EEI stated that DOE continues to utilize a ''fossil fuel equivalent'' marginal heat rate for electricity, which likely leads to overestimation of pollution reduction in its analysis. EEI stated that DOE should utilize the ''captured energy'' approach as outlined in an October 2016 report, ''Accounting Methodology for Source Energy of Non-Combustible Renewable Electricity Generation'' (3412 Btu/kWh for non-combustible renewable electricity generation). EEI stated that DOE could also consider the approach used in certain ASHRAE standards, such as Standard 189.1 for Green Commercial Buildings. EEI stated that either of these methodologies more accurately capture the ongoing transition in the electric sector, and DOE should utilize these more accurate metrics in its rulemaking. (EEI, No. 43 at p. 3)

DOE converts electricity consumption and savings to primary energy using annual conversion factors derived from the AEO. Traditionally, EIA has used the fossil fuel equivalency approach to report noncombustible renewables' contribution to total primary energy, in part because the resulting shares of primary energy are closer to the shares of generated electricity.[139] The fossil fuel equivalency approach applies an annualized weighted-average heat rate for fossil fuel power plants to the electricity generated (in kWh) from noncombustible renewables. EIA recognizes that using captured energy (the net energy available for direct consumption after transformation of a noncombustible renewable energy into electricity) or incident energy (the mechanical, radiation, or thermal energy that is measurable as the ''input'' to the device) are possible alternative approaches for converting renewable electricity to a common measure of primary energy,[140] but it continues to use the fossil fuel equivalency approach in the AEO and other reporting of energy statistics. DOE contends that it is important for it to maintain consistency with EIA in DOE's accounting of primary energy savings from energy efficiency standards.

3. Net Present Value Analysis

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

As discussed in section IV.F.1 of this document, DOE developed consumer water heaters price trends based on historical PPI data. DOE applied the same trends to project prices for each

[131] Steven Nadel, ''The Rebound Effect: Large or Small?'' ACEEE White Paper (August 2012) (Available at *www.aceee.org/files/pdf/white-paper/rebound-large-and-small.pdf*) (Last accessed May 1, 2023).

[132] Brinda Thomas and Ines Azevedo, Estimating Direct and Indirect Rebound Effects for U.S. Households with Input–Output Analysis, Part 1: Theoretical Framework, 86 *Ecological Econ.* 199–201 (2013) (Available at *www.sciencedirect.com/science/article/pii/S0921800912004764*) (Last accessed May 1, 2023).

[133] Lorna A. Greening, *et al.*, Energy Efficiency and Consumption—The Rebound Effect—A Survey, 28 *Energy Policy* 389–401 (2002) (Available at *www.sciencedirect.com/science/article/pii/S0301421500000215*) (Last accessed May 1, 2023).

[134] See: *www.eia.gov/outlooks/aeo/nems/documentation/residential/pdf/m067(2020).pdf* (Last accessed May 1, 2023).

[135] DOE. Energy Conservation Program for Certain Industrial Equipment: Energy Conservation Standards for Small, Large, and Very Large Air-Cooled Commercial Package Air Conditioning and Heating Equipment and Commercial Warm Air Furnaces; Direct final rule. 81 FR 2419 (Jan. 15, 2016) (Available at *www.regulations.gov/document/EERE-2013-BT-STD-0021-0055*) (Last accessed May 1, 2023).

[136] DOE. Energy Conservation Program: Energy Conservation Standards for Residential Boilers; Final rule. 81 FR 2319 (Jan. 15, 2016) (Available at *www.regulations.gov/document/EERE-2012-BT-STD-0047-0078*) (Last accessed May 1, 2023).

[137] DOE. Energy Conservation Program: Energy Conservation Standards for Commercial Packaged Boilers; Final Rule. 85 FR 1592 (Jan. 10, 2020) (Available at *www.regulations.gov/document/EERE-2013-BT-STD-0030-0099*) (Last accessed May 1, 2023).

[138] For more information on NEMS, refer to *The National Energy Modeling System: An Overview 2018,* DOE/EIA–0581(2018), April 2019. Available at *www.eia.gov/outlooks/aeo/nems/overview/pdf/0581(2018).pdf* (last accessed May 1, 2023).

[139] Without adjusting primary energy for fossil fuel equivalence, the non-combustible renewable share of total energy consumption for utility-scale electricity generation in 2018 would have been 6% instead of the 15% share under the fossil fuel equivalency approach. On a physical units basis, net generation from noncombustible renewable energy sources was 16% of total utility-scale net generation in the same year. (see *www.eia.gov/todayinenergy/detail.php?id=41013*).

[140] See: *www.eia.gov/totalenergy/data/monthly/pdf/sec12_28.pdf.*

product class at each considered efficiency level. By 2059, which is the end date of the projection period, the average consumer water heaters price doesn't change relative to 2022. 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 consumer water heaters. In addition to the default price trend, DOE considered two product price sensitivity cases: (1) a price decline case and (2) a price increase case based on PPI data. The derivation of these price trends and the results of these sensitivity cases are described in appendix 10C of the NOPR TSD.

DOE requests comments on its approach for product price projections.

The operating cost savings are the sum of the differences in energy cost savings, maintenance, and repair costs. The maintenance and repair costs derivation is described in section IV.F.5. The energy cost savings are calculated using the estimated energy savings in each year and the projected price of the appropriate form of energy. To estimate energy prices in future years, DOE multiplied the average regional energy prices by the projection of annual national-average residential and commercial energy price changes in the Reference case from *AEO2023,* which has an end year of 2050. To estimate price trends after 2050, DOE used the average annual rate of change in prices from 2046 through 2050. As part of the NIA, DOE also analyzed scenarios that used inputs from variants of the *AEO2023* Reference case that have lower and higher economic growth. Those cases have lower and higher energy price trends compared to the Reference case. NIA results based on these cases are presented in appendix 10D of the NOPR TSD.

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

DOE requests comments on its approach to monetizing the impact of the rebound effect.

In calculating the NPV, DOE multiplies the net savings in future years by a discount factor to determine their present value. For this 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.[141] 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 three subgroups: (1) low-income households, (2) senior-only households, and (3) small businesses. The analysis used subsets of the RECS 2015 sample composed of households and CBECS 2018 sample composed of commercial buildings that meet the criteria for the three subgroups. DOE used the LCC and PBP spreadsheet model to estimate the impacts of the considered efficiency levels on these subgroups. Chapter 11 in the NOPR TSD describes the consumer subgroup analysis.

1. Low-Income Households

Low-income households are significantly more likely to be renters or live in subsidized housing units, compared to homeowners. DOE notes that in these cases the landlord purchases the equipment and may pay the gas bill as well. RECS 2015 includes data on whether a household pays for the gas bill, allowing DOE to categorize households appropriately in the analysis.[142] For this consumer subgroup analysis, DOE considers the impact on the low-income household narrowly, 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 representative manner. DOE takes into account a fraction of renters that face product switching (when landlords switch to products that have lower upfront costs but higher operating costs, which will be incurred by tenants).

The majority of low-income households that experience a net cost at higher efficiency levels are homeowner households, as opposed to renters. These households either have a smaller capacity water heater or lower hot water use. Unlike renters, homeowners would bear the full cost of installing a new water heater. For these households, a potential rebate program to reduce the total installed costs would be effective in lowering the percentage of low-income consumers with a net cost. DOE understands that the landscape of low-income consumers with a water heater may change before the compliance date of amended energy conservation standards, if finalized. For example, point-of-sale rebate programs are being considered that may moderate the impact on low-income consumers to help offset the total installed cost of a higher efficiency water heater, particularly given the lower total installed cost of smaller capacity water heater. Currently, DOE is aware that the Inflation Reduction Act will likely include incentives for certain water heaters, although the specific implementation details have yet to be finalized. DOE is also aware of State or utility program rebates in the Northeast or California, for example, that support additional heat pump deployment as a result of decarbonization policy goals. Point-of-sale rebates or weatherization programs could also reduce the total number of low-income consumers that would be impacted because the household no longer has a water heater to upgrade. DOE is particularly interested in seeking comment around

[141] United States Office of Management and Budget. *Circular A–4: Regulatory Analysis.* September 17, 2003. Section E. Available at *www.whitehouse.gov/omb/memoranda/m03-21.html* (last accessed May 1, 2023).

[142] RECS 2015 includes a category for households that pay only some of the gas bill. For the low-income consumer subgroup analysis, DOE assumes that these households pay 50 percent of the gas bill, and, therefore, would receive 50 percent of operating cost benefits of an amended energy conservation standard.

the landscape of heating replacements leading up to 2030, which may impact the low-income consumer economics being presented and considered in this proposed rulemaking.

Measures of energy insecurity provide another accounting of the number of households that are affected by cost changes due to rules for water heating equipment energy efficiency in addition to the senior-only and low-income categories used by DOE in this analysis. Energy insecurity in the 2020 RECS quantifies the households reporting one or more of the metrics for energy insecurity, including that they that are forgoing basic necessities to pay for energy, and that they leave their home at an unhealthy temperature due to energy cost. The energy insecurity data are disaggregated by water heating equipment type, income category, race, ethnicity, presence of children, presence of seniors, regional distribution, and ownership/rental status. DOE has determined that the energy insecure designation captures more households than the low-income and seniors-only categories used for distributional analysis. Similar PBP and net savings/net cost analysis applied to energy insecure households could result in larger impacts than for the categories DOE chose to analyze and may be more directly interpreted in terms of welfare changes that can be disaggregated by the factors already listed. DOE seeks comment on conducting distributional analysis for energy insecure households in addition to, or instead of, the low-income and seniors-only categories currently analyzed and described in the NOPR.

BWC noted their concern regarding the implications of DOE's analysis for smaller storage volume products, especially how it may impact installations in low to median income households. (BWC, No. 32 at p. 2) As discussed in section IV.F.2, installation cost analysis accounts for significant installation costs for smaller tank volumes in particular installed in space constrained installations in mobile homes, multi-family buildings, or closet installations in single-family homes, which impacts a significant fraction of low-income households. DOE has explicitly considered small electric storage water heaters as part of this NOPR analysis. See section V.B.1.b for the low-income household results, which show that at the considered efficiency levels the average LCC savings and PBP are not substantially different from the average for all households.

DOE requests comments on its approach to estimate low-income consumer impacts for higher efficiency standards.

J. Manufacturer Impact Analysis

1. Overview

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

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

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

DOE conducted the MIA for this rulemaking in three phases. In Phase 1 of the MIA, DOE prepared a profile of the consumer water heaters manufacturing industry based on the market and technology assessment, preliminary manufacturer interviews, and publicly-available information. This included a top-down analysis of consumer water heaters 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 consumer water heaters manufacturing industry, including company filings of form 10–K from the SEC,[143] corporate annual reports, the U.S. Census Bureau's *Economic Census*,[144] and reports from Dunn & Bradstreet.[145]

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 consumer water heaters 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.

[143] U.S. Securities and Exchange Commission. Company Filings. Available at *https://www.sec.gov/edgar/searchedgar/companysearch.html*.

[144] The U.S. Census Bureau. Quarterly Survey of Plant Capacity Utilization. Available at *www.census.gov/programs-surveys/qpc/data/tables.html*.

[145] The Dun & Bradstreet Hoovers login is available at *app.dnbhoovers.com*.

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, ''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, 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 2023 (the base year of the analysis) and continuing to 2059. DOE calculated INPVs by summing the stream of annual discounted cash flows during this period. For manufacturers of consumer water heaters, 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 information gathered from industry stakeholders during the course of manufacturer interviews and subsequent Working Group meetings. The GRIM results are presented in section V.B.2. 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 equipment is typically more expensive than manufacturing baseline equipment due to the use of more complex components, which are typically more costly than baseline components. The changes in the MPCs of covered products can affect the revenues, gross margins, and cash flow of the industry.

As discussed in section IV.C.1 of this document, DOE conducted a market analysis of currently available models listed in DOE's CCD to determine which efficiency levels were most representative of the current distribution of consumer water heaters available on the market. DOE also completed physical teardowns of commercially available units to determine which design options manufacturers may use to achieve certain efficiency levels for each water heater category analyzed. DOE requested comments from stakeholders and conducted interviews with manufacturers concerning these initial efficiency levels, which have been updated in this NOPR based on the feedback DOE received. For a complete description of the MPCs, see chapter 5 of the NOPR TSD.

b. Shipments Projections

The GRIM estimates manufacturer revenues based on total unit shipment projections and the distribution of those shipments by efficiency level. Changes in sales volumes and efficiency mix over time can significantly affect manufacturer finances. For this analysis, the GRIM uses the NIA's annual shipment projections derived from the shipments analysis from 2023 (the base year) to 2059 (the end year of the analysis period). See chapter 9 of the NOPR TSD for additional details.

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

To evaluate the level of product conversion costs manufacturers would likely incur to comply with amended energy conservation standards, DOE relied on feedback from manufacturer interviews. DOE contractors conducted interviews with manufacturer of gas-fired storage, gas-fired instantaneous, oil-fired storage, electric storage, electric instantaneous, tabletop, and grid-enabled water heaters. The interviewed manufacturers account for approximately 80 percent of unit sales in the industry. DOE used market share weighted feedback from interviews to extrapolate industry-level product conversion costs from the manufacturer feedback.

To evaluate the level of capital conversion costs manufacturers would likely incur to comply with amended energy conservation standards, DOE relied on estimate of equipment and tooling from its engineering analysis and on feedback from manufacturer interviews. DOE modeled the green field investments required for a major manufacturer to setup a production facility. The investment figures included capital required for manufacturing equipment, tooling, conveyor, facility. DOE then modeled the incremental investment required by increases in standards. DOE multiplied the incremental investment by number of major manufacturers. These investment levels aligned well with feedback from interviews. Additionally, DOE determined that smaller manufacturers would have lower investment levels given their lower production volumes and accounted for those lower investments for manufacturer with lower market share.

In general, DOE assumes all conversion-related investments occur between the year of publication of the final rule and the year by which manufacturers must comply with the 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 these markups in the standards case yields different sets of impacts on manufacturers. For the MIA, DOE modeled two standards-case markup scenarios to represent uncertainty regarding the potential impacts on prices and profitability for manufacturers following the implementation of amended energy conservation standards: (1) a 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'' markup 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 estimated gross margin percentages of 24% for the gas-fired storage product class, 22% for electric storage, 23% for oil-fired storage, and 31% for gas-fired instantaneous.[146] 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 to industry profitability under an amended energy conservation standard.

Under the preservation of operating profit markup scenario, DOE modeled a situation in which manufacturers are not able to increase per-unit operating profit in proportion to increases in manufacturer production costs. 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 compliance date of the amended standards. The implicit assumption behind this scenario is that the industry can only maintain its operating profit in absolute dollars after the standard. A comparison of industry financial impacts under the two manufacturer markup scenarios is presented in section V.B.2.a of this document.

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

3. Manufacturer Interviews

DOE interviewed manufacturers representing approximately 80 percent of the consumer water heaters industry by shipment volume. Participants included manufacturers of gas-fired storage, gas-fired instantaneous, oil-fired storage, electric storage, electric instantaneous, tabletop, and grid enabled water heaters.

In interviews, DOE asked manufacturers to describe their major concerns regarding potential amended standards for consumer water heaters. The following section highlights manufacturer concerns in an aggregated fashion 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. Level of Investment Associated With Concurrent Technology Shifts

Manufacturers raised concerns about the potential for multiple significant technology shifts associated with this rulemaking. They noted that the adoption of a standard level requiring condensing technology for gas-fired storage water heaters would potentially require large investments to expand production capacity. At higher condensing efficiencies, manufacturers anticipated a range of manufacturing bottlenecks associated with more complex assembly, heavier products, and longer production times. To resolve these bottlenecks, manufacturers expected investments in additional production equipment and tooling. Manufacturers further noted that, in some cases, new additional production lines would have to be added.

Manufacturers also raised concern that the adoption of a standard level requiring heat pump technology for electric storage water heaters would require substantial investment in expanding and retooling production facilities. Manufacturers noted that only a small percentage of the electric storage water heaters market uses heat pumps today. Manufacturers would need to update a broad range of designs to meet market needs. Additionally, industry would need to substantially expand heat pump water heater production. Manufacturers noted they would need to significantly change their electric water heater manufacturing layout. Some manufacturers anticipated the need to develop multiple new production lines to service the market.

Manufactures noted that concurrent shifts in technology would lead to very high investment levels in a short period of time. Additional manufacturers were concerned about having the technical resources to manage the technology changes within the conversion period. Finally, manufacturers noted that the shift to heat pump water heaters is further complicated by regulatory and market uncertainty related to refrigerants due to the American Innovation and Manufacturing (AIM) Act, which directs EPA to phase down hydrofluorocarbons (HFCs) production and consumption and includes sector-based restrictions. Additionally, manufacturers noted that several states have introduced their own HFC phase-down regulations. Manufacturers raised concerns that state actions could further complicate refrigerant restrictions.

b. Lowboy Electric Storage Water Heaters

In interviews, manufacturers raised concerns about the effect higher standards would have on specific designs, known as ''lowboys,'' which are used in height-restricted installations. In particular, manufacturers asserted that the adoption of integrated heat pump technology, which would add significant height to water heaters, would present challenges for some

[146] The gross margin percentage of 24 percent for gas-fired storage is based on a manufacturer markup of 1.31. The gross margin percentage of 22 percent for electric storage is based on a manufacturer markup of 1.28.The gross margin percentage of 23 percent for oil-fired storage is based on a manufacturer markup of 1.30. The gross margin percentage of 31 percent for gas-fired instantaneous is based on a manufacturer markup of 1.45.

installations. For this reason, manufacturers stated that lowboy electric storage water heaters could not be easily replaced with heat pump water heaters that are currently available on the market. However, as discussed in the engineering analysis, DOE has tentatively determined that split-system heat pump designs would still be feasible for lowboy installations without increasing the height of the product. See section IV.C.1 for details.

4. Discussion of MIA Comments

BWC urged DOE to consider the cumulative burden placed on manufacturers by the simultaneous occurrence of multiple rulemakings. Additionally, BWC requested DOE consider the impact of regulations outside the seven-year period around when this rulemaking would come into effect. (BWC, No. 32 at pp. 4)

DOE analyzes cumulative regulatory burden pursuant to appendix A. Pursuant to appendix A, the Department will recognize and consider the overlapping effects on manufacturers of new or revised DOE standards and other Federal regulatory actions affecting the same products or equipment. The results of this analysis can be found in section V.B.2.e of this document.

BWC stated that Steffes Corporation and Hubbell were not included in DOE's list of small business manufacturers of consumer water heaters and suggested they be added. (BWC, No. 32 at p. 5). DOE notes that Hubbell Corporation was included in DOE's list of manufacturers under the name of its parent company at the time, HEH Holdings. Hubbell's parent company has since changed to the Nudyne Group LLC. DOE continues to consider the company and its products in its analyses. Based on BWC's written comment, DOE reviewed the products from Steffes Corporation. Based on publicly available product information, Steffes Corporation's products appear to be for multi-family homes and the products' rated input would exceed the thresholds for consumer water heaters. DOE has not included Steffes Corporation in its list of small business consumer water heater manufacturers.

K. Emissions Analysis

The emissions analysis consists of two components. The first component estimates the effect of potential energy conservation standards on power sector and site (where applicable) combustion emissions of 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 *AEO2023.* 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.[147]

The on-site operation of consumer water heaters 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 Inventories and, for NO_X and SO_2 emissions intensity factors from an EPA publication.[148]

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.

BWC stated that in regard to the NOPR Emissions Impact Analysis, in addition to DOE's consideration of the upstream emissions as it relates to the power sector, they recommend DOE also analyze additional emissions generated to comply with an amended standard. With an amended standard more complex components and more of certain existing components will be required to comply. BWC believes that more emissions will be generated to produce these components to comply with an amended standard versus what will be saved by requiring higher efficiency equipment. (BWC, No. 32 at p. 6)

In determining the economic justification of a standard, EPCA requires DOE 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)) DOE considers full-fuel cycle energy savings, including the energy consumed in electricity production, in distribution and transmission, and in extracting, processing, and transporting primary fuels. DOE further analyzes the emissions savings associated with those projected energy savings. DOE does not analyze energy or emissions savings related to manufacturing, recycling, or disposing of products, as such impacts would not be considered a direct result of the standard on the energy use of the covered product. DOE did take into account the increased electricity consumption due to increased electricity use in higher efficiency design options. See chapter 7 for more details.

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

1. Air Quality Regulations Incorporated in DOE's Analysis

DOE's no-new-standards case for the electric power sector reflects the *AEO,* which incorporates the projected impacts of existing air quality regulations on emissions. *AEO2023* generally represents current legislation and environmental regulations, including recent government actions, that were in place at the time of preparation of *AEO2023,* including the emissions control programs discussed in the following paragraphs.[149]

SO_2 emissions from affected electric generating units (''EGUs'') are subject to nationwide and regional emissions cap-and-trade programs. Title IV of the Clean Air Act sets an annual emissions cap on SO_2 for affected EGUs in the 48 contiguous States and the District of Columbia (DC). (42 U.S.C. 7651 *et seq.*) SO_2 emissions from numerous States in the eastern half of the United States are also limited under the Cross-State Air Pollution Rule (''CSAPR''). 76 FR 48208

[147] U.S. Environmental Protection Agency. Emission Factors for Greenhouse Gas Inventories. Available at *www.epa.gov/sites/production/files/2021-04/documents/emission-factors_apr2021.pdf* (last accessed May 1, 2023).

[148] 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 May 1, 2023).

[149] For further information, see the Assumptions to *AEO2023* report that sets forth the major assumptions used to generate the projections in the Annual Energy Outlook. Available at *www.eia.gov/outlooks/aeo/assumptions/* (last accessed May 1, 2023).

(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.[150] *AEO2023* 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). The final rule establishes power plant emission standards for mercury, acid gases, and non-mercury metallic toxic pollutants. *I*n 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 *AEO2023.*

CSAPR also established limits on NO_X emissions for numerous States in the eastern half of the United States. Energy conservation standards would have little effect on NO_X emissions in those States covered by CSAPR emissions limits if excess NO_X emissions allowances resulting from the lower electricity demand could be used to permit offsetting increases in NO_X emissions from other EGUs. In such case, NO_X emissions would remain near the limit even if electricity generation goes down. A different case could possibly result, depending on the configuration of the power sector in the different regions and the need for allowances, such that NO_X emissions might not remain at the limit in the case of lower electricity demand. In this case, energy conservation standards might reduce NO_X emissions in covered States. Despite this possibility, DOE has chosen to be conservative in its analysis and has maintained the assumption that standards will not reduce NO_X emissions in States covered by CSAPR. Energy conservation standards would be expected to reduce NO_X emissions in the States not covered by CSAPR. DOE used *AEO2023* data to derive NO_X emissions factors for the group of States not covered by CSAPR.

The MATS limit mercury emissions from power plants, but they do not include emissions caps and, as such, DOE's energy conservation standards would be expected to slightly reduce Hg emissions. DOE estimated mercury emissions reduction using emissions factors based on *AEO2023,* which incorporates the MATS.

L. Monetizing Emissions Impacts

As part of the development of this 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.

To monetize the benefits of reducing GHG emissions, this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990* published in February 2021 by the IWG.

1. Monetization of Greenhouse Gas Emissions

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

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

DOE estimated the global social benefits of CO_2, CH_4, and N_2O reductions using SC–GHG values that were based on the interim values presented in the Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990, published in February 2021 by the IWG. 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 CH4 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

[150] 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).

science available at the time of that process, and with input from the public. Specifically, in 2009, the IWG, that included the DOE and other executive branch agencies and offices was established to ensure that agencies were using the best available science and to promote consistency in the social cost of carbon (SC–CO_2) values used across agencies. The IWG published SC–CO_2 estimates in 2010 that were developed from an ensemble of three widely cited integrated assessment models (IAMs) that estimate global climate damages using highly aggregated representations of climate processes and the global economy combined into a single modeling framework. The three IAMs were run using a common set of input assumptions in each model for future population, economic, and CO_2 emissions growth, as well as equilibrium climate sensitivity—a measure of the globally averaged temperature response to increased atmospheric CO_2 concentrations. These estimates were updated in 2013 based on new versions of each IAM. In August 2016 the IWG published estimates of the social cost of methane (SC–CH_4) and nitrous oxide (SC–N_2O) using methodologies that are consistent with the methodology underlying the SC–CO_2 estimates. The modeling approach that extends the IWG SC–CO_2 methodology to non-CO_2 GHGs has undergone multiple stages of peer review. The SC–CH_4 and SC–N_2O estimates were developed by Marten *et al.*[151] and underwent a standard double-blind peer review process prior to journal publication. In 2015, as part of the response to public comments received to a 2013 solicitation for comments on the SC–CO_2 estimates, the IWG announced a National Academies of Sciences, Engineering, and Medicine review of the SC–CO_2 estimates to offer advice on how to approach future updates to ensure that the estimates continue to reflect the best available science and methodologies. In January 2017, the National Academies released their final report, Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide, and recommended specific criteria for future updates to the SC–CO_2 estimates, a modeling framework to satisfy the specified criteria, and both near-term updates and longer-term research needs pertaining to various components of the estimation process (National Academies, 2017).[152] Shortly thereafter, in March 2017, President Trump issued Executive Order 13783, which disbanded the IWG, withdrew the previous TSDs, and directed agencies to ensure SC–CO_2 estimates used in regulatory analyses are consistent with the guidance contained in OMB's Circular A–4, ''including with respect to the consideration of domestic versus international impacts and the consideration of appropriate discount rates'' (E.O. 13783, Section 5(c)). Benefit-cost analyses following E.O. 13783 used SC–GHG estimates that attempted to focus on the U.S.-specific share of climate change damages as estimated by the models and were calculated using two discount rates recommended by Circular A–4, 3 percent and 7 percent. All other methodological decisions and model versions used in SC–GHG calculations remained the same as those used by the IWG in 2010 and 2013, respectively.

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

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

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

[152] 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.

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,[153] 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% discount rates as ''default'' values, Circular A–4 also reminds agencies that ''different regulations may call for different emphases in the analysis, depending on the nature and complexity of the regulatory issues and the sensitivity of the benefit and cost estimates to the key assumptions.'' On discounting, Circular A–4 recognizes that ''special ethical considerations arise when comparing benefits and costs across generations,'' and Circular A–4 acknowledges that analyses may appropriately ''discount future costs and consumption benefits . . . at a lower rate than for intragenerational analysis.'' In the 2015 Response to Comments on the Social Cost of Carbon for Regulatory Impact Analysis, OMB, DOE, and the other IWG members recognized that ''Circular A–4 is a living document'' and ''the use of 7 percent is not considered appropriate for intergenerational discounting. There is wide support for this view in the academic literature, and it is recognized in Circular A–4 itself.'' Thus, DOE concludes that a 7% discount rate is not appropriate to apply to value the social cost of greenhouse gases in the analysis presented in this analysis.

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

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

There are a number of limitations and uncertainties associated with the SC–GHG estimates. First, the current scientific and economic understanding of discounting approaches suggests discount rates appropriate for intergenerational analysis in the context of climate change are likely to be less than 3 percent, near 2 percent or lower.[154] 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,

[153] Interagency Working Group on Social Cost of Carbon. *Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866.* 2010. United States Government. Available at *www.epa.gov/sites/default/files/2016-12/documents/scc_tsd_2010.pdf* (last accessed May 1, 2023); Interagency Working Group on Social Cost of Carbon. *Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866.* 2013. Available at *www.federalregister.gov/documents/2013/11/26/2013-28242/technical-support-document-technical-update-of-the-social-cost-of-carbon-for-regulatory-impact* (last accessed May 1, 2023); Interagency Working Group on Social Cost of Greenhouse Gases, United States Government. Technical Support Document: Technical Update on the Social Cost of Carbon for Regulatory Impact Analysis—Under Executive Order 12866. August 2016. Available at *www.epa.gov/sites/default/files/2016-12/documents/sc_co2_tsd_august_2016.pdf* (last accessed May 1, 2023); Interagency Working Group on Social Cost of Greenhouse Gases, United States Government. Addendum to Technical Support Document on Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866: Application of the Methodology to Estimate the Social Cost of Methane and the Social Cost of Nitrous Oxide. August 2016. Available at *www.epa.gov/sites/default/files/2016-12/documents/addendum_to_sc-ghg_tsd_august_2016.pdf* (last accessed May 1, 2023).

[154] 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/* (last accessed May 1, 2023).

uncertainty in the extrapolation of damages to high temperatures, and inadequate representation of the relationship between the discount rate and uncertainty in economic growth over long time horizons. Likewise, the socioeconomic and emissions scenarios used as inputs to the models do not reflect new information from the last decade of scenario generation or the full range of projections. The modeling limitations do not all work in the same direction in terms of their influence on the SC–CO_2 estimates. However, as discussed in the February 2021 TSD, the IWG has recommended that, taken together, the limitations suggest that the interim SC–GHG estimates used in this final rule likely underestimate the damages from GHG emissions. DOE concurs with this assessment.

DOE's derivations of the SC–CO_2, SC–N_2O, and SC–CH_4 values used for this NOPR are discussed in the following sections, and the results of DOE's analyses estimating the benefits of the reductions in emissions of these GHGs are presented in section V.A.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 the IWG's February 2021 TSD. Table IV.30 shows the updated sets of SC–CO_2 estimates from the IWG's TSD in 5-year increments from 2020 to 2050. The full set of annual values that DOE used is presented in appendix 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.[155]

TABLE IV—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$.[156] 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 consumer water heaters 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 2022$ using the implicit price deflator for gross domestic product (''GDP'') from the Bureau of Economic Analysis. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the four cases using the specific discount rate that had been used to obtain the SC–CO_2 values in each case.

b. Social Cost of Methane and Nitrous Oxide

The SC–CH_4 and SC–N_2O values used for this NOPR were based on the values developed for the February 2021 TSD. Table IV.31 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—ANNUAL SC–CH_4 AND SC–N_2O VALUES FROM 2021 INTERAGENCY UPDATE, 2020–2050

[2020$ per Metric Ton]

Year	SC–CH_4				SC–N_2O			
	Discount rate and statistic				Discount rate and statistic			
	5%	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

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

[156] See EPA, *Revised 2023 and Later Model Year Light-Duty Vehicle GHG Emissions Standards: Regulatory Impact Analysis,* Washington, DC, December 2021. Available at: *nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1013ORN.pdf* (last accessed May 1, 2023).

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

[2020$ per Metric Ton]

Year	SC–CH_4				SC–N_2O			
	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
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 gross domestic product (''GDP'') from the Bureau of Economic Analysis. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the cases using the specific discount rate that had been used to obtain the SC–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.[157] 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 combined the EPA benefit per ton estimates with regional information on electricity consumption and emissions to define weighted-average national values for NO_X and SO_2 as a function of sector (see appendix 14B of the NOPR TSD).

DOE also estimated the monetized value of NO_X and SO_2 emissions reductions from site use of natural gas, LPG and fuel oil in consumer water heaters 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.[158] The EPA document provides high and low estimates for 2025 and 2030 at 3- and 7-percent discount rates.[159] 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. 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. For consumer water heaters, it is particularly important to look at the aggregated impacts as characterized by TSLs due to the changes in consumer purchasing decisions as a result of the increased product and installation costs that impact the shipments model. The changes to the shipments model will drive differential national impacts both on the consumer and manufacturer side that are more realistic of how the market may change in response to amended DOE standards.

In the analysis conducted for this NOPR, DOE analyzed the benefits and burdens of six TSLs for consumer water heaters. 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 IV.32 presents the TSLs and the corresponding efficiency levels that DOE has identified for potential amended energy conservation standards for consumer water heaters. TSL 6 represents the maximum technologically feasible (''max-tech'') energy efficiency for all product classes. TSL 5 represents the highest efficiency level for each product class with a positive NPV at 7 percent discount rate for all product classes. For gas-fired gas storage water heater, the NPV at 7 percent discount rate is negative from EL 3 to EL 5. Therefore, TSL 5 is constructed by reducing the efficiency level for gas-fired storage water heaters (*i.e.,* EL 2) and with the same efficiency level for all other product class compared to the max-tech. TSL 4 represents the highest efficiency level for each product class with the maximum NPV at 7 percent discount rate for all product classes. Therefore, TSL 4 is constructed by reducing the efficiency level for electric storage water heaters (*i.e.,* EL 2) and gas-fired instantaneous water heaters (*i.e.,* EL 3). TSL 3 represents an interim energy efficiency level between the joint stakeholder recommendation (*i.e.,* TSL 2) and TSL 4. TSL 2 represents the joint stakeholder recommendation. Finally, because EL 1 is the lowest analyzed efficiency level above baseline, TSL 1 is constructed with EL 1 for all product classes, except for electric storage water heaters (20 gal ≤ V_{eff} ≤55 gal) which is set equal to the current standard level.

[157] *Estimating the Benefit per Ton of Reducing $PM_{2.5}$ Precursors from 21 Sectors.* Available at: *www.epa.gov/benmap/estimating-benefit-ton-reducing-pm25-precursors-21-sectors* (last accessed May 1, 2023).

[158] ''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.

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

TABLE IV—TRIAL STANDARD LEVELS FOR CONSUMER WATER HEATERS

Product class	Trial standard level					
	1	2	3	4	5	6
	Efficiency level					
Gas-fired Storage Water Heaters (20 gal ≤ V_{eff} ≤55 gal)	1	2	2	2	2	5
Oil-fired Storage Water Heaters (V_{eff} ≤50 gal)	1	2	2	2	2	2
Small electric storage water heaters (20 gal ≤ V_{eff} ≤35 gal and FHR <51 gal)	0	0	1	1	1	1
Electric Storage Water Heaters (20 gal ≤ V_{eff} ≤55 gal, excluding small electric storage water heaters)	0	1	1	2	3	3
Electric Storage Water Heaters (55 gal < V_{eff} ≤120 gal)	1	1	1	2	3	3
Gas-fired Instantaneous Water Heaters (V_{eff} <2 gal, Rated Input >50,000 Btu/h)	1	2	2	3	4	4

DOE constructed the TSLs for this NOPR to include ELs representative of ELs with similar characteristics (*i.e.,* using similar technologies and/or efficiencies, and having roughly comparable equipment availability). The use of representative ELs provided for greater distinction between the TSLs. While representative ELs were included in the TSLs, DOE considered all efficiency levels as part of its analysis.[160]

Rheem recommended that DOE separately analyze the ELs by draw pattern and refrain from proposing a single EL across all draw patterns unless that EL is economically justified for each draw pattern individually. (Rheem, No. 45 at p. 4) Atmos also recommended that the DOE consider EL life-cycle cost evaluations independently as TSLs for competing consumer water heating options, rather than grouping ELs and, thus, combining costs and benefits. Atmos stated that the current approach of grouping ELs appears to average away the distinctions in EL life-cycle cost performance and that the grouping of diversely performing ELs is likely to result in distortions in the representation of TSLs. (Atmos, No. 38 at p. 5)

DOE typically evaluates potential amended standards for products and equipment at the product class level and by grouping select individual efficiency levels for each class into TSLs. Use of TSLs allows DOE to identify and consider industry-level manufacturer cost interactions between the product classes, to the extent that there are such interactions, and national-level market cross-elasticity from consumer purchasing decisions that may change when different standard levels are set. For consumer water heaters, it is particularly important to look at the aggregated impacts as characterized by TSLs due to the changes in consumer purchasing decisions as a result of the increased product and installation costs that impact the shipments model. The changes to the shipments model will drive differential national impacts both on the consumer and manufacturer side that are more realistic of how the market may change in response to amended DOE standards. DOE notes that its engineering analysis results in TSLs that are prescribed across multiple efficiency levels and draw patterns; proposing a separate efficiency level for each draw pattern would not significantly influence the resulting TSL. DOE proposes efficiency levels across draw patterns to ensure calculated energy savings for consumers if manufacturers change the draw patterns of their products, which was previously observed as a result of standards prescribed for gas-fired and electric storage water heaters larger than 55 gallons. In other words, although each draw pattern constitutes a separate product class in the regulations, in this analysis DOE did not make that distinction (for example, gas-fired storage water heaters 20–55 gallons is treated as a single group rather than four product classes for the four draw patterns). Although DOE presents the results in terms of TSLs, DOE analyzes and evaluates all possible ELs for each product class in its analysis. Additionally, DOE notes that although a single EL may be proposed for multiple draw patterns, the resultant energy conservation standards equations are different for each draw pattern.

N. Utility Impact Analysis

The utility impact analysis estimates the changes in installed electrical capacity and generation projected to result for each considered TSL. The analysis is based on published output from the NEMS associated with *AEO2023.* NEMS produces the *AEO* Reference case, as well as a number of side cases that estimate the economy-wide impacts of changes to energy supply and demand. For the current analysis, impacts are quantified by comparing the levels of electricity sector generation, installed capacity, fuel consumption and emissions in the *AEO2023* Reference case and various side cases. Details of the methodology are provided in the appendices to chapters 13 and 15 of the NOPR TSD.

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

NEEA, ACEEE, and NWPCC stated that the connectivity components of the electric water heaters including HPWHs, may have less impact on site electricity use but are critical to the ability to compare products for their grid value, including primary and full fuel cycle energy use. NEEA, ACEEE, and NWPCC encourage DOE to add a definition of connectivity to the performance standard and calculate the value that a

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

connected water heater offers to the electric grid. (NEEA, ACEEE, and NWPCC, No. 47 at p. 10) DOE agrees that connectivity features on electric water heaters can have an impact on the electric grid. The current efficiency levels DOE is proposing do not include any design requirement for electric water heaters to have connectivity features. DOE therefore did not calculate the value that a connected water heater offers to the electric grid for this rulemaking.

O. 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.[161] 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'').[162] ImSET is a special-purpose version of the ''U.S. Benchmark National Input-Output'' (''I–O'') model, which was designed to estimate the national employment and income effects of energy-saving technologies. The ImSET software includes a computer-based I–O model having structural coefficients that characterize economic flows among 187 sectors most relevant to industrial, commercial, and residential building energy use.

DOE notes that ImSET is not a general equilibrium forecasting model, and that the uncertainties involved in projecting employment impacts, especially 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 (2030–2035), 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 consumer water heaters. It addresses the TSLs examined by DOE, the projected impacts of each of these levels if adopted as energy conservation standards for consumer water heaters, 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. Economic Justification and Energy Savings

1. Economic Impacts on Individual Consumers

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

a. Life-Cycle Cost and Payback Period

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

Table V.1 through Table V.12 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.

[161] See U.S. Department of Commerce—Bureau of Economic Analysis. *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II).* 1997. U.S. Government Printing Office: Washington, DC. Available at *www.bea.gov/resources/methodologies/RIMSII-user-guide* (last accessed April 1, 2023).

[162] 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. Available at *www.pnnl.gov/main/publications/external/technical_reports/PNNL-24563.pdf* (last accessed May 1, 2023).

TABLE V.1—AVERAGE LCC AND PBP RESULTS FOR GAS-FIRED STORAGE WATER HEATERS

[20 gal ≤ V_{eff} ≤55 gal]

TSL	Efficiency level	Average costs (2022$)				Simple payback (years)	Average lifetime (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
0	0	1,524	265	3.090	4,614	NA	14.5
1	1	1,566	259	3,030	4,596	8.1	14.5
2,3,4,5	2	1,668	246	2,888	4,556	7.9	14.5
6	5	2,325	216	2,583	4,908	16.4	14.5

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.2—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR GAS-FIRED STORAGE WATER HEATERS

[20 gal ≤ V_{eff} ≤55 gal]

TSL	Efficiency level	Life-cycle cost savings	
		Average LCC savings * (2022$)	Percent of consumers that experience net cost
1	1	17	22
2,3,4,5	2	52	36
6	5	(247)	70

* The savings represent the average LCC for affected consumers.

TABLE V.3—AVERAGE LCC AND PBP RESULTS FOR OIL-FIRED STORAGE WATER HEATERS

[V_{eff} ≤50 gal]

TSL	Efficiency level	Average costs (2022$)				Simple payback (years)	Average lifetime (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
0	0	4,120	844	9,069	13,189	NA	15.5
1	1	4,216	822	8,828	13,044	4.4	15.5
2,3,4,5,6	2	4,394	801	8,600	12,994	6.4	15.5

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.4—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR OIL-FIRED STORAGE WATER HEATERS

[V_{eff} ≤50 gal]

TSL	Efficiency level	Life-cycle cost savings	
		Average LCC savings * (2022$)	Percent of consumers that experience net cost
1	1	145	9
2,3,4,5,6	2	165	25

* The savings represent the average LCC for affected consumers.

TABLE V.5—AVERAGE LCC AND PBP RESULTS FOR SMALL ELECTRIC STORAGE WATER HEATERS

[20 gal ≤ V_{eff} ≤35 gal and FHR <51 gal]

TSL	Efficiency level	Average costs (2022$)				Simple payback (years)	Average lifetime (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
1,2	0	841	386	4,481	5,322	NA	15.1

TABLE V.5—AVERAGE LCC AND PBP RESULTS FOR SMALL ELECTRIC STORAGE WATER HEATERS—Continued

[20 gal ≤ V_{eff} ≤35 gal and FHR <51 gal]

TSL	Efficiency level	Average costs (2022$)				Simple payback (years)	Average lifetime (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
3,4,5,6	1	2,385	210	2,520	4,905	8.8	15.1

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.6—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR SMALL ELECTRIC STORAGE WATER HEATERS

[20 gal ≤ V_{eff} ≤35 gal and FHR <51 gal]

TSL	Efficiency level	Life-cycle cost savings	
		Average LCC savings* (2022$)	Percent of consumers that experience net cost
1,2	0	NA	0
3,4,5,6	1	418	56

* The savings represent the average LCC for affected consumers.

TABLE V.7—AVERAGE LCC AND PBP RESULTS FOR ELECTRIC STORAGE WATER HEATERS

[20 gal ≤ V_{eff} ≤55 gal, excluding small electric storage water heaters]

TSL	Efficiency level	Average costs (2022$)				Simple payback (years)	Average lifetime (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
1	0	947	463	5,301	6,248	NA	15.1
2,3	1	1,670	225	2,669	4,339	3.0	15.1
4	2	1,713	182	2,195	3,908	2.7	15.1
5,6	3	1,831	170	2,060	3,892	3.0	15.1

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.8—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR ELECTRIC STORAGE WATER HEATERS

[20 gal ≤ V_{eff} ≤55 gal, excluding small electric storage water heaters]

TSL	Efficiency level	Life-cycle cost savings	
		Average LCC savings* (2022$)	Percent of consumers that experience net cost
1,2	0	NA	0
2,3	1	1,868	25
4	2	2,283	23
5,6	3	2,101	30

* The savings represent the average LCC for affected consumers.

TABLE V.9—AVERAGE LCC AND PBP RESULTS FOR ELECTRIC STORAGE WATER HEATERS

[55 gal < V_{eff} ≤120 gal]

TSL	Efficiency level	Average costs (2022$)				Simple payback (years)	Average lifetime (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
0	0	2,013	285	3,347	5,361	NA	15.1
1,2,3	1	2,024	239	2,835	4,858	0.2	15.1
4	2	2,052	190	2,283	4,335	0.4	15.1

TABLE V.9—AVERAGE LCC AND PBP RESULTS FOR ELECTRIC STORAGE WATER HEATERS—Continued

[55 gal < V_{eff} ≤120 gal]

TSL	Efficiency level	Average costs (2022$)				Simple payback (years)	Average lifetime (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
5,6	3	2,178	172	2,082	4,260	1.5	15.1

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.10—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR ELECTRIC STORAGE WATER HEATERS

[55 gal < V_{eff} ≤120 gal]

TSL	Efficiency level	Life-cycle cost savings	
		Average LCC savings* (2022$)	Percent of consumers that experience net cost
1,2,3	1	501	0.2
4	2	599	1
5,6	3	170	42

*The savings represent the average LCC for affected consumers.

TABLE V.11—AVERAGE LCC AND PBP RESULTS FOR GAS-FIRED INSTANTANEOUS WATER HEATERS

[V_{eff} <2 gal, rated input >50,000 Btu/h]

TSL	Efficiency level	Average costs (2022$)				Simple payback (years)	Average lifetime (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
0	0	2,320	262	3,846	6,166	NA	20.0
1	1	2,424	248	3,665	6,089	7.3	20.0
2,3	2	2,447	240	3,556	6,004	5.9	20.0
4	3	2,465	237	3,509	5,975	5.9	20.0
5,6	4	2,493	234	3,468	5,962	6.3	20.0

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.12—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR GAS-FIRED INSTANTANEOUS WATER HEATERS

[V_{eff} <2 gal, rated input >50,000 Btu/h]

TSL	Efficiency level	Life-cycle cost savings	
		Average LCC savings* (2022$)	Percent of consumers that experience net cost
1	1	66	13
2,3	2	135	13
4	3	89	29
5,6	4	95	36

*The savings represent the average LCC for affected consumers.

b. Consumer Subgroup Analysis

In the consumer subgroup analysis, DOE estimated the impact of the considered TSLs on low-income households, senior-only households, and small businesses. Table V.13 through Table V.18 compare the average LCC savings and PBP at each efficiency level for the consumer subgroups with similar metrics for the entire consumer sample for each consumer water heater product class analyzed. In most cases, the average LCC savings and PBP for low-income households and senior-only households at the considered efficiency levels are not substantially different from the average for all households. Chapter 11 of the NOPR TSD presents the complete LCC and PBP results for the subgroups.

TABLE V.13—COMPARISON OF LCC SAVINGS AND PBP FOR CONSUMER SUBGROUPS AND ALL HOUSEHOLDS; GAS-FIRED STORAGE WATER HEATERS

[20 gal ≤ V_{eff} ≤55 gal]

	Low-income households	Senior-only households	Small businesses	All households
Average LCC savings (2022$)				
TSL 1	44	28	(18)	17
2,3,4,5	137	89	(49)	52
6	192	(257)	(527)	(247)
Simple Payback Period (years)				
TSL 1	3.2	6.9	11	8.1
2,3,4,5	3.1	6.6	9.7	7.9
6	6.9	19	17	16
Consumers with Net Cost (%)				
TSL 1	8	19	44	22
2,3,4,5	13	29	66	36
6	31	64	82	70
Consumers with Net Benefit (%)				
TSL 1	40	33	11	34
2,3,4,5	56	42	12	42
6	58	30	18	29

TABLE V.14—COMPARISON OF LCC SAVINGS AND PBP FOR CONSUMER SUBGROUPS AND ALL HOUSEHOLDS; OIL-FIRED STORAGE WATER HEATERS

[V_{eff} ≤50 gal]

	Low-income households	Senior-only households	Small businesses	All households
Average LCC Savings (2022$)				
TSL 1	186	158	21	145
2,3,4,5,6	307	205	(46)	165
Simple Payback Period (years)				
TSL 1	1.2	3.9	5.4	4.4
2,3,4,5,6	1.9	5.6	7.8	6.4
Consumers with Net Cost (%)				
TSL 1	2	5	22	9
2,3,4,5,6	5	16	61	25
Consumers with Net Benefit (%)				
TSL 1	60	60	45	58
2,3,4,5,6	71	66	23	58

TABLE V.15—COMPARISON OF LCC SAVINGS AND PBP FOR CONSUMER SUBGROUPS AND ALL HOUSEHOLDS; SMALL ELECTRIC STORAGE WATER HEATERS

[20 gal ≤ V_{eff} ≤35 gal and FHR <51 gal]

	Low-income households	Senior-only households	Small businesses	All households
Average LCC Savings (2022$)				
TSL 1,2 *	NA	NA	NA	NA
2,3,4,5,6	1,481	69	(1,196)	418
Simple Payback Period (years)				
TSL 1,2 *	NA	NA	NA	NA
2,3,4,5,6	3.5	10	23	8.8
Consumers with Net Cost (%)				
TSL 1,2 *	NA	NA	NA	NA
2,3,4,5,6	20	47	89	56
Consumers with Net Benefit (%)				
TSL 1,2 *	NA	NA	NA	NA
2,3,4,5,6	71	47	10	43

* TSLs 1 and 2 represent no new amended standards for small electric storage water heaters.

TABLE V.16—COMPARISON OF LCC SAVINGS AND PBP FOR CONSUMER SUBGROUPS AND ALL HOUSEHOLDS; ELECTRIC STORAGE WATER HEATERS

[20 gal ≤ V_{eff} ≤55 gal, except small electric storage water heaters]

	Low-income households	Senior-only households	Small businesses	All households
Average LCC Savings (2022$)				
TSL 1	NA	NA	NA	NA
2,3	2,475	1,018	556	1,868
4	2,943	1,270	707	2,283
5,6	2,773	1,149	566	2,101
Simple Payback Period (years)				
TSL 1	NA	NA	NA	NA
2,3	1.3	3.9	3.4	3.0
4	1.2	3.5	3.2	2.7
5,6	1.3	3.9	3.6	3.0
Consumers with Net Cost (%)				
TSL 1	0.0	0.0	0.0	0.0
2,3	9.9	24	62	25
4	9.0	23	61	23
5,6	12	29	70	30
Consumers with Net Benefit (%)				
TSL 1	0	0	0	0
2,3	69	54	25	62
4	71	56	26	64
5,6	76	57	26	65

TABLE V.17—COMPARISON OF LCC SAVINGS AND PBP FOR CONSUMER SUBGROUPS AND ALL HOUSEHOLDS; ELECTRIC STORAGE WATER HEATERS

[55 gal < V_{eff} ≤120 gal]

	Low-income households	Senior-only households	Small businesses	All households
Average LCC Savings (2022$)				
TSL 1,2,3	474	479	336	501
4	674	488	291	599
5,6	270	89	25	170
Simple Payback Period (years)				
TSL 1,2,3	0.1	0.3	0.3	0.2
4	0.2	0.6	0.5	0.4
5,6	0.7	2.2	1.6	1.5
Consumers with Net Cost (%)				
TSL 1,2,3	0.0	0.1	1.6	0.2
4	0.1	1.1	7.7	1.2
5,6	19	47	70	42
Consumers with Net Benefit (%)				
TSL 1,2,3	4.3	2.4	1.7	2.8
4	15	12	7.0	13
5,6	65	36	20	46

TABLE V.18—COMPARISON OF LCC SAVINGS AND PBP FOR CONSUMER SUBGROUPS AND ALL HOUSEHOLDS; GAS-FIRED INSTANTANEOUS WATER HEATERS

[V_{eff} <2 gal, rated input >50,000 Btu/h]

	Low-income households	Senior-only households	Small businesses	All households
Average LCC Savings (2022$)				
TSL 1	109	4	41	66
2,3	158	58	95	135
4	108	41	68	89
5,6	125	37	65	95
Simple Payback Period (years)				
TSL 1	4.9	10.9	5.0	7.3
2,3	4.1	8.7	4.0	5.9
4	4.1	8.6	3.8	5.9
5,6	4.3	9.2	4.1	6.3
Consumers with Net Cost (%)				
TSL 1	7.7	13	18	13
2,3	7.2	14	22	13
4	17	32	45	29

TABLE V.18—COMPARISON OF LCC SAVINGS AND PBP FOR CONSUMER SUBGROUPS AND ALL HOUSEHOLDS; GAS-FIRED INSTANTANEOUS WATER HEATERS—Continued

[V_{eff} <2 gal, rated input >50,000 Btu/h]

	Low-income households	Senior-only households	Small businesses	All households
5,6	19	42	53	36
Consumers with Net Benefit (%)				
TSL 1	22	15	13	17
2,3	32	22	18	24
4	62	49	39	55
5,6	67	46	39	55

c. Rebuttable Presumption Payback

As discussed in section III.E.2, 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 consumer water heaters. In contrast, the PBPs presented in section V.B.1.a 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 consumer water heaters. 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

TSL	1	2	3	4	5	6
GSWH	6.6	6.4	6.4	6.4	6.4	10.8
OSWH	4.2	6.1	6.1	6.1	6.1	6.1
ESWH (20 gal ≤ V_{eff} ≤35 gal, FHR < 51 gal)	NA	NA	8.4	8.4	8.4	8.4
ESWH (20 gal ≤ V_{eff} ≤55 gal, excluding small ESWH)	NA	2.3	3.3	2.9	2.9	3.2
ESWH (55 gal < V_{eff} ≤120 gal)	0.3	0.3	0.3	0.5	1.5	1.5
GIWH	11.7	8.5	8.5	8.5	8.3	8.3

2. Economic Impacts on Manufacturers

DOE performed an MIA to estimate the impact of amended energy conservation standards on manufacturers of consumer water heaters. The following section describes the expected impacts on manufacturers at each considered TSL. Chapter 12 of the NOPR TSD explains the analysis in further detail.

a. Industry Cash Flow Analysis Results

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

As discussed in section IV.J.2.d of this document, DOE modeled two scenarios to evaluate a range of cash flow impacts on the consumer water heater industry: (1) the preservation of gross margin percentage scenario and (2) the preservation of operating profit. Under the preservation of gross margin percentage scenario, DOE applied a single uniform ''gross margin percentage'' across all efficiency levels. As MPCs increase with efficiency, this scenario implies that the absolute dollar markup will increase. DOE assumed a manufacturer ''gross margin percentage'' of 31% for gas-fired storage water heaters, 30% for oil-fired storage water heaters, 28% for all electric storage water heaters, and 45% for gas-fired instantaneous water heaters. This manufacturer markup is the same as the one DOE assumed in the engineering analysis and the no-new-standards case of the GRIM. Because this scenario assumes that a manufacturer's absolute dollar markup would increase as MPCs increase in the standards cases, it represents the upper-bound to industry profitability under potential new 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.

Each of the modeled manufacturer markup scenarios results in a unique set of cash-flows and corresponding industry values at each TSL. In the following discussion, the INPV results refer to the difference in industry value between the no-new-standards case and each standards case resulting from the sum of discounted cash-flows from 2023 through 2059. To provide perspective on the short-run cash-flow impact, DOE includes in the discussion of results a comparison of free cash flow between the no-new-standards case and the standards case at each TSL in the year before new standards are required.

TABLE V.20—MANUFACTURER IMPACT ANALYSIS FOR CONSUMER WATER HEATERS UNDER THE PRESERVATION OF GROSS MARGIN SCENARIO

	Units	No-new-standards case	Trial standard level *					
			1	2	3	4	5	6
INPV	*2022$ millions*	2,554.7	2,602.7	2,720.2	2,596.0	2,590.1	2,619.4	2,706.9
Change in INPV	*2022$ millions*		47.9	165.5	41.2	35.3	64.7	152.2
	%		1.9	6.5	1.6	1.4	2.5	6.0
Product Conversion Costs.	*2022$ millions*		4.2	13.4	15.4	16.9	17.9	28.4
Capital Conversion Costs.	*2022$ millions*		4.0	214.7	307.9	359.8	406.2	623.1
Total Investment Required **.	*2022$ millions*		8.2	228.1	323.3	376.7	424.1	651.5

* Numbers in parentheses indicate a negative number.
** Numbers may not sum exactly due to rounding.

TABLE V.21—MANUFACTURER IMPACT ANALYSIS FOR CONSUMER WATER HEATERS UNDER THE PRESERVATION OF OPERATING PROFIT SCENARIO

	Units	No-new-standards case	Trial standard level *					
			1	2	3	4	5	6
INPV	*2022$ millions*	2,554.7	2,532.9	2,347.4	2,168.6	2,115.9	2,044.0	1,804.2
Change in INPV	*2022$ millions*		(21.8)	(207.3)	(386.1)	(438.8)	(510.7)	(750.5)
	%		(0.9)	(8.1)	(15.1)	(17.2)	(20.0)	(29.4)
Product Conversion Costs.	*2022$ millions*		4.2	13.4	15.4	16.9	17.9	28.4
Capital Conversion Costs.	*2022$ millions*		4.0	214.7	307.9	359.8	406.2	623.1
Total Investment Required**.	*2022$ millions*		8.2	228.1	323.3	376.7	424.1	651.5

* Numbers in parentheses indicate a negative number.
** Numbers may not sum exactly due to rounding.

At TSL 1, DOE estimates that impacts on INPV will range from −$21.8 million to $47.9 million, or a change in INPV of −0.9 to 1.9 percent. At TSL 1, industry free cash-flow is $210.1 million, which is a decrease of $3.2 million compared to the no-new-standards case value of $213.3 million in 2029, the year leading up to the proposed standards. Industry conversion costs total $8.2 million.

TSL 1 would set the energy conservation standard for gas-fired storage water heaters at EL 1, oil-fired storage water heaters at EL 1, small electric storage water heaters at baseline, electric storage water heaters with an effective storage volume at least 20 gallons and less or equal to 55 gallons (excluding small electric storage water heaters) at baseline, electric storage water heaters with effective volumes above 55 gallons at EL 1, and gas-fired instantaneous water heaters at EL 1. At TSL 1, DOE estimates that manufacturers will incur approximately $4.2 million in product conversion costs, as some gas-fired storage water heaters, electric storage water heaters, and gas-fired instantaneous water heaters will need to be redesigned to comply with the standard. DOE also estimates that manufacturers will incur approximately $4.0 million in capital conversion costs at TSL 1 to accommodate the need for increased capacity for gas-fired & electric storage water heaters.

At TSL 1, the shipment-weighted average MPC for all consumer water heaters increases by 3.3 percent relative to the no-new-standards case shipment-weighted average MPC for all water heaters in 2030. In the preservation of gross margin markup scenario, manufacturers are able to fully pass on this slight cost increase to consumers. The slight increase in shipment-weighted average MPC for consumer water heaters outweighs the $8.2 million in conversion costs, causing a slightly positive change in INPV at TSL 2 under the preservation of gross margin markup scenario.

Under the preservation of operating profit markup scenario, manufacturers earn the same per-unit operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments. In this scenario, the 3.3 percent shipment-weighted average MPC increase results in a reduction in the manufacturer markup after the analyzed compliance year. This reduction in the manufacturer markup and the $8.2 million in conversion costs incurred by manufacturers cause a slightly negative change in INPV at TSL 1 under the preservation of operating profit markup scenario.

At TSL 2, DOE estimates that impacts on INPV will range from −$207.3 million to $165.5 million, or a change in INPV of −8.1 to 6.5 percent. At TSL 2, industry free cash-flow is $112.2 million, which is a decrease of $101.1 million compared to the no-new-standards case value of $213.3 million in 2029, the year leading up to the proposed standards. Industry conversion costs total $228.1 million.

TSL 2 would set the energy conservation standard for gas-fired storage water heaters at EL 2, oil-fired storage water heaters at EL 2, small electric storage water heaters at baseline, electric storage water heaters with an effective storage volume at least 20 gallons and less than 55 gallons (excluding small electric storage water heaters) at EL 1, electric storage water heaters with effective volume above 55 gallons at EL 1, and gas-fired instantaneous water heaters at EL 2. At TSL 2, DOE estimates that manufacturers will incur approximately $13.4 million in product conversion costs, as some gas-fired storage water heaters, electric storage water heaters, and gas-fired instantaneous water heaters will need to be redesigned to comply with the standard. While small electric storage water heaters could remain reliant on electric resistance technology, most electric storage water heaters would need to transition to heat pump technology. Heat pump ESWHs currently comprises approximately 5% of the electric storage water heater market. TSL 2 would shift an estimated 63% of electric storage water heaters to heat pumps by 2030, driving large investments to expand production capacity of heat exchangers and to optimize production costs. As a result, DOE estimates that manufacturers will incur approximately $191.9 million in capital conversion costs for ESWHs (and $214.7 million in capital conversion costs for all product classes) at TSL 2 to accommodate the need for increased capacity.

At TSL 2, the shipment-weighted average MPC for all consumer water heaters increases by 27.7 percent relative to the no-new-standards case shipment-weighted average MPC for all water heaters in 2030. In the preservation of gross margin markup scenario, manufacturers are able to fully pass on this slight cost increase to consumers. The increase in shipment-weighted average MPC for consumer water heaters outweighs the $228.1 million in conversion costs, causing a slightly positive change in INPV at TSL 2 under the preservation of gross margin markup scenario.

Under the preservation of operating profit markup scenario, manufacturers earn the same per-unit operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments. In this scenario, the 27.7 percent shipment-weighted average MPC increase results in a reduction in the manufacturer markup after the analyzed compliance year. This reduction in the manufacturer markup and the $228.1 million in conversion costs incurred by manufacturers cause a negative change in INPV at TSL 2 under the preservation of operating profit markup scenario.

At TSL 3, DOE estimates that impacts on INPV will range from −$386.1 million to $41.2 million, or a change in INPV of −15.1 to 1.6 percent. At TSL 3, industry free cash-flow is $69.5 million, which is a decrease of $143.8 million compared to the no-new-standards case value of $192.8 million in 2029, the year leading up to the proposed standards. Industry conversion costs total $323.3 million.

TSL 3 would set the energy conservation standard for gas-fired storage water heaters at EL 2, oil-fired storage water heaters at EL 2, small electric storage water heaters at EL 1, electric storage water heaters with an effective storage volume at least 20 gallons and less than 55 gallons (excluding small electric storage water heaters) at EL 1, electric storage water heaters with effective volume above 55 gallons at EL 1, and gas-fired instantaneous water heaters at EL 2. At TSL 3, DOE estimates that manufacturers will incur approximately $15.4 million in product conversion costs, as some gas-fired storage water heaters, electric storage water heaters with effective volume between 20 and 55 gallons, and gas-fired instantaneous water heaters will need to be redesigned to comply with the standard. At TSL 3, 100% of electric storage water heaters would need to shift to heat pump technology by 2030, driving large investments in product redesign and expanding manufacturing capacity. This will necessitate small electric storage water heater manufacturers developing split-system heat pump designs. To reach this level, DOE estimates that industry will incur approximately $307.9 million in capital conversion costs at TSL 3 to accommodate the need for increased capacity.

At TSL 3, the shipment-weighted average MPC for all consumer water heaters increases by 40.5 percent relative to the no-new-standards case shipment-weighted average MPC for all water heaters in 2030. In the preservation of gross margin markup scenario, manufacturers are able to fully pass on this slight cost increase to consumers. The increase in shipment-weighted average MPC for consumer water heaters outweighs the $323.3 million in conversion costs, causing a slightly positive change in INPV at TSL 3 under the preservation of gross margin markup scenario.

Under the preservation of operating profit markup scenario, manufacturers earn the same per-unit operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments. In this scenario, the 40.5 percent shipment-weighted average MPC increase results in a reduction in the manufacturer markup after the analyzed compliance year. This reduction in the manufacturer markup and the $323.3 million in conversion costs incurred by manufacturers cause a negative change in INPV at TSL 3 under the preservation of operating profit markup scenario.

At TSL 4, DOE estimates that impacts on INPV will range from −$438.8 million to $35.3 million, or a change in INPV of −17.2 to 1.4 percent. At TSL 4, industry free cash-flow is $45.7 million, which is a decrease of $167.6 million compared to the no-new-standards case value of $213.3 million in 2029, the year leading up to the proposed standards. Industry conversion costs total $376.7 million.

TSL 4 would set the energy conservation standard for gas-fired storage water heaters at EL 2, oil-fired storage water heaters at EL 2, small electric storage water heaters at EL 1, electric storage water heaters with an effective storage volume at least 20 gallons and less than 55 gallons (excluding small electric storage water heaters) at EL 2, electric storage water heaters with effective volume above 55 gallons at EL 2, and gas-fired instantaneous water heaters at EL 3. At TSL 4, DOE estimates that manufacturers will incur approximately $16.9 million in product conversion costs, as some gas-fired storage water heaters, electric storage water heaters with effective volume between 20 and 55 gallons, electric storage water heaters with effective volume above 55 gallons, and gas-fired instantaneous water heaters will need to be redesigned to comply with the standard. TSL 4 would shift 100% of electric storage water heaters to heat pumps, driving large investments in product capacity of heat exchangers and to optimize production costs. This will necessitate small electric storage water heater manufacturers developing split system heat pump designs. DOE estimates that manufacturers could incur approximately $359.8 million in capital conversion costs at TSL 4 to accommodate the need for increased capacity.

At TSL 4, the shipment-weighted average MPC for all consumer water heaters increases by 43.5 percent relative to the no-new-standards case shipment-weighted average MPC for all water heaters in 2030. In the preservation of gross margin markup scenario, manufacturers are able to fully pass on this slight cost increase to consumers. The increase in shipment-weighted average MPC for consumer water heaters outweighs the $376.7 million in conversion costs, causing a slightly positive change in INPV at TSL 4 under the preservation of gross margin markup scenario.

Under the preservation of operating profit markup scenario, manufacturers earn the same per-unit operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments. In this scenario, the 43.5 percent shipment-weighted average MPC increase results in a reduction in the manufacturer markup after the analyzed compliance year. This reduction in the manufacturer markup and the $376.7 million in conversion costs incurred by manufacturers cause a negative change in INPV at TSL 4 under the preservation of operating profit markup scenario.

At TSL 5, DOE estimates that impacts on INPV will range from −$510.7 million to $64.7 million, or a change in INPV of −20.0 to 2.5 percent. At TSL 5, industry free cash-flow is $24.5 million, which is a decrease of $188.8 million compared to the no-new-standards case value of $213.3 million in 2029, the year leading up to the proposed standards. Industry conversion costs total $424.1 million.

TSL 5 would set the energy conservation standard for gas-fired storage water heaters at EL 2, oil-fired storage water heaters at EL 2, small electric storage water heaters at EL 1, electric storage water heaters with an effective storage volume less than 55 gallons (excluding small electric storage water heaters) at EL 3, electric storage water heaters with effective volume above 55 gallons at EL 3, and gas-fired instantaneous water heaters at EL 4. At TSL 5, DOE estimates that manufacturers will incur approximately $17.9 million in product conversion costs, as some gas-fired storage water heaters, electric storage water heaters with effective volume of between 20 and 55 gallons, electric storage water heaters with effective volume above 55 gallons, and gas-fired instantaneous water heaters will need to be redesigned to comply with the standard. Heat pump technology currently comprises approximately 5% of the electric storage water heater market. TSL 5 would shift 100% of electric storage water heaters to heat pumps, driving large investments in product capacity of heat exchangers and to optimize production costs. This will necessitate small electric storage water heater manufacturers developing split system heat pumps. Additionally, requiring fully modulating burners for gas instantaneous water heaters and larger condensers for gas storage water heaters would require significant investments in capacity. As a result, DOE also estimates that manufacturers will incur approximately $406.2 million in capital conversion costs at TSL 5 to accommodate the need for increased capacity.

At TSL 5, the shipment-weighted average MPC for all consumer water heaters increases by 51.7 percent relative to the no-new-standards case shipment-weighted average MPC for all water heaters in 2030. In the preservation of gross margin markup scenario, manufacturers are able to fully pass on this cost increase to consumers. The increase in shipment-weighted average MPC for consumer water heaters outweighs the $424.1 million in conversion costs, causing a slightly positive change in INPV at TSL 5 under the preservation of gross margin markup scenario.

Under the preservation of operating profit markup scenario, manufacturers earn the same per-unit operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments. In this scenario, the 51.7 percent shipment-weighted average MPC increase results in a reduction in the manufacturer markup after the analyzed compliance year. This reduction in the manufacturer markup and the $424.1 million in conversion costs incurred by manufacturers cause a negative change in INPV at TSL 5 under the preservation of operating profit markup scenario.

At TSL 6, DOE estimates that impacts on INPV will range from −$750.5 million to $152.2 million, or a change in INPV of −29.4 to 6.0 percent. At TSL 6, industry free cash-flow is negative $76.7 million, which is a decrease of $290.0 million compared to the no-new-standards case value of $213.3 million in 2029, the year leading up to the proposed standards. Industry conversion costs total $651.5 million. TSL 6 would set the energy conservation standard for gas-fired storage water heaters at EL 5, oil-fired storage water heaters at EL 2, small electric storage water heaters at EL 1, electric storage water heaters with an effective storage volume less than 55 gallons (excluding small electric storage water heaters) at EL 3, electric storage water heaters with effective volume above 55 gallons at EL 3, and gas-fired instantaneous water heaters at EL 4. At TSL 6, DOE estimates that manufacturers will incur approximately $28.4 million in product conversion costs, as some gas-fired storage water heaters, electric storage water heaters with effective volume between 20 and 55 gallons, and gas-fired instantaneous water heaters will need to be redesigned to comply with the standard. Heat pump technology currently comprises approximately 5% of the electric storage water heater market. TSL 6 would shift 100% of electric storage water heaters to heat pumps, driving large investments in product capacity of heat exchangers and to optimize production costs. This will necessitate small electric storage water heater manufacturers developing split system heat pump designs. Additionally, requiring fully modulating burners for gas instantaneous water heaters and larger condensers, electronic ignition, power venting, and larger heat exchangers for gas storage water heaters would require significant investments in capacity. As a result, DOE also estimates that manufacturers will incur approximately $623.1 million in capital conversion costs at TSL 5 to accommodate the need for increased capacity.

At TSL 6, the shipment-weighted average MPC for all consumer water heaters increases by 84.3 percent relative to the no-new-standards case shipment-weighted average MPC for all water heaters in 2030. In the preservation of gross margin markup scenario, manufacturers are able to fully pass on this cost increase to consumers. The increase in shipment-weighted average MPC for consumer water heaters outweighs the $651.5 million in conversion costs, causing a slightly positive change in INPV at TSL 6 under the preservation of gross margin markup scenario.

Under the preservation of operating profit markup scenario, manufacturers earn the same per-unit operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments. In this scenario, the 84.3 percent shipment-weighted average MPC increase results in a reduction in the manufacturer markup after the analyzed compliance year. This reduction in the manufacturer markup and the $651.5 million in conversion costs incurred by manufacturers cause a negative change in INPV at TSL 6 under the preservation of operating profit markup scenario.

b. Direct Impacts on Employment

To quantitatively assess the potential impacts of amended energy conservation standards on direct employment in the consumer water heaters 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. 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;[163] 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[164] 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 70 percent of consumer water heaters 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 employees 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 above, non-production domestic employees are extrapolated by multiplying the ratio of non-production workers in the industry compared to production employees. DOE assumes that this employee distribution ratio remains constant between the no-new-standards case and standards cases.

Direct employment is the sum of domestic production employees and non-production employees. Using the GRIM, DOE estimates in the absence of new energy conservation standards there would be 6,589 domestic employees for consumer water heaters in 2030. Table V.22 shows the range of the impacts of energy conservation standards on U.S. manufacturing employment in the consumer water heaters industry. The following discussion provides a qualitative evaluation of the range of potential impacts presented in Table V.22.

TABLE V.22—DOMESTIC DIRECT EMPLOYMENT IMPACTS FOR CONSUMER WATER HEATER MANUFACTURERS IN 2030

	No-new-standards case	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Direct Employment in 2030	6,589	6,847	7,450	7,342	7,255	7,578	8,978
Potential Changes in Direct Employment Workers in 2030*		0 to 258	(1,719) to 861	(2,236) to 753	(2,236) to 666	(2,236) to 989	(2,236) to 2,389

* DOE presents a range of potential employment impacts. Numbers in parentheses denote negative values.

The direct employment impacts shown in Table V.22 represent the potential domestic employment changes that could result following the compliance date for the consumer water heater product classes in this proposal. Employment could increase or decrease due to the labor content of the various products being manufactured domestically or if manufacturers decided to move production facilities abroad because of the amended standards. The upper bound estimate corresponds to an increase in the number of domestic workers that would result from amended energy conservation standards if manufacturers continue to produce the same scope of covered products within the United States after compliance takes effect. The lower bound estimate represents the maximum decrease in production workers if manufacturing of heat pump electric storage water heaters moved to lower labor-cost countries. Many manufacturers currently produce at least a portion of their electric storage consumer water heaters in countries with lower labor costs. DOE anticipates that adopting an amended standard will necessitate large investments in production capability and capacity for the industry to transition to heat pump technology for electric storage water heaters. This large investment could increase the risk that manufacturers reevaluate domestic production siting options. Siting decisions depend on a wide range of factors beyond the standard. Additionally, many OEMs have traditionally kept the most advanced manufacturing and more efficient technologies at domestic production facilities. However, to establish a lower bound, the direct employment analysis assumed a reduction in domestic employment commensurate with the percentage of electric storage water heaters shipments that transition to heat pump designs.

Additional detail on the analysis of direct employment can be found in chapter 12 of the NOPR TSD. Additionally, the employment impacts

[163] 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 April 1, 2023).

[164] 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 April 1, 2023).

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

Industry concerns around manufacturing capacity were driven by potential technology transitions. In particular, manufacturers focused on the transition to heat pump technology for electric storage water heaters with rated storage volumes between 20 and 55 gallons. The vast majority of sales today in this product class are electric resistance water heaters. DOE estimates less than 8 percent of current sales are heat pump units. At the proposed level, all electric storage water heaters with rated storage volumes above 35 gallons, and all ESWHs with medium or high draw patterns, would incorporate heat pump technology. Industry would need to add capacity to produce an additional three to four million heat pump electric storage water heater units per year. In interviews, manufacturers noted that heat pump electric storage water heaters are more complex to manufacture than electric resistance water heaters. In written comments, Rheem noted the need for significant capital investments for new and upgraded manufacturing facilities (Rheem, No. 45 at p. 5). DOE estimated conversion costs based on both industry feedback and estimates of capital investment from the engineering analysis. DOE's analysis indicated significant investment in additional production floor space and in production capacity for heat exchangers. At the proposed level, conversion costs total $230 million, presuming all OEMs of electric storage water heaters invest in the transition to heat pump models.

d. Impacts on Subgroups of Manufacturers

As discussed in section IV.J.1 of this document, using average cost assumptions to develop an industry cash-flow estimate may not be adequate for assessing differential impacts among manufacturer subgroups. Small manufacturers, niche manufacturers, and manufacturers exhibiting a cost structure substantially different from the industry average could be affected disproportionately. DOE used the results of the industry characterization to group manufacturers exhibiting similar characteristics. Consequently, DOE identified small business manufacturers as a subgroup for a separate impact analysis.

For the small business subgroup analysis, DOE applied the small business size standards published by the Small Business Administration (''SBA'') to determine whether a company is considered a small business. The size standards are codified at 13 CFR part 121. To be categorized as a small business under NAICS code 335220, ''major household appliance manufacturing,'' a consumer water heater manufacturer and its affiliates may employ a maximum of 1,500 employees. The 1,500-employee threshold includes all employees in a business's parent company and any other subsidiaries. Based on this classification, DOE identified two potential manufacturers that could qualify as domestic small businesses.

The small business subgroup analysis is discussed in more detail in chapter 12 of the NOPR TSD. DOE examines the potential impacts on small business manufacturers in section VI.B of this NOPR.

e. Cumulative Regulatory Burden

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

Some consumer water heater manufacturers also make other products or equipment that could be subject to energy conservation standards set by DOE. DOE looks at other regulations that affects manufacturer of consumer water heater manufacturers that are Federal, are product-specific, and that will take effect three years before or after the estimated 2029 compliance date. Therefore, this cumulative regulatory burden analysis focuses on DOE regulations taking place between 2026 and 2032. This information is presented in Table V.23.

DOE does not incorporate any regulations not yet finalized into its analysis, as cost and timing would be speculative. However, stakeholders listed a number of on-going appliance standards as cumulative regulatory burden. Where these DOE appliance standard rulemakings have reached the NOPR stage, DOE includes them in Table V.23 for tracking purposes.

TABLE V.23—COMPLIANCE DATES AND EXPECTED CONVERSION EXPENSES OF FEDERAL ENERGY CONSERVATION STANDARDS AFFECTING CONSUMER WATER HEATER MANUFACTURERS

Federal energy conservation standard	Number of manufacturers*	Number of manufacturers affected from this rule**	Approx. standards year	Industry conversion costs (millions)	Industry conversion costs/product revenue†
Room Air Conditioners 88 FR 34298 (May 26, 2023)	8	3	2026	$24.8 (2021$)	0.4%
Consumer Pool Heaters 88 FR 34624 (May 30, 2023)	20	3	2028	$48.4 (2021$)	4.7%
Commercial Water Heating Equipment†† 87 FR 30610 (May 19, 2022)	14	7	2026	$34.6 (2020$)	4.7%
Consumer Furnaces†† 87 FR 40590 (July 7, 2022)	15	2	2029	$150.6 (2020$)	1.4%
Consumer Clothes Dryers†† 87 FR 51734 (August 23, 2022)	15	3	2027	$149.7 (2020$)	1.8%
Microwave Ovens†† 87 FR 52282 (August 24, 2022)	18	3	2026	$46.1 (2021$)	0.7%
Residential Clothes Washers†† 88 FR 13520 (March 3, 2023)	19	3	2027	$690.3 (2021$)	5.2%
Refrigerators, Freezers, and Refrigerator-Freezers†† 88 FR 12452 (February 27, 2023)	49	3	2027	$1,323.6 (2021$)	3.8%

TABLE V.23—COMPLIANCE DATES AND EXPECTED CONVERSION EXPENSES OF FEDERAL ENERGY CONSERVATION STANDARDS AFFECTING CONSUMER WATER HEATER MANUFACTURERS—Continued

Federal energy conservation standard	Number of manufacturers *	Number of manufacturers affected from this rule **	Approx. standards year	Industry conversion costs (millions)	Industry conversion costs/product revenue †
Miscellaneous Refrigeration Products †† 88 FR 19382 (March 31, 2023)	38	8	2029	$126.9 (2021$)	3.1%
Dishwashers †† 88 FR 32514 (May 19, 2023)	22	2	2027	$125.6 (2021$)	2.1%

* This column presents the total number of manufacturers identified in the energy conservation standard rule contributing to cumulative regulatory burden.
** This column presents the number of manufacturers producing consumer water heaters that are also listed as manufacturers in the listed energy conservation standard contributing to cumulative regulatory burden.
† This column presents industry conversion costs as a percentage of product revenue during the conversion period. Industry conversion costs are the upfront investments manufacturers must make to sell compliant products/equipment. The revenue used for this calculation is the revenue from just the covered product/equipment associated with each row. The conversion period is the time frame over which conversion costs are made and lasts from the publication year of the final rule to the compliance year of the energy conservation standard. The conversion period typically ranges from 3 to 5 years, depending on the rulemaking.
†† Indicates a NOPR publications. Values may change on publication of a Final Rule.

BWC provided a comment on regulations DOE should take into consideration for its cumulative regulatory burden. (BWC, No. 32 at p. 4). Some of the DOE rulemakings BWC listed, such as the consumer boilers standard rulemaking,[165] are not in Table V.23. because the rulemakings are on-going and do not yet have a proposed standard level or proposed compliance date. Any estimation of cost or timing at this time would be speculative. Additionally, DOE does not list test procedures in Table V.23. When applicable, test procedure costs are considered in the energy conservation standards analysis. The Federal Energy Efficiency Standards Final Rules for Commercial and Multi-family High rise Residential Buildings [166] and Low-rise Residential Buildings Design and Construction [167] rulemaking identified by BWC were not explicitly considered to be cumulative regulatory burden because the regulated entities are not consumer water heater manufacturers, but DOE did incorporate the impact of these final rules in shipment analysis.

In addition to these Federal rulemakings, BWC noted several California governance bodies have ongoing rulemakings regarding Zero NO_X Emissions Standards, including the California Air Resources Board,[168] the Bay Area Air Quality Management District,[169] and the South Coast Air Quality Management District.[170] DOE incorporated a distribution of shipments that are low NO_X & ultra-low NO_X into its shipment analysis, as well as accounted for the differences in manufacturer product costs for low NO_X & ultra-low NO_X and the impact of low NO_X & ultra-low NO_X on the overall NO_X emission savings.

DOE requests information regarding the impact of cumulative regulatory burden on manufacturers of consumer water heaters 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 savings and the NPV of consumer benefits that would result from each of the TSLs considered as potential amended standards.

a. Significance of Energy Savings

To estimate the energy savings attributable to potential amended standards for consumer water heaters, DOE compared their energy consumption under the no-new-standards case to their anticipated energy consumption under each TSL. The savings are measured over the entire lifetime of products purchased in the 30-year period that begins in the first full year of anticipated compliance with amended standards (2030–2059). Table V.24 presents DOE's projections of the national energy savings for each TSL considered for consumer water heaters. The savings were calculated using the approach described in section IV.H.2 of this document.

TABLE V.24—CUMULATIVE NATIONAL ENERGY SAVINGS FOR CONSUMER WATER HEATERS; 30 YEARS OF SHIPMENTS
[2030–2059]

Energy savings	Product class	Trial standard level					
		1	2	3	4	5	6
		quads					
Primary energy	GSWH	0.4	1.8	1.8	1.8	1.8	7.5
	OSWH	0.001	0.001	0.001	0.001	0.001	0.001
	Small ESWH (20 gal ≤V_{eff} ≤ 35 gal and FHR <51 gal).	0.00	0.00	1.5	1.5	1.5	1.5
	ESWH (20 gal ≤V_{eff} ≤55 gal), excluding Small ESWH.	0.00	24.3	28.5	33.3	34.3	34.3
	ESWH (55 gal <V_{eff} ≤120 gal)	0.001	0.001	0.001	0.005	0.01	0.01
	GIWH	0.3	0.4	0.4	0.7	0.8	0.8
	Total	0.7	26.6	32.4	37.4	38.5	44.1

[165] *www.regulations.gov/docket/EERE-2012-BT-STD-0047.*

[166] *www.regulations.gov/docket/EERE-2022-BT-STD-0012.*

[167] *www.regulations.gov/docket/EERE-2022-BT-STD-0013.*

[168] *https://ww2.arb.ca.gov/sites/default/files/2021-10/2022_SSS_October_Workshop_Presentation.pdf.*

[169] *https://www.baaqmd.gov/rules-and-compliance/rule-development/building-appliances.*

[170] *https://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2022-air-quality-management-plan/2022-aqmp-residential-and-commercial-buildings-working-group/2022-aqmd-residential-and-commercial-building-wgm-2.pdf?sfvrsn=6.*

TABLE V.24—CUMULATIVE NATIONAL ENERGY SAVINGS FOR CONSUMER WATER HEATERS; 30 YEARS OF SHIPMENTS—Continued

[2030–2059]

Energy savings	Product class	Trial standard level					
		1	2	3	4	5	6
		quads					
FFC energy	GSWH	0.5	2.0	2.0	2.0	2.0	8.4
	OSWH	0.001	0.002	0.002	0.002	0.002	0.002
	Small ESWH (20 gal ≤V_{eff} ≤35 gal and FHR <51 gal).	0.00	0.00	1.6	1.6	1.6	1.6
	ESWH (20 gal ≤V_{eff} ≤55 gal), excluding Small ESWH.	0.00	24.8	29.1	34.1	35.1	35.1
	ESWH (55 gal <V_{eff} ≤120 gal)	0.001	0.001	0.001	0.005	0.01	0.01
	GIWH	0.3	0.5	0.5	0.7	0.9	0.9
	Total	0.8	27.3	33.3	38.4	39.7	46.0

Note: totals may not equal sums due to rounding.

OMB Circular A–4 [171] 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 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.[172] The review timeframe established in EPCA is generally not synchronized with the product lifetime, product manufacturing cycles, or other factors specific to consumer water heaters. Thus, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology. The NES sensitivity analysis results based on a 9-year analytical period are presented in Table V.25. The impacts are counted over the lifetime of consumer water heaters purchased in 2030–2059.

TABLE V.25—CUMULATIVE NATIONAL ENERGY SAVINGS FOR CONSUMER WATER HEATERS; 9 YEARS OF SHIPMENTS

[2030–2038]

Energy savings	Product class	Trial standard level					
		1	2	3	4	5	6
		quads					
Primary energy	GSWH	0.1	0.6	0.6	0.6	0.6	2.3
	OSWH	0.000	0.001	0.001	0.001	0.001	0.001
	Small ESWH (20 gal ≤V_{eff} ≤35 gal and FHR <51 gal).	0.00	0.00	0.4	0.4	0.4	0.4
	ESWH (20 gal ≤V_{eff} ≤55 gal), excluding Small ESWH.	0.00	7.3	8.4	9.8	10.1	10.1
	ESWH (55 gal <V_{eff} ≤120 gal)	0.000	0.000	0.000	0.001	0.004	0.004
	GIWH	0.08	0.13	0.13	0.18	0.23	0.23
	Total	0.2	8.0	9.6	11.0	11.4	13.1
FFC energy	GSWH	0.1	0.7	0.7	0.7	0.7	2.6
	OSWH	0.000	0.001	0.001	0.001	0.001	0.001
	Small ESWH (20 gal ≤V_{eff} ≤35 gal and FHR <51 gal).	0.0	0.0	0.4	0.4	0.4	0.4
	ESWH (20 gal ≤V_{eff} ≤55 gal), excluding Small ESWH.	0.0	7.5	8.6	10.1	10.4	10.4
	ESWH (55 gal <V_{eff} ≤120 gal)	0.000	0.000	0.000	0.001	0.004	0.004
	GIWH	0.09	0.15	0.15	0.21	0.25	0.25
	Total	0.2	8.3	9.9	11.4	11.7	13.7

Note: totals may not equal sums due to rounding.

[171] U.S. Office of Management and Budget. *Circular A–4: Regulatory Analysis.* September 17, 2003. *www.whitehouse.gov/omb/circulars_a004_a-4/* (last accessed May 1, 2023).

[172] 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.

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 consumer water heaters. In accordance with OMB's guidelines on regulatory analysis,[173] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. Table V.26 shows the consumer NPV results with impacts counted over the lifetime of products purchased in 2030–2059.

TABLE V.26—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR CONSUMER WATER HEATERS; 30 YEARS OF SHIPMENTS

[2030–2059]

Discount rate	Product class	Trial standard level					
		1	2	3	4	5	6
		billion 2022$					
3 percent	GSWH	1.6	7.1	7.1	7.1	7.1	10.6
	OSWH	0.01	0.02	0.02	0.02	0.02	0.02
	Small ESWH (20 gal ≤V_{eff} ≤35 gal and FHR <51 gal).	0.0	0.0	4.2	4.2	4.2	4.2
	ESWH (20 gal ≤V_{eff} ≤55 gal), excluding Small ESWH.	0.0	152	177	213	214	214
	ESWH (55 gal <V_{eff} ≤120 gal)	0.005	0.005	0.005	0.03	0.1	0.1
	GIWH	1.3	2.6	2.6	3.9	4.8	4.8
	Total	3.0	161	191	228	230	234
7 percent	GSWH	0.4	2.0	2.0	2.0	2.0	(1.6)
	OSWH	0.004	0.01	0.01	0.01	0.01	0.01
	Small ESWH (20 gal ≤V_{eff} ≤35 gal and FHR <51 gal).	0.0	0.0	0.6	0.6	0.6	0.6
	ESWH (20 gal ≤V_{eff} ≤55 gal), excluding Small ESWH.	0.0	53.0	61.3	74.6	74.2	74.2
	ESWH (55 gal <V_{eff} ≤120 gal)	0.002	0.002	0.002	0.01	0.02	0.02
	GIWH	0.4	0.8	0.8	1.2	1.4	1.4
	Total	0.8	55.8	64.6	78.3	78.1	74.6

Note: totals may not equal sums due to rounding.

The NPV results based on the aforementioned 9-year analytical period are presented in Table V.27. The impacts are counted over the lifetime of products purchased in 2030–2059. 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.27—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR CONSUMER WATER HEATERS; 9 YEARS OF SHIPMENTS

[2030–2038]

Discount rate	Product class	Trial standard level					
		1	2	3	4	5	6
		billion 2022$					
3 percent	GSWH	0.6	2.7	2.7	2.7	2.7	1.1
	OSWH	0.005	0.009	0.009	0.009	0.009	0.009
	Small ESWH (20 gal ≤V_{eff} ≤35 gal).	0.00	0.00	1.1	1.1	1.1	1.1
	ESWH (20 gal ≤V_{eff} ≤55 gal), excluding Small ESWH.	0.00	57	65	78	79	79
	ESWH (55 gal <V_{eff} ≤120 gal)	0.002	0.002	0.002	0.01	0.02	0.02
	GIWH	0.5	1.0	1.0	1.4	1.6	1.6
	Total	1.1	60.2	69.5	83.4	84.3	82.7
7 percent	GSWH	0.2	1.0	1.0	1.0	1.0	(2.3)
	OSWH	0.002	0.004	0.004	0.004	0.004	0.004
	Small ESWH (20 gal ≤V_{eff} ≤35 gal).	0.00	0.00	0.06	0.06	0.06	0.06
	ESWH (20 gal ≤V_{eff} ≤55 gal), excluding Small ESWH.	0.00	26	30	37	37	37
	ESWH (55 gal <V_{eff} ≤120 gal)	0.001	0.001	0.001	0.006	0.010	0.010

[173] U.S. Office of Management and Budget. *Circular A–4: Regulatory Analysis.* September 17, 2003. *www.whitehouse.gov/omb/circulars_a004_a-4/* (last accessed May 1, 2023).

TABLE V.27—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR CONSUMER WATER HEATERS; 9 YEARS OF SHIPMENTS—Continued

[2030–2038]

Discount rate	Product class	Trial standard level					
		1	2	3	4	5	6
		billion 2022$					
	GIWH	0.18	0.39	0.39	0.55	0.63	0.63
	Total	0.4	27.7	31.5	38.4	38.3	35.1

Note: totals may not equal sums due to rounding.

The previous NPV results reflect the use of a default trend to estimate the change in price for consumer water heaters over the analysis period (see section IV.F.1 of this document). DOE also conducted a sensitivity analysis that considered one scenario with a price decline compared to the reference case and one scenario with a price increase compared to the reference case. The results of these alternative cases are presented in appendix 10C of the NOPR TSD. In the price-decline case, the NPV of consumer benefits is higher than in the default case. In the price-increase 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 consumer water heaters would reduce energy expenditures for consumers of those products, with the resulting net savings being redirected to other forms of economic activity. These expected shifts in spending and economic activity could affect the demand for labor. As described in section IV.N of this document, DOE used an input/output model of the U.S. economy to estimate indirect employment impacts of the TSLs that DOE considered. There are uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Therefore, DOE generated results for near-term timeframes (2030–2059), where these uncertainties are reduced.

The results suggest that the proposed standards would be likely to have a negligible impact on the net demand for labor in the economy. The net change in jobs is so small that it would be imperceptible in national labor statistics and might be offset by other, unanticipated effects on employment. Chapter 16 of the NOPR TSD presents detailed results regarding anticipated indirect employment impacts.

4. Impact on Utility or Performance of Products

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

5. Impact of Any Lessening of Competition

DOE considered any lessening of competition that would be likely to result from new or amended standards. As discussed in section III.E.1.e, 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 rulemaking.

Energy conservation resulting from potential energy conservation standards for consumer water heaters is expected to yield environmental benefits in the form of reduced emissions of certain air pollutants and greenhouse gases. Table V.28 provides DOE's estimate of cumulative emissions reductions expected to result from the TSLs considered in this rulemaking. The emissions were calculated using the multipliers discussed in section IV.K. DOE reports annual emissions reductions for each TSL in chapter 13 of the NOPR TSD.

TABLE V.28—CUMULATIVE EMISSIONS REDUCTION FOR CONSUMER WATER HEATERS SHIPPED IN 2030–2059

	Trial standard level					
	1	2	3	4	5	6
Power Sector and Site Emissions						
CO_2 (*million metric tons*)	36.3	453	530	633	660	981
CH_4 (*thousand tons*)	0.7	31.5	38.4	44.3	45.6	51.7
N_2O (*thousand tons*)	0.1	4.4	5.3	6.1	6.3	6.9
NO_X (*thousand tons*)	31.9	224	250	311	329	615

TABLE V.28—CUMULATIVE EMISSIONS REDUCTION FOR CONSUMER WATER HEATERS SHIPPED IN 2030–2059—Continued

	Trial standard level					
	1	2	3	4	5	6
SO_2 (*thousand tons*)	0.2	140	174	197	202	200
Hg (*tons*)	0.0	1.0	1.2	1.4	1.4	1.4
Upstream Emissions						
CO_2 (*million metric tons*)	5.1	49	56	68	72	117
CH_4 (*thousand tons*)	517	4,509	5,154	6,300	6,614	11,239
N_2O (*thousand tons*)	0.0	0.2	0.2	0.3	0.3	0.4
NO_X (*thousand tons*)	80.3	764	880	1,069	1,120	1,835
SO_2 (*thousand tons*)	0.0	2.6	3.2	3.6	3.7	3.9
Hg (*tons*)	0.0	0.003	0.004	0.005	0.005	0.005
Total FFC Emissions						
CO_2 (*million metric tons*)	41.4	501	586	702	732	1,098
CH_4 (*thousand tons*)	518	4,541	5,193	6,345	6,660	11,290
N_2O (*thousand tons*)	0.1	4.6	5.6	6.4	6.6	7.2
NO_X (*thousand tons*)	112	988	1,130	1,380	1,448	2,450
SO_2 (*thousand tons*)	0.2	143	177	201	206	204
Hg (*tons*)	0.0	1.0	1.2	1.4	1.4	1.4

Note: totals may not equal sums due to rounding.

As part of the analysis for this rulemaking, DOE estimated monetary benefits likely to result from the reduced emissions of CO_2 that DOE estimated for each of the considered TSLs for consumer water heaters. Section IV.L of this document discusses the SC–CO_2 values that DOE used. Table V.29 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.29—PRESENT VALUE OF CO_2 EMISSIONS REDUCTION FOR CONSUMER WATER HEATERS SHIPPED IN 2030–2059

TSL	SC–CO_2 Case			
	Discount rate and statistics			
	5% Average	3% Average	2.5% Average	3% 95th percentile
	Billion 2022$			
1	0.3	1.5	2.4	4.7
2	4.3	19	30	58
3	5.1	22	35	68
4	6.0	27	42	81
5	6.3	28	44	84
6	9.5	42	66	127

As discussed in section IV.L.2, 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 consumer water heaters. Table V.30 presents the value of the CH_4 emissions reduction at each TSL, and Table V.31 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.30—PRESENT VALUE OF METHANE EMISSIONS REDUCTION FOR CONSUMER WATER HEATERS SHIPPED IN 2030–2059

TSL	SC–CH_4 Case			
	Discount rate and statistics			
	5% Average	3% Average	2.5% Average	3% 95th percentile
	Billion 2022$			
1	0.2	0.6	0.9	1.7
2	1.8	5.7	8.0	15
3	2.1	6.4	9.1	17
4	2.5	7.8	11	21

TABLE V.30—PRESENT VALUE OF METHANE EMISSIONS REDUCTION FOR CONSUMER WATER HEATERS SHIPPED IN 2030–2059—Continued

TSL	SC–CH_4 Case			
	Discount rate and statistics			
	5% Average	3% Average	2.5% Average	3% 95th percentile
	Billion 2022$			
5	2.6	8.2	12	22
6	4.5	14	20	37

TABLE V.31—PRESENT VALUE OF NITROUS OXIDE EMISSIONS REDUCTION FOR CONSUMER WATER HEATERS SHIPPED IN 2030–2059

TSL	SC–N_2O Case			
	Discount rate and statistics			
	5% Average	3% Average	2.5% Average	3% 95th percentile
	Billion 2022$			
1	0.0003	0.001	0.002	0.003
2	0.02	0.06	0.10	0.17
3	0.02	0.08	0.12	0.20
4	0.02	0.09	0.14	0.23
5	0.02	0.09	0.14	0.24
6	0.02	0.10	0.16	0.26

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 consumer water heaters. The dollar-per-ton values that DOE used are discussed in section IV.L of this document. Table V.32 presents the present value for NO_X emissions reduction for each TSL calculated using 7-percent and 3-percent discount rates, and Table V.33 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.32—PRESENT VALUE OF NO_X EMISSIONS REDUCTION FOR CONSUMER WATER HEATERS SHIPPED IN 2030–2059

TSL	3% Discount rate	7% Discount rate
	Billion 2022$	
1	1.2	3.5
2	14	40
3	16	47
4	19	56
5	20	58
6	31	90

TABLE V.33—PRESENT VALUE OF SO_2 EMISSIONS REDUCTION FOR CONSUMER WATER HEATERS SHIPPED IN 2030–2059

TSL	3% Discount rate	7% Discount rate
	Billion 2022$	
1	0.002	0.01
2	3.0	8.4
3	3.6	10
4	4.1	12
5	4.2	12
6	4.2	12

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, NO_X, and SO_2 are captured in the values above, and additional unquantified benefits from the reductions of those pollutants as well as from the reduction of 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.34 presents the NPV values that result from adding the estimates of the potential economic benefits resulting from reduced GHG and NO_X and SO_2 emissions to the NPV of consumer benefits calculated for each TSL considered in this rulemaking. The consumer benefits are domestic U.S. monetary savings that occur as a result of purchasing the covered consumer water heaters, and are measured for the lifetime of products shipped in 2030–2059. 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 consumer water heaters shipped in 2030–2059.

TABLE V.34—CONSUMER NPV COMBINED WITH PRESENT VALUE OF CLIMATE BENEFITS AND HEALTH BENEFITS

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Using 3% discount rate for Consumer NPV and Health Benefits (billion 2022$)						
5% Average SC–GHG case	7.0	216	255	304	310	350
3% Average SC–GHG case	8.6	235	277	330	337	392
2.5% Average SC–GHG case	10	248	292	349	356	422
3% 95th percentile SC–GHG case	13	283	333	398	407	500
Using 7% discount rate for Consumer NPV and Health Benefits (billion 2022$)						
5% Average SC–GHG case	2.6	79	92	110	112	124
3% Average SC–GHG case	4.2	98	113	136	139	166
2.5% Average SC–GHG case	5.3	111	129	155	158	196
3% 95th percentile SC–GHG case	8.4	146	170	204	209	275

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

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

DOE also notes that the economics literature provides a wide-ranging discussion of how consumers trade off upfront costs and energy savings in the absence of government intervention. Much of this literature attempts to explain why consumers appear to undervalue energy efficiency improvements. There is evidence that consumers undervalue future energy savings as a result of (1) a lack of information, (2) a lack of sufficient salience of the long-term or aggregate benefits, (3) a lack of sufficient savings to warrant delaying or altering purchases, (4) excessive focus on the short term, in the form of inconsistent weighting of future energy cost savings relative to available returns on other investments, (5) computational or other difficulties associated with the evaluation of relevant tradeoffs, and (6) a divergence in incentives (for example, between renters and owners, or builders and purchasers). Having less than perfect foresight and a high degree of uncertainty about the future, consumers may trade off these types of investments at a higher than expected rate between current consumption and uncertain future energy cost savings.

In DOE's current regulatory analysis, potential changes in the benefits and costs of a regulation due to changes in consumer purchase decisions are included in two ways. First, if consumers forego the purchase of a product in the standards case, this decreases sales for product manufacturers, and the impact on manufacturers attributed to lost revenue is included in the MIA. Second, DOE accounts for energy savings attributable only to products actually used by consumers in the standards case; if a standard decreases the number of products purchased by consumers, this decreases the potential energy savings from an energy conservation standard. DOE provides estimates of shipments and changes in the volume of product purchases in chapter 9 of the 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.[174]

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

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

estimated in the regulatory process.[175] DOE welcomes comments on how to more fully assess the potential impact of energy conservation standards on consumer choice and how to quantify this impact in its regulatory analysis in future rulemakings.

1. Benefits and Burdens of TSLs Considered for Consumer Water Heater Standards

Table V.35and Table V.36 summarize the quantitative impacts estimated for each TSL for consumer water heaters. The national impacts are measured over the lifetime of consumer water heaters purchased in the 30-year period that begins in the anticipated year of compliance with amended standards (2030–2059). 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.35—SUMMARY OF ANALYTICAL RESULTS FOR CONSUMER WATER HEATER TSLS: NATIONAL IMPACTS

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Cumulative FFC National Energy Savings						
Quads	0.8	27.3	33.3	38.4	39.7	46.0
Cumulative FFC Emissions Reduction						
CO_2 (*million metric tons*)	41	501	586	702	732	1,098
CH_4 (*thousand tons*)	518	4,541	5,193	6,345	6,660	11,290
N_2O (*thousand tons*)	0.1	4.6	5.6	6.4	6.6	7.2
NO_X (*thousand tons*)	112	988	1,130	1,380	1,448	2,450
SO_2 (*thousand tons*)	0.2	143	177	201	206	204
Hg (*tons*)	0.0	1.0	1.2	1.4	1.4	1.4
Present Value of Monetized Benefits and Costs (3% discount rate, billion 2022$)						
Consumer Operating Cost Savings	5.1	198	241	280	290	326
Climate Benefits *	2.2	25	29	35	36	56
Health Benefits **	3.5	49	57	68	71	102
Total Benefits †	11	271	327	383	397	484
Consumer Incremental Product Costs ‡	2.1	36	50	52	60	93
Consumer Net Benefits	3.0	161	191	228	230	234
Total Net Benefits	8.6	235	277	330	337	392
Present Value of Monetized Benefits and Costs (7% discount rate, billion 2022$)						
Consumer Operating Cost Savings	1.9	75	90	105	109	123
Climate Benefits *	2.2	25	29	35	36	56
Health Benefits **	1.2	17	20	24	25	35
Total Benefits †	5.3	117	139	163	169	214
Consumer Incremental Product Costs ‡	1.1	19	26	27	31	48
Consumer Net Benefits	0.8	56	65	78	78	75
Total Net Benefits	4.2	98	113	136	139	166

Note: This table presents the costs and benefits associated with consumer water heaters shipped in 2030 – 2059. These results include benefits to consumers which accrue after 2059 from the products shipped in 2030–2059.

* To monetize the benefits of reducing greenhouse gas emissions this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990* published in February 2021 by the Interagency Working Group on the Social Cost of Greenhouse Gases (IWG). 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.

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

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

[175] Sanstad, A.H. *Notes on the Economics of Household Energy Consumption and Technology Choice.* 2010. Lawrence Berkeley National Laboratory. *www1.eere.energy.gov/buildings/appliance_standards/pdfs/consumer_ee_theory.pdf (last accessed May 1, 2023).*

TABLE V.36—SUMMARY OF ANALYTICAL RESULTS FOR CONSUMER WATER HEATER TSLS: MANUFACTURER AND CONSUMER IMPACTS

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Manufacturer Impacts						
Industry NPV (*million 2022$*) (No-new-standards case INPV = 2,554.7)	2,532.9 to 2,602.7	2,347.4 to 2,720.2	2,168.6 to 2,596.0	2,115.9 to 2,590.1	2,044.0 to 2,619.4	1,804.2 to 2,706.9
Industry NPV (*% change*)	(0.9) to 1.9	(8.1) to 6.5	(15.1) to 1.6	(17.2) to 1.4	(20.0) to 2.5	(29.4) to 6.0
Consumer Average LCC Savings (2022$)						
GSWH	17	52	52	52	52	(247)
OSWH	145	165	165	165	165	165
Small ESWH (20 gal ≤ V_{eff} ≤35 gal and FHR <51 gal)	NA	NA	418	418	418	418
ESWH (20 gal ≤V_{eff} ≤55 gal excluding Small ESWH)	NA	1,868	1,868	2,283	2,101	2,101
ESWH (55 gal <V_{eff} ≤120 gal)	501	501	501	599	170	170
GIWH	66	135	135	89	95	95
Shipment-Weighted Average *	25	910	873	982	943	73
Consumer Simple PBP (years)						
GSWH	8.1	7.9	7.9	7.9	7.9	16.4
OSWH	4.4	6.4	6.4	6.4	6.4	6.4
Small ESWH (20 gal ≤V_{eff} ≤35 gal and FHR <51 gal)	NA	NA	8.8	8.8	8.8	8.8
ESWH (≥20 gal and ≤55 gal excluding Small ESWH)	NA	3.0	3.0	2.7	3.0	3.0
ESWH (≥55 gal and ≤120 gal)	0.2	0.2	0.2	0.4	1.5	1.5
GIWH	7.3	5.9	5.9	5.9	6.3	6.3
Shipment-Weighted Average *	3.7	5.4	6.2	6.2	6.4	11.4
Percent of Consumers that Experience a Net Cost						
GSWH	22	36	36	36	36	70
OSWH	9	25	25	25	25	25
Small ESWH	0	0	56	56	56	56
ESWH (≥20 gal and ≤55 gal excluding Small ESWH)	0	25	25	23	30	30
ESWH (≥55 gal and ≤120 gal)	0	0	0	1	42	42
GIWH	13	13	13	29	36	36
Shipment-Weighted Average*	11	27	30	31	35	49

* Weighted by market share in start year of 2030.

DOE first considered TSL 6, which represents the max-tech efficiency levels for all product classes. At TSL 6, the design options for GSWHs and GIWHs include condensing technology; the design options for ESWHs include heat pump technology; and the design options for OSWHs include extra insulation and multi-flue heat exchangers. TSL 6 would require extensive changes to the way manufacturers currently produce water heaters. The percent of shipments expected to meet or exceed the efficiency levels in TSL 6 by the compliance date of the proposed standard is 0.2 percent of shipments for GSWHs, 17 percent of shipments for OSWHs, 1 percent of small ESWH, 5 percent of shipments for electric storage water heaters with an effective storage volume less than 55 gallons (excluding small electric storage water heaters), 11 percent of ESWHs with an effective storage volume greater than or equal to 55 gallons, and 8 percent of shipments for GIWHs. There would be a significant ramp up in manufacturing capacity, especially for gas storage and electric storage water heaters, needed to support the market due and transition to accommodate these advance technologies.

TSL 6 would save an estimated 46.0 quads of energy, an amount DOE considers significant. Under TSL 6, the NPV of consumer benefit would be $75 billion using a discount rate of 7 percent, and $234 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 6 are 1,098 Mt of CO_2, 11,290 thousand tons of CH_4, 7.2 thousand tons of N_2O, 2,450 thousand tons of NO_X, 204 thousand tons of SO_2, and 1.4 tons of Hg. 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 6 is $56 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 6 is $35 billion using a 7-percent discount rate and $102 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 6 is $166 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 6 is $392 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 6, consumers will experience an average LCC increase of $247 for GSWHs, which is primarily driven by the total installed cost increases for gas condensing technology. For OSWHs, consumers will experience an average LCC savings of $165 and for GIWHs, consumers will experience an average LCC savings of $95. For electric storage water heaters, consumers will experience an LCC savings. For GSWHs, the consumers experiencing a net LCC cost is 70 percent and for small ESWHs, the consumers experiencing a net LCC cost is 56 percent. While there are LCC savings for ESWHs, DOE notes that the incremental installed costs are more than double those of baseline efficiency products, which can be a burden on consumers replacing their water heater when it fails, particularly lower income homeowners, if they need to find a way to cover the payment up front to purchase and install the replacement.

At TSL 6, the projected change in INPV ranges from a decrease of $750.5 million to an increase of $152.2 million, which corresponds to a decrease of 29.4 percent and an increase of 6.0 percent, respectively. The range of the impacts is driven primarily by the ability of manufacturers to recover their compliance costs. DOE estimates that industry must invest $651.5 million to comply with standards set at TSL 6. DOE believes that manufacturers would need to significantly upgrade their facilities to accommodate gas-condensing technologies for GIWHs as well as heat pump technology for ESWHs. Upgrades to produce heat pump electric storage water heaters include expansion of heat exchanger facilities and inclusion of refrigeration charging systems. In addition, manufacturers would need to expand their component sourcing of compressors and more sophisticated controls to produce these more advanced technology products. DOE estimates that manufacturers would need to scale up production of heat pump electric storage water heaters from approximately 5% of ESWH sales today (0.23 million units in 2023) to 100% of ESWH units in 2030. DOE believes significant research and development efforts would also be needed to support the introduction of a wider variety of heat pump water heater models in the market to meet the various needs of consumers, especially split system heat pump water heaters that would be needed to support the replacement of small electric storage water heaters. Currently, there are very limited split system heat pump water heater models commercially available in the United States, which are produced by only a few manufacturers and are sold in low quantities. DOE is concerned that sufficient products may not be available to support the small electric storage water heaters market, and new products may not be introduced by a large majority of water heater manufacturers by the compliance date of this proposed rule. In sum, DOE is concerned that industry will not be able to transition to 100% of electric storage water heaters to heat pump designs within a 5-year compliance window, as would be necessary to comply with TSL 6.

DOE requests comment on the ability of manufacturers to transition to producing heat pump water heaters within the compliance window.

DOE is also concerned about training the workforce that would be needed to install and service the heat pump water heater market by the compliance date of the standards. ESWHs are typically installed by plumbers. Advance technology water heaters require the ability to work with refrigerants similar to heating, ventilation, and air conditioning servicing contractors. DOE hopes that the emergence of workforce programs supported by the Inflation Reduction Act and the Bipartisan Infrastructure Law will begin to support the training and education of the workforce needed to support the clean energy transition. However, DOE understands this transition will take time and the workforce may not be ready at the scale necessary to support TSL 6.

DOE requests comment on the pace at which workforce development is expected to install and service the heat pump water heater market by the compliance date of the standards.

The Secretary tentatively concludes that at TSL 6 for consumer water heaters, the benefits of energy savings, positive NPV of consumer benefits, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by economics impacts to manufacturers, primarily driven by the ramp up in scale and offerings needed to support both ESWHs and GWSHs efficiencies at TSL 6, the economic costs for small ESHW consumers (many of whom are low income), and the distinct impact of high initial costs for low-income consumers purchasing replacement water heaters in emergency circumstances. As mentioned above, less than 0.1 percent of gas-storage water heater shipments and approximately 5 percent of all electric storage water heaters shipments currently meet TSL 6 efficiencies. DOE also notes that new technologies have recently been introduced into the heat pump water heater market such as 120-volt water heaters, whose efficiencies are lower than TSL 6. Such 120-volt water heaters can be more readily adopted by more households, lowering installation costs. While DOE expects continued innovation in the heat pump water heat market at this time, DOE is worried that prematurely requiring TSL 6 efficiency levels will remove these new products from the market prematurely. The Secretary is also concerned about the uncertainty in the market to ensure GSWHs and ESWHs will continue to be available to all consumers, including small ESWH replacements. Consequently, the Secretary has tentatively concluded that TSL 6 is not economically justified.

DOE then considered TSL 5, which represents the max-tech efficiency levels for all product classes except for GSWHs, which includes a lower non-condensing efficiency level. At TSL 5, the design options for GSWHs include either gas-actuated or electric flue dampers instead of condensing technologies. For the remainder of the product classes, the efficiency levels and technologies are the same as in TSL 6: that is, for ESWHs, TSL 5 includes max-technology efficiency levels for heat pump water heaters across all ESWH product classes, including small ESWHs. The percent of shipments expected to meet or exceed the efficiency levels in TSL 5 is the same as TSL 6 except approximately 5 percent of shipments for GSWHs are expected to meet by the compliance date of the proposed standards. At TSL 5, the standard would transition all consumer electric storage water heaters to heat pump technology across all effective storage volumes, delivery capacity offerings, and sizes in the market.

TSL 5 would save an estimated 39.7 quads of energy, an amount DOE considers significant. Under TSL 5, the NPV of consumer benefit would be $78 billion using a discount rate of 7 percent, and $230 billion using a discount rate of 3 percent.

At TSL 5, DOE estimates that consumers will see a life cycle cost savings for all product classes. At TSL 5, the average LCC savings is $52 for GSWH consumers, which is driven by the lower installed costs as compared to the TSL 6 condensing level. While the LCC savings are positive for a majority of consumers across TSL 5 product classes, 56 percent of small ESWH consumers will experience a net cost when installing a split system heat pump water heater.

At TSL 5, the projected change in INPV ranges from a decrease of $510.7 million to an increase of $64.7 million, which correspond to a decrease of 20.0 percent and an increase of 2.5 percent, respectively. DOE estimates that industry must invest $424.1 million to comply with standards set at TSL 5. The primary driver of high conversion costs is the industry's investment to meet market demand for heat pump electric storage water heaters. As noted above, DOE estimates that manufacturers would need to scale up production of heat pump electric storage water heaters from approximately 5% of all ESWH units (0.23 million units in 2023) to 100% of units in 2030. As a part of this scale-up, manufacturers would need to develop new split-system heat pumps for the small electric storage water heater market. Manufacturers would likely need to invest in cost optimization of existing designs, in new designs, and in additional manufacturing capacity for heat pump water heaters. For GIWHs, manufacturers would need to update product designs and production tooling to accommodate increased heat exchanger sizes. Additionally, given the greater complexity and assembly time of condensing GIWHs, manufacturers would likely need to add manufacturing lines to maintain production capacity.

Similar to the discussion at TSL 6, DOE's concerns continue to be driven by the ramp up in manufacturing, research, and development that would be needed to support the heat pump water heater market to continue today's volumes. TSL 5 would require the expansion of heat pump lines and the introduction of new products to support the entire market, especially small ESWHs.

The Secretary tentatively concludes that at TSL 5 for consumer water heaters, the benefits of energy savings, positive NPV of consumer benefits, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the impacts on manufacturers, driven by the uncertainty in the ramp up needed to support a full transition of all volumes to heat pump water heaters for ESWHs, the impacts on consumers of small ESWHs, and the increase in initial costs. While the LCC savings are positive for a majority of consumers across TSL 5 product classes, 56 percent of small ESWH consumers would experience net costs when installing a split system heat pump water heater. DOE is concerned about the increase in first costs for consumers forced to purchase a replacement water heater when their existing water heater fails and the inability for the market to introduce cost-optimized heat pump water heaters as an offering to consumers to help mitigate the initial first cost increase. As at TSL 5, DOE is also concerned about the workforce being ready to service and install at the volumes necessary to support such a transition in 5 years. Consequently, the Secretary has tentatively concluded that TSL 5 is not economically justified.

DOE then considered TSL 4, which represents a lower efficiency level for ESWHs and GIWHs and maintains the same efficiency levels for OSWHs and GSWHs as at TSL 5. At TSL 4, the design options for GSWHs include either gas-actuated or electric flue dampers; the design options for OSWHs include extra insulation and multi-flue heat exchangers; the design options for ESWHs include heat pump technology; and the design options for GIWHs include condensing technology. The percent of shipments in 2030 expected to meet the proposed level in for ESWHs with an effective storage volume less than 55 gallons is 13 percent, which is a significant increase from the max-tech efficiency levels. But for small ESWHs, the percent of shipments expected to meet TSL 4 remains at 1. At TSL 4, the standard would transition all consumer electric storage water heaters to heat pump technology, but at a more moderate efficiency level for non-small ESWHs. DOE still expects this transition to be significant, but DOE notes that manufacturers have more experience producing non-small ESWHs at these efficiency levels due to the prevalence of the ENERGY STAR program. DOE also expects the programs from the Inflation Reduction Act, including the appliance rebates and tax credits, to help support the expansion of this market.

TSL 4 would save an estimated 38.4 quads of energy, an amount DOE considers significant. Under TSL 4, the NPV of consumer benefit would be $78 billion using a discount rate of 7 percent, and $228 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 4 are 702 Mt of CO_2, 6,345 thousand tons of CH_4, 6.4 thousand tons of N_2O, 1,380 thousand tons of NO_X, 458 thousand tons of SO_2, and 1.4 tons of Hg. 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 $35 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 4 is $24 billion using a 7-percent discount rate and $68 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 $136 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 4 is $330 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.

The average LCC across all product classes is positive. However, DOE continues to be concerned about the development of new models that would need to be introduced into the split-system heat pump water heater market to support the small ESWH replacements. As DOE noted in discussing TSL 6, only a few manufacturers produce products today in very small volumes and would not be able to support the entire small ESWH market today. Similar to TSLs 5 and 6, 56 percent of small ESWH consumers will experience a net cost when installing a split system heat pump water heater

At TSL 4, the projected change in INPV ranges from a decrease of $438.8 million to an increase of $35.3 million, which correspond to a decrease of 17.2 percent and an increase of 1.4 percent, respectively. DOE estimates that industry must invest $376.7 million to comply with standards set at TSL 4. For ESWH manufacturers, stepping down from max-tech provides greater flexibility in the design process and reduces the level of model-specific optimization. This results in lower conversion costs. However, manufacturers would still need to develop new split-system heat pumps for the small ESWH market and scale up production capacity for integrated heat pump water heaters. As noted above, DOE estimates that manufacturers would need to scale up production of heat pump electric storage water heaters from approximately 5% of ESWH sales in 2023 to 100% of units in 2030. For GIWH manufacturers, all models would have to incorporate condensing technology. TSL 4 is a step down from max-tech but still represents an efficiency level that has not yet been broadly adopted in by the GIWH market. While 66% of GIWHs are already sold at condensing levels, only 15% of shipments meet TSL 4. Given the greater complexity and assembly time of condensing GIWHs, as well as the increased heat exchanger sizes necessary to meet this level, manufacturers would likely need to add manufacturing lines to maintain current production capacity.

The Secretary tentatively concludes that at TSL 4 for consumer water heaters, the benefits of energy savings, positive NPV of consumer benefits, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the manufacturing concerns and by the uncertainty associated with the industry's ability to ramp up production at the levels necessary to meet a standard at TSL 4 within a 5-year period. Given TSL 4 represents a lower efficiency level that would require less model specific optimization, DOE expects the research and development efforts to be smaller and DOE does expect significant ramp of this greater efficiency market segment in response to the incentive programs. However, DOE continues to be concerned about industry's ability to produce more than 3 million units a year, while introducing new innovative products to meet consumers' needs and optimizing to produce lower costs products. As at TSLs 6 and 5, DOE is concerned that the efficiency level required by TSL 4 may preclude the introduction of 120-volt water heaters into the broader market, which DOE considered as a qualitative factor that DOE has considered in its decision-making. Adopting a standard level at TSL 4 would prevent innovation around these technologies (such as reducing their costs). Consequently, the Secretary has tentatively concluded that TSL 4 is not economically justified.

DOE then considered TSL 3, which represents the same levels as TSL 4 except includes a lower efficiency level for ESWHs and GIWHs. For those ESWHs less than 55 gallons of effective storage volume (including small ESWHs), TSL 3 includes an ''entry'' level heat pump efficiency level to accommodate some of the new product innovations that have been recently introduced into the market. At TSL 3, currently available 120–V heat pump water heaters would be able to comply with the required efficiencies. For ESWHs greater than 55 gallons of effective storage volume, TSL 3 includes an incremental increase in heat pump efficiency over the current standards. At TSL 3, the standard would still transition all consumer electric storage water heaters to heat pump technology. As noted earlier, heat pump technology currently comprises approximately 5% of the electric storage water heater market. TSL 3 would shift 100% of electric storage water heaters to heat pumps, driving large investments in design of new heat pump offerings and new product capacity. For GIWHs, TSL 3 still requires condensing technology but can be achieved with simpler or smaller heat exchangers than at TSL 4.

TSL 3 would save an estimated 33.3 quads of energy, an amount DOE considers significant. Under TSL 3, the NPV of consumer benefit would be $65 billion using a discount rate of 7 percent, and $191 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 3 are 586 Mt of CO_2, 5,193 thousand tons of CH_4, 5.6 thousand tons of N_2O, 1,130 thousand tons of NO_X, 177 thousand tons of SO_2, and 1.2 tons of Hg. The estimated monetary value of the climate benefits from reduced GHG emissions (associated with the average SC–GHG at a 3-percent discount rate) at TSL 3 is $29 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 3 is $20 billion using a 7-percent discount rate and $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 3 is $113 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 3 is $277 billion. The estimated total NPV is provided for additional information, however DOE primarily relies upon the NPV of consumer benefits when determining whether a proposed standard level is economically justified.

At TSL 3, the average LCC impact is a savings across all product classes. Similar to TSLs 4, 5, and 6, 56 percent of small ESWH consumers will experience a net cost when installing a split system heat pump water heater.

At TSL 3, the projected change in INPV ranges from a decrease of $386.1 million to an increase of $41.2 million, which correspond to a decrease of 15.1 percent and an increase of 1.6 percent, respectively. DOE estimates that industry must invest $32 3.3 million to comply with standards set at TSL 3. Manufacturers would need to develop new split-system heat pumps for the small ESWH market. They would also need to scale up production capacity for integrated heat pump water heaters. For GIWH manufactures, all product lines would have to incorporate condensing technology. However, the industry has extensive experience producing GIWH models that meet TSL 3, as 59% of GIWH sales meet or exceed this level today.

The Secretary tentatively concludes that at TSL 3 for consumer water heaters, the benefits of energy savings, positive NPV of consumer benefits, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the uncertainty associated with the ability for industry to meet the demand necessary to support the entire market for ESWHs, including the workforce transition needed to service and install all of these HPWHs. For small ESWHs, DOE estimates that the fraction of consumers experiencing a net cost is 56 percent. Based on those costs to small ESWH consumers and the possible difficulty of meeting the market needs within the compliance timeframe, the Secretary has tentatively concluded that TSL 3 is not economically justified.

DOE then considered TSL 2, which represents the baseline efficiency level for small ESWHs and heat pump efficiency levels for all other ESWHs. TSL 2 also includes a condensing level for GIWHs, max-tech efficiency levels for OSWHs, and a moderate increase in efficiency for GSWHs. TSL 2 also aligns most closely with the Joint Stakeholder Recommendation efficiency levels with minor differences to the small ESWH product class as discussed in section IV.C. While DOE recognizes that TSL 2 is not the TSL that maximizes net monetized benefits, DOE has weighed other non-quantified and non-monetized factors in accordance with EPCA in reaching this determination.

TSL 2 would save an estimated 27.3 quads of energy, an amount DOE considers significant. Under TSL 2, the NPV of consumer benefit would be $56 billion using a discount rate of 7 percent, and $161 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 2 are 501 Mt of CO_2, 4,541 thousand tons of CH_4, 4.6 thousand tons of N_2O, 988 thousand tons of NO_X, 143 thousand tons of SO_2, and 1.0 tons of Hg. The estimated monetary value of the climate benefits from reduced GHG emissions (associated with the average SC–GHG at a 3-percent discount rate) at TSL 3 is $25 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 2 is $17 billion using a 7-percent discount rate and $49 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, health benefits from reduced SO_2 and NO_X emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 2 is $98 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 2 is $235 billion. The estimated total NPV is provided for additional information, however DOE primarily relies upon the NPV of consumer benefits when determining whether a proposed standard level is economically justified.

At TSL 2, the average LCC impact is a savings for all product classes. the average LCC impact is a savings of $52 for GSWHs, savings of $165 for OSWHs, savings of $1,868 for ESWHs (20 gal ≤ V_{eff} ≤55 gal) excluding small ESWHs, savings of $501 for ESWHs (55 gal < V_{eff} ≤120 gal), and savings of $135 for GIWHs. The fraction of consumers experiencing a net LCC cost is 36 percent for GSWHs, 25 percent for OSWHs, 25 percent for ESWHs (20 gal ≤ V_{eff} ≤55 gal) excluding Small ESWHs, 0 percent for ESWHs (55 gal < V_{eff} ≤120 gal), and 13 percent for GIWHs. Consumers of small ESWH (20 gal ≤ V_{eff} ≤35 gal) are not impacted at TSL 2 as the standard is not proposed to be amended.

At TSL 2, the projected change in INPV ranges from a decrease of $207.3 million to an increase of $165.5 million, which correspond to a decrease of 8.1 percent and an increase of 6.5 percent, respectively. DOE estimates that industry must invest $228.1 million to comply with standards set at TSL 2.

At higher TSLs, the primary driver of high conversion costs is the industry's investment to meet market demand for heat pump electric storage water heaters. TSL 2 preserves the existing market for small ESWHs, allowing small ESWHs utilizing only electric resistance technology (*i.e.,* that do not utilize a heat pump) to remain in the market. In turn, this reduces the level of investment needed to meet market demand for heat pump water heaters. DOE estimates industry would need to scale up production of heat pump electric storage water heaters from approximately 5% of ESWHs today to 63% of ESWHs in 2030, a significant reduction from higher TSLs. This approach, while still requiring a significant ramp up in manufacturing capacity for heat pump water heaters, allows for a more incremental transition to heat pump technology. It limits the investment required of manufacturers relative to higher TSLs that would require transitioning the entire ESWH market to heat pump technology and recognizes the benefits of providing additional time for small electric storage water heater designs using heat pump technology to mature. DOE believes that having major manufacturers sign on to the Joint Recommendation is a testament to industry's ability to ramp up capacity to produce the volumes necessary to support the heat pump water heater market that will be required by TSL 2 by the compliance date of the proposed standards.

After considering the analysis and weighing the benefits and burdens, the Secretary has tentatively concluded that standards set at TSL 2 for consumer water heaters would be economically justified. At this TSL, the average LCC savings for consumers of all product classes are expected to be positive. The average LCC savings across all ESWH excluding small ESWHs consumers is $1,867. At TSL 2, the efficiency levels for ESWHs allow for continued development and innovation with 120 V heat pump ESWHs as well as split system heat pump ESWHs. The efficiency levels at TSL 2 also allow for existing small ESWHs to remain on the market, providing an important option for a subset of consumers. The FFC national energy savings are significant and the NPV of consumer benefits is positive using both a 3-percent and 7-percent discount rate. These national benefits vastly outweigh the costs. The positive LCC savings—a different way of quantifying consumer benefits—reinforces this conclusion. The standard levels at TSL 2 are economically justified even without weighing the estimated monetary value of emissions reductions. When those emissions reductions are included—representing $25 billion in climate benefits (associated with the average SC–GHG at a 3-percent discount rate), and $17 billion (using a 7-percent discount rate) or $49 billion (using a 3-percent discount rate) in health benefits—the rationale becomes stronger still.

In addition, DOE considered that the efficiency levels across TSL 2 are generally representative of the Joint Stakeholder agreement. More specifically, DOE believes the Joint Stakeholder agreement from a cross-section group of stakeholders provides the Department a good indication of stakeholder views on this rulemaking and provides the Department with some assurance that industry can transition to these levels and the market will see significant benefits as indicated by DOE's analysis.

Accordingly, the Secretary has tentatively concluded that TSL 2 would offer the maximum improvement in efficiency that is technologically feasible and economically justified, and would result in the significant conservation of energy. Although results are presented here in terms of TSLs, DOE analyzes and evaluates all possible ELs for each product class in its analysis. TSL 2 is comprised of efficiency levels that offer significant LCC savings while keeping the percent of consumers experiencing a net cost at a modest level. Lower income homeowners, in particular, who currently use small ESWHs are significantly less likely to be disproportionately impacted at TSL 2. TSL 2 also reduces the percentage of the market that would be transitioning to heat pump water heaters within a 5-year period. While DOE still understands the ramp up to accommodate heat pump water heaters and condensing GIWHs is significant, DOE believes manufacturers can leverage their existing operations, knowledge, workforce networks, and R&D to scale at a level needed to support a proposed standard at TSL 2. Lastly, TSL 2 most closely represents the recommended standard levels submitted by Joint Stakeholders to DOE, providing further support for standard levels set at TSL 2, a factor the Secretary considers significant.

As discussed in section IV.F.9, DOE does not expect any significant amount of switching across product classes as a result of the proposed standards. There are a number of significant additional costs involved in switching from electric equipment to gas equipment and vice versa, such as replacing an electrical panel or installing new gas lines (both inside and outside of the home) and new venting. These additional costs can possibly exceed $1,000 on top of the installed costs estimated in this proposed rule, making product switching as a result of standards very likely to be a minimal effect at most.

Therefore, based on the above considerations, DOE proposes the conservation standards for consumer water heaters at TSL 2 for those product classes where there are existing applicable UEF standards. For the remaining product classes, DOE proposes to convert the existing standards to the UEF metric based on the amended appendix E test procedure. Altogether, the proposed energy conservation standards for consumer water heaters, which are expressed as UEF, are shown in Table V.37.

TABLE V.37—PROPOSED ENERGY CONSERVATION STANDARDS FOR CONSUMER WATER HEATERS

Product class	Effective storage volume and input rating * (if applicable)	Draw pattern	Uniform energy factor
Gas-fired Storage Water Heater	<20 gal	Very Small	$0.2062 - (0.0020 \times V_{eff})$
		Low	$0.4893 - (0.0027 \times V_{eff})$
		Medium	$0.5758 - (0.0023 \times V_{eff})$
		High	$0.6586 - (0.0020 \times V_{eff})$
	≥20 gal and ≤55 gal	Very Small	$0.3925 - (0.0020 \times V_{eff})$
		Low	$0.6451 - (0.0019 \times V_{eff})$
		Medium	$0.7046 - (0.0017 \times V_{eff})$
		High	$0.7424 - (0.0013 \times V_{eff})$
	>55 gal and ≤100 gal	Very Small	$0.6470 - (0.0006 \times V_{eff})$
		Low	$0.7689 - (0.0005 \times V_{eff})$
		Medium	$0.7897 - (0.0004 \times V_{eff})$
		High	$0.8072 - (0.0003 \times V_{eff})$
	>100 gal	Very Small	$0.1482 - (0.0007 \times V_{eff})$
		Low	$0.4342 - (0.0017 \times V_{eff})$
		Medium	$0.5596 - (0.0020 \times V_{eff})$
		High	$0.6658 - (0.0019 \times V_{eff})$
Oil-fired Storage Water Heater	≤50 gal	Very Small	$0.2909 - (0.0012 \times V_{eff})$
		Low	$0.5730 - (0.0016 \times V_{eff})$
		Medium	$0.6478 - (0.0016 \times V_{eff})$
		High	$0.7215 - (0.0014 \times V_{eff})$
	>50 gal	Very Small	$0.1580 - (0.0009 \times V_{eff})$
		Low	$0.4390 - (0.0020 \times V_{eff})$
		Medium	$0.5389 - (0.0021 \times V_{eff})$
		High	$0.6172 - (0.0018 \times V_{eff})$
Very Small Electric Storage Water Heater.	<20 gal	Very Small	$0.5925 - (0.0059 \times V_{eff})$
		Low	$0.8642 - (0.0030 \times V_{eff})$
		Medium	$0.9096 - (0.0020 \times V_{eff})$
		High	$0.9430 - (0.0012 \times V_{eff})$
Small Electric Storage Water Heater	≥20 gal and ≤35 gal	Very Small	$0.8808 - (0.0008 \times V_{eff})$
		Low	$0.9254 - (0.0003 \times V_{eff})$
Electric Storage Water Heaters	>20 and ≤55 gal (excluding small electric storage water heaters).	Very Small	2.30
		Low	2.30
		Medium	2.30
		High	2.30
	>55 gal and ≤120 gal	Very Small	2.50
		Low	2.50
		Medium	2.50
		High	2.50
	>120 gal	Very Small	$0.3574 - (0.0012 \times V_{eff})$
		Low	$0.7897 - (0.0019 \times V_{eff})$
		Medium	$0.8884 - (0.0017 \times V_{eff})$
		High	$0.9575 - (0.0013 \times V_{eff})$
Tabletop Water Heater	<20 gal	Very Small	$0.5925 - (0.0059 \times V_{eff})$
		Low	$0.8642 - (0.0030 \times V_{eff})$
	≥20 gal and ≤120 gal	Very Small	$0.6323 - (0.0058 \times V_{eff})$
		Low	$0.9188 - (0.0031 \times V_{eff})$
Instantaneous Gas-fired Water Heater	<2 gal and ≤50,000 Btu/h	Very Small	0.64
		Low	0.64
		Medium	0.64
		High	0.64
	<2 gal and >50,000 Btu/h	Very Small	0.89
		Low	0.91
		Medium	0.91
		High	0.93
	≥2 gal and ≤200,000 Btu/h	Very Small	$0.2534 - (0.0018 \times V_{eff})$
		Low	$0.5226 - (0.0022 \times V_{eff})$
		Medium	$0.5919 - (0.0020 \times V_{eff})$
		High	$0.6540 - (0.0017 \times V_{eff})$
Instantaneous Oil-fired Water Heater	<2 gal and ≤210,000 Btu/h	Very Small	0.61
		Low	0.61
		Medium	0.61
		High	0.61
	≥2 gal and ≤210,000 Btu/h	Very Small	$0.2780 - (0.0022 \times V_{eff})$
		Low	$0.5151 - (0.0023 \times V_{eff})$
		Medium	$0.5687 - (0.0021 \times V_{eff})$
		High	$0.6147 - (0.0017 \times V_{eff})$
Instantaneous Electric Water Heater	<2 gal	Very Small	0.91
		Low	0.91
		Medium	0.91
		High	0.92

TABLE V.37—PROPOSED ENERGY CONSERVATION STANDARDS FOR CONSUMER WATER HEATERS—Continued

Product class	Effective storage volume and input rating* (if applicable)	Draw pattern	Uniform energy factor
	≥2 gal	Very Small	$0.8086 - (0.0050 \times V_{eff})$
		Low	$0.9123 - (0.0020 \times V_{eff})$
		Medium	$0.9252 - (0.0015 \times V_{eff})$
		High	$0.9350 - (0.0011 \times V_{eff})$
Grid-Enabled Water Heater	>75 gal	Very Small	$1.0136 - (0.0028 \times V_{eff})$
		Low	$0.9984 - (0.0014 \times V_{eff})$
		Medium	$0.9853 - (0.0010 \times V_{eff})$
		High	$0.9720 - (0.0007 \times V_{eff})$
Gas-fired Circulating Water Heater	≤200,000 Btu/h	Very Small	$0.8000 - (0.0011 \times V_{eff})$
		Low	$0.8100 - (0.0011 \times V_{eff})$
		Medium	$0.8100 - (0.0011 \times V_{eff})$
		High	$0.8100 - (0.0011 \times V_{eff})$
Oil-fired Circulating Water Heater	≤210,000 Btu/h	Very Small	$0.6100 - (0.0011 \times V_{eff})$
		Low	$0.6100 - (0.0011 \times V_{eff})$
		Medium	$0.6100 - (0.0011 \times V_{eff})$
		High	$0.6100 - (0.0011 \times V_{eff})$
Electric Circulating Water Heater	≤12 kW; for heat pump type units ≤24 A at ≤250 V	Very Small	$0.9100 - (0.0011 \times V_{eff})$
		Low	$0.9100 - (0.0011 \times V_{eff})$
		Medium	$0.9100 - (0.0011 \times V_{eff})$
		High	$0.9200 - (0.0011 \times V_{eff})$

* Effective storage volume is the representative value of storage volume as determined in accordance with the DOE test procedure at Appendix E to Subpart B of 10 CFR 430 and applicable sampling plans in 429.17.

As discussed in section IV.C.1.a.iii of this NOPR, DOE analyzed an additional efficiency level for gas-fired instantaneous water heaters as part of this proposed rule that was not analyzed in the preliminary analysis. This efficiency level, presented as EL 3 in this NOPR, generally corresponds to the ENERGY STAR specification version 5.0, which was released on July 18, 2022 and is effective since April 18, 2023. Though the proposed TSL 2 includes EL 2 for gas-fired instantaneous water heaters, DOE is also strongly considering an amended standard at EL 3 for instantaneous water heaters, which would increase the efficiency to an intermediate condensing level across all draw patterns. The Department's NOPR analysis shows that EL 3 for gas-fired instantaneous water heaters translates to an average LCC savings of $89 for consumers, with 29% of consumer experiencing a net cost. The cumulative NPV for consumers at this efficiency level is $2.6 billion using a 3-percent discount rate, and $0.8 billion using a 7-percent discount rate. EL 3 for gas-fired instantaneous water heaters also represents an energy savings of 0.7 quads, compared to the no-new-standards case. These additional benefits and savings from adopting an amended standard at EL 3 instead of EL 2 could be considered significant. DOE believes that manufacturers have experience with designing and producing GIWHs at EL 3, especially as the ENERGY STAR levels gain market share. DOE also understands that there will need to be significant increases in manufacturing capacity in order to meet current market demand for GIWHs. Therefore, DOE is specifically considering EL 3 for GIWHs in the final rule, but DOE understands this level was not chosen by the Joint Stakeholders as part of the recommended agreement submitted to DOE.

DOE requests additional information on the benefits and burdens of a potential amended standard for gas-fired instantaneous water heaters at EL 3, especially with respect to manufacturers being able to scale their entire production to EL 3 in the compliance time frame being considered by this rulemaking.

2. Annualized Benefits and Costs of the Proposed Standards

The annualized net benefit is (1) the annualized national economic value (expressed in 2022$) 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.38 shows the annualized values for consumer water heaters under TSL 2, expressed in 2022$. The results under the primary estimate are as follows.

Using a 7-percent discount rate for consumer benefits and costs and health benefits from reduced NO_X and SO_2 emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the standards proposed in this rule is $2,235 million per year in increased equipment costs, while the estimated annual benefits are $7,876 million in reduced equipment operating costs, $1,429 million in monetized climate benefits, and $1,805 million in monetized health benefits. In this case, the net monetized benefit would amount to $8,875 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the proposed standards is $2,420 million per year in increased equipment costs, while the estimated annual benefits are $11,357 million in reduced operating costs, $1,429 million in monetized climate benefits, and $2,798 million in monetized health benefits. In this case, the net monetized benefit would amount to $13,164 million per year.

TABLE V.38—ANNUALIZED MONETIZED BENEFITS AND COSTS OF PROPOSED ENERGY CONSERVATION STANDARDS FOR CONSUMER WATER HEATERS

[TSL 2]

	Billion 2022$/year		
	Primary estimate	Low-net-benefits estimate	High-net-benefits estimate
3% discount rate			
Consumer Operating Cost Savings	11.357	10.633	12.096
Climate Benefits *	1.429	1.412	1.446
Health Benefits **	2.798	2.764	2.832
Total Monetized Benefits †	15.584	14.809	16.374
Consumer Incremental Product Costs ‡	2.420	2.488	2.356
Net Monetized Benefits	13.164	12.321	14.018
Change in Producer Cashflow (INPV ††)	(0.021) − 0.017	(0.021) − 0.017	(0.021) − 0.017
7% discount rate			
Consumer Operating Cost Savings	7.876	7.380	8.382
Climate Benefits * (3% discount rate)	1.429	1.412	1.446
Health Benefits **	1.805	1.784	1.825
Total Monetized Benefits †	11.110	10.576	11.653
Consumer Incremental Product Costs ‡	2.235	2.290	2.183
Net Monetized Benefits	8.875	8.286	9.470
Change in Producer Cashflow (INPV ††)	(0.021) − 0.017	(0.021) − 0.017	(0.021) − 0.017

Note: This table presents the costs and benefits associated with consumer water heaters shipped in 2030–2059. These results include benefits to consumers which accrue after 2059 from the products shipped in 2030–2059. The Primary, Low Net Benefits, and High Net Benefits Estimates utilize projections of energy prices from the AEO2023 Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental equipment costs reflect a medium decline rate in the Primary Estimate, a low decline rate in the Low Net Benefits Estimate, and a high decline rate in the High Net Benefits Estimate. The methods used to derive projected price trends are explained in sections IV.F.1 and IV.F.4 of this document. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

* To monetize the benefits of reducing greenhouse gas emissions this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990* published in February 2021 by the Interagency Working Group on the Social Cost of Greenhouse Gases (IWG). 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.

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

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

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

†† Operating Cost Savings are calculated based on the life cycle costs analysis and national impact analysis as discussed in detail below. See sections IV.F and IV.H. DOE's NIA includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the product and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (the MIA). See section IV.J. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the industry net present value (INPV). The change in industry NPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. Change in INPV is calculated using the industry weighted average cost of capital value of 9.6% that is estimated in the manufacturer impact analysis (see chapter 12 of the NOPR TSD for a complete description of the industry weighted average cost of capital). For consumer water heaters, those values are −$21 million and $17 million. DOE accounts for that range of likely impacts in analyzing whether a TSL is economically justified. See section V.A. DOE is presenting the range of impacts to the industry net present value under two markup scenarios: the Preservation of Gross Margin scenario, which is the manufacturer markup scenario used in the calculation of Consumer Operating Cost Savings in this table, and the Preservation of Operating Profit Markup scenario, where DOE assumed manufacturers would not be able to increase per-unit operating profit in proportion to increases in manufacturer production costs. DOE includes the range of estimated INPV in the above table, drawing on the MIA explained further in Section IV.J, to provide additional context for assessing the estimated impacts of this proposal to society, including potential changes in production and consumption, which is consistent with OMB's Circular A–4 and E.O. 12866. If DOE were to include the industry net present value into the net benefit calculation for this proposed rule, the net benefits would range from $13.143 billion to $13.181 billion at 3-percent discount rate and range from $8.854 billion to $8.892 billion at 7-discount rate. DOE seeks comment on this approach.

C. Test Procedure Applicability

Manufacturers, including importers, must use product-specific certification templates to certify compliance to DOE. For consumer water heaters, the certification template reflects the general certification requirements specified at 10 CFR 429.12 and the product-specific requirements specified at 10 CFR 429.17. DOE is not proposing to amend the product-specific certification requirements for these products in this standards rulemaking.

As a result of the proposed standards in this NOPR, DOE is proposing further specificity around certain aspects of the appendix E test procedure to account for the impacts of potential new and amended standards on the distribution of products which would be available on the market as an outcome of a standards final rule. These updates are discussed in the following sections.

1. Efficiency Determinations Using High Temperature Testing

As discussed section III.B of this NOPR, the test procedure for consumer water heaters at appendix E (as amended by the June 2023 TP Final

Rule) includes provisions for high temperature testing of certain electric resistance storage water heaters (*i.e.,* setting the tank temperature to the highest temperature which allows the product to still deliver water at a nominal 125 °F with the use of a mixing valve). Until the compliance date of amended standards, manufacturers must use the normal temperature testing method for representations and compliance with the current energy conservation standards, with the high temperature test method being for optional additional representations only.

In the June 2023 TP Final Rule, DOE described how the high temperature test method would put products with the ability to increase effective storage volume through elevated storage temperatures on the same footing as products which have larger storage volumes—*i.e.,* to create an equivalent basis of comparison for products which can offer the same effective storage capacity. As discussed in that final rule, when standards were promulgated in the December 2016 Conversion Factor Final Rule requiring heat pump efficiencies for electric storage water heaters above 55 gallons of rated storage volume, DOE observed a market shift towards smaller electric storage water heater sizes where there the standards did not require heat pump technology. A new market began to emerge for consumers who still desired effective storage volumes above 55 gallons but did not want to install heat pump water heaters: electric resistance storage water heaters less than 55 gallons in rated storage volume with significantly higher effective storage volumes due to higher storage tank temperatures. 88 FR 40406, 40446.

DOE noted that it has recently become aware of products that are being marketed to consumers with ''capacity boosting'' capabilities which can avoid the need to install a larger storage-type water heater if used continuously in a high-temperature setting. The products are equipped with user-operable modes which set the water heater to boost the storage tank temperature and use a built-in mixing valve (or one installed at the point of manufacture) to automatically maintain the delivery temperature. For example, DOE noted in the June 2023 TP Final Rule that one manufacturer produces 30-, 40-, and 50-gallon water heaters with an ''X-High Setting'' claiming to provide the same amount of hot water (''Effective Capacity,'' as the manufacturer refers to it) as significantly larger water heaters with a more typical storage tank temperature of 125 °F—such as an 80-gallon capacity for the 50-gallon model, 64-gallon capacity for the 40-gallon model, and 48-gallon capacity for the 30-gallon model. Another manufacturer produces a 55-gallon water heater with a variety of settings allowing the user to get ''performance equivalency'' of a 65-, 80-, or 100-gallon tank, stating that the tank raises the temperature safely up to 170 °F. *Id.* In addition, DOE notes that most water heaters on the market today, including products without a specific ''capacity boosting'' mode, have a user-operable thermostat that can be adjusted to temperatures exceeding 125 °F. DOE believes consumers rarely modify their water heater temperature settings today. However, if additional hot water capacity were desired, a consumer could increase the thermostat setting on their water heater and use a mixing valve to temper the water to the desired outlet temperature while storing it at a much hotter temperature, similar to how the water heaters with a ''capacity boosting'' mode and mixing valve would operate.

As stated in the July 2022 TP SNOPR and the June 2023 TP Final Rule, consumers would be expected to use the high temperature mode on such water heaters as part of the regular operation of their water heater because consumers are electing to purchase the water heater based on its capacity boosting ability. Accordingly, for such products, DOE expected that a representative average use cycle would include some portion of time in high temperature mode. 87 FR 42270, 42279; 88 FR 40406, 40447. In particular, for electric resistance water heaters that can be permanently set at a high temperature to boost capacity, including water heaters with and without a specific capacity boosting mode (but not including water heaters that are set at a high temperature as part of a demand-response program), DOE believes that a representative average use cycle in the test procedure must encompass the ''capacity boosting'' capability as this is the mode that the consumer will likely be using once the water heater is installed in the field, as discussed later in this section.

In cases where a water heater has the ability to be permanently set to store water at a higher temperature than the delivered water temperature setpoint, households could purchase an undersized water heater and operate it continuously in a high-temperature mode or setting to provide sufficient hot water to the residence while using a smaller tank than would otherwise be required. DOE notes that the 40-gallon model and the 50-gallon models with a capacity boosting mode that were previously discussed are advertised by the manufacturer as being capable of providing effective capacities greater than 55 gallons, which is the volume threshold above which products must comply to heat pump-level energy conservation standards (see 10 CFR 430.32(d)).

However, until the June 2023 TP Final Rule, there did not exist a method which could capture the effect of storage capacity boosting in this manner. By implementing the high temperature test method for the subset of products that are expected to be operated this way in the field, DOE can now ensure that representations for such products are accurate and provide consumers with the means to directly compare these products to the larger water heaters they will likely compete with. Therefore, in this NOPR, DOE is proposing that certain electric storage-type water heaters would be required to use the high temperature test method for representations and compliance. The high temperature test method would apply only to certain electric storage water heaters, and DOE's reasoning for proposing only a subset to comply with this is outlined in the paragraphs that follow.

In this NOPR, DOE proposes not to amend the current standards for small electric storage water heaters. For these products, the standard is achievable with electric resistance heating elements and use of heat pump technology is not necessary. As shown in the market assessment (appendix 3A of the TSD), the most common rated storage volume for all other electric storage water heaters in the current market corresponds to a nominal volume of 40 gallons. Small electric storage water heaters are smaller than this current preferred capacity, thus, if some consumers that currently rely on 40-gallon water heaters choose to transition to smaller water heaters, DOE expects that there is a high likelihood that small electric storage water heaters would be installed at a higher temperature setpoint with a mixing valve (whether built-in or installed in the field) to achieve the same capacity as a 40-gallon water heater.

Further, in response to the March 2022 Preliminary Analysis, the CA IOUs stated that thermostatic mixing valves are relatively inexpensive, widely available, and required by the plumbing code in at least one state. The CA IOUs indicated that a water heater with a mixing valve can use a 3:1 ratio of 150 °F hot water to 60 °F cold water to achieve a 125 °F normal delivery temperature. The commenter stated that mixing valves can increase the water heater's effective FHR, such that an electric resistance model with a lower rated volume and a mixing valve installed can deliver the same amount of hot water as a model with a higher rated volume and no mixing valve. Thus, the CA IOUs expressed concern that electric resistance storage water heaters with mixing valves could claim a significant share of the market if DOE were to adopt a standard level allowing electric resistance technology for products larger than 30 gallons or in the medium or high draw patterns. (CA IOUs, No. 52 at p. 8) DOE notes that small electric storage water heaters would include some products above 30 gallons in the very small or low draw patterns.

Based on this information, DOE understands that if the proposed standards are ultimately adopted for electric storage water heaters, some consumers may choose to install smaller products (*i.e.,* models less than or equal to 35 gallons) that utilize electric resistance technology with a mixing valve and set the water heater at a higher tank temperature to increase capacity, rather than installing a water heater using heat pump technology with a larger volume. In response to the concerns raised by the CA IOUs, DOE investigated the theoretical effective volume increases that could result from a 35-gallon water heater being set to storage water at higher temperatures. DOE calculated the effective storage volume of a water heater with a rated storage volume of 35 gallons, at various mean tank temperatures, according to the effective storage volume calculation methodology established in the June 2023 TP Final Rule, assuming that the delivery temperature would be maintained at a normal range (120 °F ±5 °F). The results are shown in Table V.39.

TABLE V.39—EFFECTIVE STORAGE VOLUME OF A WATER HEATER WITH A 35-GALLON RATED STORAGE VOLUME AT VARIOUS MEAN TANK TEMPERATURES

Mean tank temperature (°F)	V_{eff} of water heater with 35-gallon V_r (gallons) *
125	35
130	** 38
135	*** 41
140	44
145	47
150	50
155	53
160	56
165	59
170	62

* V_{eff} is the effective storage volume. V_r is the rated storage volume.

** If the storage temperature is not greater than 130 °F, then the rated effective storage volume is equal to the rated storage volume. See section 6.3.1.1 of the appendix E test procedure. This was not applied when calculating V_{eff} in this table in order to clearly illustrate the impact of increasing the storage tank temperature.

*** If the proposed approach in this NOPR is finalized, a unit performing at 135 °F would not need to test per the high temperature test method, and thus it would be rated at an effective storage volume equal to rated storage volume also.

As stated before, DOE aims to ensure that the representations of UEF, FHR, and effective storage volume are accurate and reflective of the typical field application, and also provide a means of direct comparison between products which have the same effective capacities and cater to the same consumer needs. Based on the expectation that smaller electric resistance storage water heaters would be installed with mixing valves to compete with larger heat pump water heaters, high temperature testing is expected to be representative of typical average use cycle for these electric resistance storage water heaters. Hence, DOE has tentatively determined that the high temperature test method should apply to certain electric resistance storage water heaters that are capable of being operated in a permanent mode or setting that allows them to provide a larger effective stored volume capacity than their physical rated volume.

However, DOE notes that some electric resistance storage water heaters would be unlikely to be operated in a high temperature setting for an extended period of time, and for these water heaters DOE has tentatively determined that testing at a more typical temperature setpoint (125 °F ± 5 °F) is still representative of the average use cycle. These would include water heaters that are unable to heat and store water at a setpoint above 135 °F, water heaters that only temporarily raise the stored water temperature, and demand-response water heaters which only raise the stored water temperature in response to demand-response signals. For these types of electric resistance storage water heaters, DOE has tentatively determined that the high temperature test method would not produce results representative of an average use cycle. Therefore, DOE proposes that these types would be exempt from the high temperature test method.

Water heaters are commonly factory-set to a default setting of 120 °F by manufacturers in order to reduce the risk of scalding, and product literature for consumer water heaters typically includes warnings about the risk of scaling at setpoint temperatures above 125 °F. However, as discussed previously, most water heaters have user-operable thermostat control settings that allow the user to set the water heater to heat and store water at temperatures well above 125 °F. When the water heater is operated in such a manner, manufacturers recommend the installation of a mixing valve in order to temper the delivery water. Consumers may desire to raise the tank storage setpoint higher than 125 °F for a number of reasons. DOE found that manufacturers identified the following potential use cases for higher-temperature storage in their product literature: (1) increasing the hot water delivery capacity of the water heater, (2) operation with a clothes washer or dishwasher without its own heating element, or (3) to reduce bacterial growth in certain cases. The nominal setpoint temperature that is recommended for these types of applications is 140 °F. DOE is also aware that some jurisdictions may have plumbing codes which mandate a minimum temperature of 140 °F for storage-type water heaters and indirect-fired hot water storage tanks (along with the installation of ASSE 1017-conforming mixing valves).[176]

These findings indicate that the ability to increase the stored water temperature can provide consumer utility beyond simply increasing capacity (such as for households with dishwashers or clothes washers without heating elements, or for households needing to reduce potential for bacterial growth). However, as discussed previously, the ability to increase capacity by heating and storing water at an elevated temperature could result in some consumers choosing to install smaller products (*i.e.,* models less than or equal to 35 gallons) that utilize electric resistance technology with a mixing valve and set the water heater at a higher tank temperature to increase capacity, rather than installing a water heater using heat pump technology with a larger volume. As shown in Table V.39 storing water at 140 °F would increase the effective storage capacity of a 35-gallon tank to 44 gallons as compared to when the water is stored at 125 °F. DOE reasons that water heaters with the ability to heat and store water at higher temperatures are increasingly more likely to be used to replace larger water

[176] For example, the city of Nashua, NH has an ordinance requiring water heaters to be maintained at a minimum temperature of 140 °F and be equipped with a temperature-controlling device conforming to ASSE 1017. See: *https://www.nashuanh.gov/ArchiveCenter/ViewFile/Item/6680.*

heaters as the maximum setpoint temperature increases, making high temperature testing more representative for water heaters with higher maximum temperatures. However, DOE also seeks to avoid negatively impacting the product utility for consumers who find utility from heating water above 120 °F. DOE, therefore, proposes that water heaters not capable of storing water beyond 135 °F would not be subject to high temperature testing. DOE tentatively concludes that water heaters with a maximum setpoint temperature of 135 °F (or lower) would be less likely to be used in a high temperature mode for increasing capacity, such that testing in the normal temperature mode continues to be representative. In addition, DOE tentatively concludes that the ability to heat water up to 135 °F would not impact the utility of these products for consumers who desire hotter water for certain situations. Therefore, a maximum setpoint temperature of 135 °F provides balance between preserving utility and limiting the likelihood that the unit will be used permanently in a high temperature mode to avoid installing a larger water heater that may be subject to more stringent standards.

DOE requests comment on its proposal to exempt from high temperature testing any water heaters that cannot heat and store water above 135 °F. DOE is particularly interested in whether there would be any reduction in product utility if a water heater were to limit the maximum setpoint temperature to 135 °F.

Additionally, some electric resistance water heaters could offer high temperature modes that allow for setpoints above the intended delivery temperature to boost delivery capacity, but only temporarily before automatically reverting to the normal temperature mode. This contrasts with several models that are currently available, which remain in the high temperature setting until the consumer changes the mode or setting to deactivate the high temperature mode. Temporary modes would be intended for occasional use in situations in which there is a short-term increased demand for hot water, while non-temporary modes would be more likely to be used long-term. In the June 2023 TP Final Rule, DOE discussed comments it received from stakeholders regarding water heaters with high temperature modes. Specifically, stakeholders indicated that high temperature modes are not intended to be the primary mode of operation and should not be used continuously, and that testing in these modes would not reflect their intended use. 88 FR 40406, 40449.

DOE understands that temporary high temperature modes would be unlikely to be used long-term because they would automatically return the setpoint to a more typical temperature after a certain period of time has elapsed. Because these temporary modes cannot be used permanently, DOE has tentatively determined that units capable of storing water at a setpoint above 135 °F only through a temporary, consumer-initiated, high temperature mode lasting no longer than 120 hours should not be subject to high temperature testing. DOE expects that such products would operate in non-high temperature modes for the majority of the time and therefore testing in the high temperature mode would not be representative. DOE is proposing to limit the high temperature mode duration to 120 hours as a reasonable amount of time that demand may be temporarily higher than normal (such as when guests are visiting). Further, DOE expects that models with permanent high temperature modes, whether shipped from the factory with that mode as the default mode or simply as a user-selectable mode, would be likely to be used continuously in the high temperature mode. Therefore, DOE tentatively concludes it is representative to test such water heaters in the high temperature modes and is proposing to require such testing.

Additionally, in the June 2023 TP Final Rule, DOE discussed how demand-response water heaters can undergo periods of high-temperature water storage in response to utility grid signals (*i.e.,* advanced load-up). In the rulemaking stages prior to the publication of the June 2023 TP Final Rule, DOE had initially proposed that demand-response water heaters would not be subject to high temperature testing, because the additional energy consumption from high-temperature water storage is compensated for by periods of water heater inactivity (*i.e.,* a curtailment period). As such, demand-response water heaters do not engage in high-temperature water storage in order to directly increase capacity over a representative average use cycle of 24 hours. 88 FR 40406, 40449. For these reasons, DOE continues to find it appropriate to exempt from high temperature testing any water heaters that can only heat and store water at temperatures above 135 °F in response to instructions received from a utility or third-party demand-response program.

DOE is proposing to amend 10 CFR 429.17(a) to add a requirement that representations for all electric storage water heaters that are capable of heating and storing water above 135 °F, except for those that meet the definition of "heat pump-type" water heater,[177] those that are only capable of heating and storing water above 135 °F temporarily, or those that that are only capable of heating the stored water above 135 °F in response to instructions received from a utility or third-party demand-response program, shall be tested using the high temperature testing method presented in section 5.1.2 of the appendix E test procedure, as amended by the June 2023 TP Final Rule. Water heaters that are only capable of heating and storing water above 135 °F temporarily or are capable of heating the stored water above 135 °F only in response to instructions received from a utility or third-party demand-response program are exempt from this requirement. As a result, the UEF, delivery capacity (either FHR or maximum GPM), and effective storage volume for electric resistance storage water heaters (specifically those which allow the user to increase the storage tank temperature) would be determined in accordance with the highest tank temperature setting available on the water heater with a mixing valve installed. The applicable standard would then be based on the effective storage volume as determined during testing. For example if high temperature testing yields a delivery capacity corresponding to either the low draw pattern or the very small draw pattern and the effective storage volume does not exceed 35 gallons, then the standard for the small electric storage water heater class, which can be met using electric resistance heating elements, would apply to the water heater. However, if high temperature testing results in the water heater model being in the medium or high draw pattern, or if the effective storage volume goes above 35 gallons, then the standards for the appropriate class based on the test results, which currently can only be met through use of heat pump technology, would apply to the water heater.

DOE requests feedback on its tentative determination that high temperature testing should be used for electric resistance storage water heaters that offer the user the ability to increase the storage tank temperature permanently

[177] The definition of "water heater" at 10 CFR 430.2 specifies heat pump type units have a maximum current rating of 24 amperes at a voltage no greater than 250 volts, and are products designed to transfer thermal energy from one temperature level to a higher temperature level for the purpose of heating water, including all ancillary equipment such as fans, storage tanks, pumps, or controls necessary for the device to perform its function.

beyond a setpoint of 135 °F. DOE also requests feedback on its proposal to exempt from high temperature testing any water heaters that cannot heat and store water above 135 °F, or that can only do so temporarily for a period of 120-hour or less before returning to the normal operating mode, or that can only do so in response to instructions received from a utility or third-party demand-response program.

2. Circulating Water Heaters

a. Storage Tank for Circulating Heat Pump Water Heaters

In the June 2023 TP Final Rule, DOE established provisions in section 4.10 requiring circulating heat pump water heaters to be tested in a pairing with a 40-gallon (±5 gallons) electric storage water heater in the medium draw pattern that has a UEF rating equal to the minimum UEF required at 10 CFR 430.32(d) rounded to the nearest 0.01. 88 FR 40406, 40467. This test procedure provision was developed with feedback from stakeholders stating that an electric resistance storage water heater is the most likely type of tank that is paired with circulating heat pump water heaters in the field. DOE further surmises that it is unlikely for consumers to pair a circulating heat pump water heater with an integrated heat pump water heater because they would already receive the energy-saving benefits of the integrated heat pump water heater. The specifications of the electric storage water heater at section 4.10 reflect a baseline electric storage water heater in the most prevalent size.

However, such an electric storage water heater would not comply with the proposed standards in this NOPR because products in the medium draw pattern would be required to meet UEF levels only achievable by heat pump technology. To address this, DOE is proposing to amend section 4.10 of the appendix E test procedure to instead require the separate storage tank to be a minimally-compliant electric storage water heater that is 30 gallons ±5 gallons and in the low draw pattern to reflect the products which would remain using electric resistance heating as a result of the proposed standards.

DOE requests feedback on the proposed separate storage tank requirements for circulating heat pump water heaters.

b. Product-Specific Enforcement Provisions for Circulating Water Heaters

As discussed in section III.B of this document, the June 2023 TP Final Rule updated the test method for consumer water heaters to provide additional instructions for testing circulating water heaters and low-temperature water heaters for UEF, which includes testing with a separate tank. 88 FR 40406. The June 2023 TP Final Rule requires circulating water heaters to comply with new test procedure once amended energy conservation standards are adopted and this NOPR proposes to amend the energy conservation standards for these products to account for the changes to the test method. Because the separate storage tank used for testing to determine the FHR and UEF ratings is not part of the basic model number of the circulating water heater, DOE is proposing product-specific enforcement provisions to delineate the steps that the Department would take to perform testing on a circulating water heater. As discussed in the paragraphs that follow, DOE intends to test circulating water heaters with a tank that is as close as possible to the tank which was used for the certification rating.

First, DOE proposes that the effective storage volume of the circulating water heater would be determined during the assessment or enforcement test so that, in the case wherein DOE cannot acquire the exact tank which was paired for the circulating water heater's rating, compliance with standards would be assessed on the basis of the tank used during assessment or enforcement testing.

Second, DOE proposes that, if the manufacturer of the circulating water heater certifies the tank that was used to determine the circulating water heater's ratings, the Department would use the same model of electric storage water heater or unfired hot water storage tank as a first step. If this is not possible (*e.g.,* if that tank model is discontinued or otherwise unavailable), DOE proposes to test with as similar a tank as possible.

Specifically, for heat pump circulating water heaters, DOE proposes to use another eligible electric storage water heater with a rated storage volume that is within ±3 gallons of the rated storage volume of the electric storage water heater used to determine the certified ratings of the electric heat pump circulating water heater. If that is not possible, DOE proposes to use another eligible electric storage water heater.

For all other circulating water heaters (which would be tested with unfired hot water storage tanks), DOE proposes to use another eligible unfired hot water storage tank from the same tank manufacturer with the same storage volume. If one is not available from that tank manufacturer, DOE would next attempt to find a tank with the same volume and R-value from another tank manufacturer. If that is not successful, DOE proposes to test with an eligible tank from the original tank manufacturer, but with a volume that is within ±5 gallons of the original tank. Should that also not be feasible, the Department proposes that it would use such a tank from a different tank manufacturer. Lastly, if there are still no unfired hot water storage tanks which meet these descriptions, DOE proposes to test the circulating water heater with another eligible unfired hot water storage tank (having a certified storage volume between 80 gallons and 120 gallons and with a certified R-value that meets but does not exceed the standard set at 10 CFR 431.110(a)).

DOE requests feedback on the proposed product-specific enforcement provisions for circulating water heaters.

3. Determination of Storage Volume for Water Heaters Less Than 2 Gallons

This NOPR proposes to establish new UEF-based standards for electric and gas storage-type water heaters with less than 20 gallons of effective storage volume. In its market assessment (see chapter 3 of the TSD), DOE has found models of consumer electric storage-type water heaters which are less than 2 gallons in nominal volume. In order for manufacturers to determine compliance for these products, the test procedure must include provisions for calculating the rated storage volume and effective storage volume.

The current method to determine storage tank volume in the appendix E test procedure, as amended by the June 2023 TP Final Rule, states:

For water heaters with a rated storage volume greater than or equal to 2 gallons and for separate storage tanks used for testing circulating water heaters, determine the storage capacity, of the water heater or separate storage tank under test, in gallons (liters), by subtracting the tare weight from the gross weight of the storage tank when completely filled with water at the supply water temperature specified in section 2.3.

(*See* section 5.2.1 of the amended appendix E test procedure); 88 FR 40406, 40478.

However, this method does not explicitly cover storage-type water heaters less than 2 gallons which will be covered under the proposed new UEF-based standards. Therefore, in this NOPR, DOE is proposing to amend section 5.2.1 such that it is applicable to water heaters of all volumes and not restricted to only products greater than or equal to 2 gallons.

VI. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866, 13563 and 14094

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

Section 6(a) of E.O. 12866 also requires agencies to submit ''significant regulatory actions'' to OIRA for review. OIRA has determined that this 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 proposed 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 rulemaking.

For manufacturers of consumer water heaters, the SBA has set a size threshold, which defines those entities classified as ''small businesses'' for the purposes of the statute. DOE used the SBA's small business size standards to determine whether any small entities would be subject to the requirements of the rule. (*See* 13 CFR part 121.) The size standards are listed by North American Industry Classification System (''NAICS'') code and industry description and are available at *www.sba.gov/document/support--table-size-standards*. Manufacturing of consumer water heaters 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

EPCA prescribed energy conservation standards for consumer water heaters (42 U.S.C. 6295(e)(1)), and directed DOE to conduct two cycles of rulemakings [178] to determine whether to amend these standards. (42 U.S.C. 6295(e)(4)) 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))

2. Objectives of, and Legal Basis for, Rule

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

3. Description on Estimated Number of Small Entities Regulated

To estimate the number of companies that could be small business manufacturers of products covered by this proposed rulemaking, DOE conducted a market survey using public information and subscription-based company reports to identify potential small manufacturers. DOE's research involved DOE's Compliance Certification Database (''CCD''),[179] AHRI's Directory of Certified Product Performance,[180] individual company websites, and market research tools

[178] DOE completed the first of these rulemaking cycles on January 17, 2001, by publishing in the **Federal Register** a final rule amending the energy conservation standards for consumer water heaters. 66 FR 4474. Subsequently, DOE completed the second rulemaking cycle to amend the standards for consumer water heaters by publishing a final rule in the **Federal Register** on April 16, 2010. 75 FR 20112.

[179] U.S. Department of Energy's Compliance Certification Database is available at *regulations.doe.gov/certification-data* (last accessed April 1, 2023).

[180] AHRI's Directory of Certified Product Performance is available at *https://www.ahridirectory.org/Search/SearchHome?ReturnUrl=%2f* (last accessed April 1, 2023).

[56] The Dun & Bradstreet subscription login is available at *app.dnbhoovers.com.*

(*e.g.,* reports from Dun & Bradstreet [56]) to create a list of companies that manufacture, produce, import, or assemble the products covered by this rulemaking. DOE also asked stakeholders and industry representatives if they were aware of any other small manufacturers during manufacturer interviews and at DOE public meetings.

DOE identified 22 OEMs of consumer water heaters sold in the United States. Of the twenty-two OEMs, DOE identified 2 small, domestic manufacturers affected by proposed amended standards for gas-fired storage water heater, oil-fired storage water heater, or electric storage water heater products. The first small businesses is an OEM of oil-fired storage water heaters. The second small business is an OEM of electric storage water heaters.

DOE requests comment the number of small, domestic OEMs in the industry.

4. Description and Estimate of Compliance Requirements Including Differences in Cost, if Any, for Different Groups of Small Entities

The first small businesses is an OEM that certifies 3 models of oil-fired storage water heaters. One of the three models would meet the proposed standard. Given the small and shrinking market for oil-fired storage water heaters, DOE does not expect the small manufacturer would redesign non-compliant models. Rather, the company would likely reduce their range of model offerings. At this point in time, DOE does not anticipate significant conversion costs but does solicit input.

DOE requests comments on the potential impacts of the proposed standard on small business manufacturing of oil-fired storage water heaters, including the extent of model redesign and manufacturing lines changes necessitated by standards.

The second small business is an OEM that certifies nine models of electric storage water heaters. The company offers two small ESWHs, four electric storage water heaters with an effective storage volume greater than or equal to 20 gallons and less than or equal to 55 gallons, and three ESWHs with effective storage volumes above 55 gallons. The two small ESWH models would not require redesign. Three non-small ESWHs would not meet the proposed standard, while one of the four non-small ESWHs is a heat pump that would require minimal redesign to meet the proposed standard. DOE expects the company would expand heat pump offering rather than redesign the electric resistance products that do not meet the proposed standard. The company offers three ESWHs with effective volumes above 55 gallons. All three of these are heat pumps but do not meet the proposed standard. After reviewing the three ESWHs with effective volumes above 55 gallons, DOE believes the three models could be updated to meet the proposed standard. In total, the company would need to redesign up to seven models.

DOE assumed the company would need to invest the equivalent to one year of all consumer water heater R&D resources to update its product lines. DOE does not anticipate significant capital conversion costs, as the company offers a broad line of heat pump ESWHs today. DOE estimates total conversion costs to be $200,000 for the small manufacturer. Based on market research tools, DOE estimated the company's annual revenue to be $10 million. Taking into account the five-year conversion period, DOE expects conversion costs to be less than 1% of conversion period revenue.

DOE requests comments on the potential impacts of the proposed standard on small business manufacturing of electric storage water heaters, including the extent of model redesign and manufacturing lines changes necessitated by standards.

Finally, DOE has tentatively determined that there are no small business manufacturers of consumer water heaters which currently have EF-based standards and are being transitioned to the UEF metric as proposed in this NOPR.

DOE requests information on whether any small businesses would be impacted by the new requirements to determine UEF ratings for consumer water heaters that have new UEF-based standards proposed in this rulemaking.

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 2. In reviewing alternatives to the proposed rule, DOE examined energy conservation standards set at lower efficiency levels. While TSL 1 would reduce the impacts on small business manufacturers, it would come at the expense of a reduction in energy savings. TSL 1 achieves 97 percent lower energy savings compared to the energy savings at TSL 2.

Based on the presented discussion, establishing standards at TSL 2 balances the benefits of the energy savings with the potential burdens placed on consumer water heater 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

Manufacturers of consumer water heaters must certify to DOE that their products comply with any applicable energy conservation standards. In certifying compliance, manufacturers must test their products according to the DOE test procedures for consumer water heaters, including any amendments adopted for those test procedures. DOE has established regulations for the certification and recordkeeping requirements for all covered consumer products and commercial equipment, including consumer water heaters. (*See generally* 10 CFR part 429). The collection-of-information requirement for the certification and recordkeeping is subject to review and approval by OMB under the Paperwork Reduction Act (''PRA''). This requirement has been approved by OMB under OMB control number 1910–1400. Public reporting burden for the certification is estimated to average 35 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

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

D. Review Under the National Environmental Policy Act of 1969

DOE is analyzing this proposed regulation in accordance with the National Environmental Policy Act of 1969 (''NEPA'') and DOE's NEPA implementing regulations (10 CFR part 1021). DOE's regulations include a categorical exclusion for rulemakings that establish energy conservation standards for consumer products or industrial 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. Public Law 104–4, section 201 (codified at 2 U.S.C. 1531). For a proposed regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a proposed ''significant intergovernmental mandate,'' and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect them. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820. DOE's policy statement is also available at *www.energy.gov/sites/prod/files/gcprod/documents/umra_97.pdf*.

Although this proposed rule does not contain a Federal intergovernmental mandate, it may require expenditures of $100 million or more in any one year by the private sector. Such expenditures may include: (1) investment in research and development and in capital expenditures by consumer water heaters 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 consumer water heaters, 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 consumer water heaters that are designed to achieve the maximum improvement in energy efficiency that DOE has determined to be both technologically feasible and economically justified, as required by 6295(o)(2)(A) and 6295(o)(3)(B). A full discussion of the alternatives considered by DOE is presented in chapter 17 of the TSD for this proposed rule.

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

Section 654 of the Treasury and General Government Appropriations Act, 1999 (Pub. L. 105–277) requires Federal agencies to issue a Family Policymaking Assessment for any rule that may affect family well-being. This 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 consumer water heaters, 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.[181] Generation of this report involved a rigorous, formal, and documented evaluation using objective criteria and qualified and independent reviewers to make a judgment as to the technical/scientific/business merit, the actual or anticipated results, and the productivity and management effectiveness of programs and/or projects. Because available data, models, and technological understanding have changed since 2007, DOE has engaged with the National Academy of Sciences to review DOE's analytical methodologies to ascertain whether modifications are needed to improve the Department's analyses. DOE is in the process of evaluating the resulting report.[182]

VII. Public Participation

A. Attendance at the Public Meeting

The time and date of the public meeting webinar 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 *www.energy.gov/eere/buildings/public-meetings-and-comment-deadlines*. 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 plans to present a prepared general statement may request that copies of his or her statement be made available at the public meeting. Such persons may submit requests, along with an advance electronic copy of their statement in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format, to the appropriate address shown in the **ADDRESSES** section at the beginning of this document. The request and advance copy of statements must be received at least one week before the public meeting and are to be emailed. Please include a telephone number to enable DOE staff to make follow-up contact, if needed.

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[181] 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 April 1, 2023).

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

C. Conduct of the Public Meeting Webinar

DOE will designate a DOE official to preside at the public meeting webinar and may also use a professional facilitator to aid discussion. The webinar 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 public meeting. 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 public meeting webinar, interested parties may submit further comments on the proceedings, as well as on any aspect of the rulemaking, until the end of the comment period.

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

A transcript of the public meeting 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* web page will require you to provide your name and contact information. Your contact information will be viewable to DOE Building Technologies staff only. Your contact information will not be publicly viewable except for your first and last names, organization name (if any), and submitter representative name (if any). If your comment is not processed properly because of technical difficulties, DOE will use this information to contact you. If DOE cannot read your comment due to technical difficulties and cannot contact you for clarification, DOE may not be able to consider your comment.

However, your contact information will be publicly viewable if you include it in the comment itself or in any documents attached to your comment. Any information that you do not want to be publicly viewable should not be included in your comment, nor in any document attached to your comment. Otherwise, persons viewing comments will see only first and last names, organization names, correspondence containing comments, and any documents submitted with the comments.

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

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

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

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

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

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

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

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

E. Issues on Which DOE Seeks Comment

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

(1) DOE requests comment on the methodology used to present the change in producer cashflow (INPV) in the monetized benefits and cost tables (I.3, I.4, and V.38 of this document).

(2) DOE requests comment on its proposed deferral of consideration of amended, more-stringent standards for circulating water heaters.

(3) DOE requests comment on its proposal to limit the tabletop water heater designation to products in the very small and low draw patterns.

(4) DOE requests comment on the outlook for the emergence of 120 V heat pump water heaters, information regarding how their design and operation may differ from 240 V heat pump water heaters, and data on performance characteristics and efficiencies.

(5) DOE seeks further information that would assist in potentially re-evaluating the stringency of EL 2, especially data regarding the technologies employed in 45-gallon medium draw pattern products at a UEF of 3.50.

(6) DOE requests comment on the potential design specifications, manufacturing processes, and efficiencies of split-system heat pump water heaters.

(7) DOE requests comment on the analysis assumptions used to estimate shipping costs for consumer water heaters.

(8) DOE requests comment on the cost-efficiency results in this engineering analysis.

(9) DOE requests comment on the analytical approach used to determine equivalent baseline standards for circulating water heaters.

(10) DOE seeks comment from interested parties regarding the appropriateness of the converted UEF-based standards presented in Table IV.30 and whether products on the market can meet or exceed the proposed levels. If products are found to generally exceed the proposed levels, the Department requests information and data on the UEF of products within these product classes.

(11) DOE seeks comments about DOE's approach for distribution channels and markup values.

(12) DOE requests comments on its approach for taking into account electrification efforts in its shipments analysis.

(13) DOE requests comments on its approach for developing efficiency trends after 2030.

(14) DOE requests comments on its approach and value of the rebound effect for consumer water heaters.

(15) DOE requests comments on its approach for product price projections.

(16) DOE requests comments on its approach to monetizing the impact of the rebound effect.

(17) DOE requests comments on its approach to estimate low-income consumer impacts for higher efficiency standards.

(18) DOE requests comment on the ability of manufacturers to transition to producing heat pump water heaters within the compliance window.

(19) DOE requests comment on the pace at which workforce development is expected to install and service the heat pump water heater market by the compliance date of the standards.

(20) DOE requests additional information on the benefits and burdens of a potential amended standard for gas-fired instantaneous water heaters at EL 3, especially with respect to impacts to manufacturers of these products and the ability for industry to convert to this efficiency level as being potential burdens to adopting EL 3.

(21) DOE requests feedback on its tentative determination that high temperature testing is only representative of an average 24-hour use cycle for electric resistance storage water heaters that offer the user the ability to increase the storage tank temperature.

(22) DOE requests feedback on the proposed separate storage tank requirements for circulating heat pump water heaters.

(23) DOE requests feedback on the proposed product-specific enforcement provisions for circulating water heaters.

(24) DOE requests comments on the potential impacts of the proposed standard on small business manufacturing of oil-fired storage water heaters, including the extent of model redesign and manufacturing lines changes necessitated by standards.

(25) DOE requests comments on the potential impacts of the proposed standard on small business manufacturing of electric storage water heaters, including the extent of model redesign and manufacturing lines changes necessitated by standards.

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

10 CFR Part 429

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

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 July 13, 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 July 14, 2023.

Treena V. Garrett,

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

For the reasons set forth in the preamble, DOE proposes to amend parts 429 and 430 of chapter II, subchapter D, of title 10 of the Code of Federal Regulations, as set forth below:

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

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

Authority: 42 U.S.C. 6291–6317; 28 U.S.C. 2461 note.

■ 2. Amend § 429.17 by adding paragraph (a)(1)(ii)(E) to read as follows:

§ 429.17 Water heaters.

(a) * * *

(1) * * *

(ii) * * *

(E) For an electric storage water heater that has a permanent mode or setting in which it is capable of heating and storing water above 135 °F, where permanent mode or setting means a mode of operation that is continuous and does not require any external consumer intervention to maintain for longer than 120 hours, except for those that meet the definition of ''heat pump-type'' water heater at 10 CFR 430.2 or that are only capable of heating the stored water above 135 °F in response to instructions received from a utility or third-party demand-response program, the following applies:

(1) To demonstrate compliance with the energy conservation standards in 430.32(d)(1), any represented value of uniform energy factor shall be determined based on testing in accordance with section 5.1.1 of appendix E of subpart B to 10 CFR part 430.

(2) To demonstrate compliance with the energy conservation standards in § 430.32(d)(2), any represented value of uniform energy factor shall be determined based on high temperature testing in accordance with section 5.1.2 of appendix E of subpart B to 10 CFR part 430.

* * * * *

■ 3. Amend § 429.134 by adding paragraph (d)(4) to read as follows:

§ 429.134 Product-specific enforcement provisions.

* * * * *

(d) * * *

(4) *Circulating water heaters.* A storage tank for testing will be selected as described in paragraphs (i) and (ii). The effective storage volume of the circulating water heater determined in testing will be measured in accordance with appendix E to subpart B of 10 CFR part 430 with the storage tank that is used for testing.

(i) *Electric heat pump circulating water heaters.* For UEF and first-hour rating testing, electric heat pump circulating water heaters will be tested with a minimally-compliant electric storage water heater (as defined at 10 CFR 430.2) that has a rated storage volume of between 25 and 35 gallons, and is in the low draw pattern, as determined in accordance with appendix E to subpart B of 10 CFR part 430 and the standards set at 10 CFR 430.32(d). If the manufacturer certifies the specific model of electric storage water heater used for testing to determine the certified UEF and first-hour rating of the electric heat pump circulating water heater, that model of electric storage water heater will be used for testing. If this is not possible (such as if the electric storage water heater model is no longer available or has been discontinued), testing will be performed with an electric storage water heater that has a minimally-compliant UEF rating, in the low draw pattern, and a rated storage volume that is within ± 3 gallons of the rated storage volume of the electric storage water heater used to determine the certified ratings of the electric heat pump circulating water heater (but not less than 25 gallons and not greater than 35 gallons). If no such model is available, then testing will be performed with a minimally-compliant electric storage water heater that has a rated storage volume of between 25 and 35 gallons and is in the low draw pattern.

(ii) *All other circulating water heaters.* For UEF and first-hour rating testing, circulating water heaters are paired with unfired hot water storage tanks (''UFHWSTs'') that have certified storage volumes between 80 and 120 gallons and are at exactly the minimum thermal insulation standard, in terms of R-value, for UFHWSTs, as per the standards set at 10 CFR 431.110(a). Testing will be performed as follows:

(A) If the manufacturer certifies the specific model of UFHWST used for testing to determine the certified UEF and first-hour rating of the circulating water heater, that model of UFHWST will be used for testing.

(B) If it is not possible to perform testing with the same model of UFHWST certified by the manufacturer, testing will be carried out with a different model of UFHWST accordingly:

(*1*) Testing will be performed with an UFHWST from the same manufacturer as the certified UFHWST, with the same certified storage volume as the certified UFHWST, and with a certified R-value that meets but does not exceed the standard set at 10 CFR 431.110(a). If this is not possible,

(*2*) Testing will be performed with an UFHWST from a different manufacturer than the certified UFHWST, with the same certified storage volume as the certified UFHWST, and with a certified R-value that meets but does not exceed the standard set at 10 CFR 431.110(a). If this is not possible,

(*3*) Testing will be performed with an UFHWST from the same manufacturer as the certified UFHWST, having a certified storage volume within ±5 gallons of the certified UFHWST, and with a certified R-value that meets but does not exceed the standard set at 10 CFR 431.110(a). If this is not possible,

(*4*) Testing will be performed with an UFHWST from a different manufacturer than the certified UFHWST, having a certified storage volume within ±5 gallons of the certified UFHWST, and with a certified R-value that meets but does not exceed the standard set at 10 CFR 431.110(a). If this is not possible,

(*5*) Testing will be performed with an UFHWST having a certified storage volume between 80 gallons and 120 gallons and with a certified R-value that meets but does not exceed the standard set at 10 CFR 431.110(a).

* * * * *

PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

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

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

■ 5. Amend § 430.2 by:

■ a. Adding the definitions in alphabetical order of ''Electric circulating water heater'', ''Gas-fired circulating water heater'', and ''Oil-fired circulating water heater''; and

■ b. Revising the definition of ''Tabletop water heater''.

The revision and additions read as follows:

§ 430.2 Definitions.

* * * * *

Electric circulating water heater means a circulating water heater with an input of 12 kW or less; contains no more than one gallon of water per 4,000 Btu/h of input (including heat pump-only units with power inputs of no more than 24 A at 250 V).

* * * * *

Gas-fired circulating water heater means a circulating water heater with a nominal input of 200,000 Btu/h or less; contains no more than one gallon of water per 4,000 Btu/h of input.

* * * * *

Oil-fired circulating water heater means a circulating water heater with a nominal input of 210,000 Btu/h or less; contains no more than one gallon of water per 4,000 Btu/h of input.

* * * * *

Tabletop water heater means a water heater in a rectangular box enclosure designed to slide into a kitchen countertop space with typical dimensions of 36 inches high, 25 inches deep, and 24 inches wide, and with a certified first-hour rating that results in either the very small draw pattern or the low draw pattern, as specified in Table I at appendix E to this subpart.

* * * * *

■ 6. Amend § 430.23 by revising paragraph (e) to read as follows:

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

* * * * *

(e) *Water heaters.*

(1) The estimated annual operating cost is calculated as:

(i) For a gas-fired or oil-fired water heater, the sum of: The product of the annual gas or oil energy consumption, determined according to section 6.3.11 or section 6.4.7 of appendix E of this subpart, times the representative average unit cost of gas or oil, as appropriate, in dollars per Btu as provided by the Secretary; plus the product of the annual electric energy consumption, determined according to section 6.3.10 or section 6.4.6 of appendix E of this subpart, times the representative average unit cost of electricity in dollars per kilowatt-hour as provided by the Secretary. Round the resulting sum to the nearest dollar per year.

(ii) For an electric water heater, the product of the annual energy consumption, determined according to section 6.3.10 or 6.4.6 of appendix E of this subpart, times the representative average unit cost of electricity in dollars per kilowatt-hour as provided by the Secretary. Round the resulting product to the nearest dollar per year.

(2) For an individual unit, the uniform energy factor is rounded to the nearest 0.01 and determined in accordance with section 6.3.8 or section 6.4.4 of appendix E of this subpart.

* * * * *

■ 7. Appendix E to subpart B of part 430 is amended by revising the Note, sections 4.10, 5.1.2 and 5.2.1 to read as follows:

Appendix E To Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Water Heaters

Note: Prior to December 18, 2023, representations with respect to the energy use or efficiency of consumer water heaters covered by this test method, including compliance certifications, must be based on testing conducted in accordance with either this appendix as it now appears or appendix E as it appeared at 10 CFR part 430, subpart B revised as of January 1, 2021. Prior to June 15, 2024, representations with respect to the energy use or efficiency of residential-duty commercial water heaters covered by this test method, including compliance certifications, must be based on testing conducted in accordance with either this appendix as it now appears or appendix E as it appeared at 10 CFR part 430, subpart B revised as of January 1, 2021.

On and after December 18, 2023, representations with respect to energy use or efficiency of consumer water heaters covered by this test method, including compliance certifications, must be based on testing conducted in accordance with this appendix, except as described in the paragraphs that follow. On and after June 15, 2024, representations with respect to energy use or efficiency of residential-duty commercial water heaters covered by this test method, including compliance certifications, must be based on testing conducted in accordance with this appendix, except as follows.

Prior to [*date 5 years after date of publication of the final rule in the* **Federal Register**], consumer water heaters subject to section 4.10 of this appendix may optionally apply the requirements of section 4.10 of this appendix. For residential-duty commercial water heaters subject to section 4.10 of this appendix the requirements of section 4.10 of this appendix may optionally be applied prior to the compliance date of any final rule reviewing potential amended energy conservation standards for this equipment published after June 21, 2023.

Prior to [*date 5 years after date of publication of the final rule in the* **Federal Register**], consumer water heaters subject to section 5.1.2 of this appendix (as specified at 10 CFR 429.17(a)(1)(ii)(E)) may optionally apply the requirements of section 5.1.2 of this appendix in lieu of the requirements in section 5.1.1 of this appendix.

On or after [*date 5 years after date of publication of the final rule in the* **Federal Register**], representations with respect to energy use or efficiency of consumer water heaters subject to sections 4.10 and section 5.1.2 of this appendix must be based on testing conducted in accordance with those provisions.

* * * * *

4.10 *Storage Tank Requirement for Circulating Water Heaters.* On or after the compliance date of a final rule reviewing potential amended energy conservation standards for these products published after June 21, 2023, when testing a gas-fired, oil-fired, or electric resistance circulating water heater (*i.e.,* any circulating water heater that does not use a heat pump), the tank to be used for testing shall be an unfired hot water storage tank having volume between 80 and 120 gallons (364–546 liters) determined using the method specified in section 5.2.1 that meets but does not exceed the minimum energy conservation standards required according to 10 CFR 431.110. When testing a heat pump circulating water heater, the tank to be used for testing shall be an electric storage water heater that has a measured volume of 30 gallons (±5 gallons), has a First-Hour Rating greater than or equal to 18 gallons and less than 51 gallons resulting in classification under the low draw pattern, and has a rated UEF equal to the minimum UEF standard specified at 10 CFR 430.32(d), rounded to the nearest 0.01. If the circulating water heater is supplied with a separate non-integrated circulating pump, install this pump as per the manufacturer's installation instructions and include its power consumption in energy use measurements.

* * * * *

5. * * *

5.1.2 *High Temperature Testing.* This paragraph applies to electric storage water heaters that have a permanent mode or setting in which the water heater is capable of heating and storing water above 135 °F, where permanent mode or setting means a mode of operation that is continuous and does not require any external consumer intervention to maintain for longer than 120 hours, except for those that meet the definition of ''heat pump-type'' water heater at 10 CFR 430.2 or that are only capable of heating the stored water above 135 °F in response to instructions received from a utility or third-party demand-response program.

For those equipped with factory-installed or built-in mixing valves, set the unit to maintain the highest mean tank temperature possible while delivering water at 125 °F ±5 °F. For those not so equipped, install an ASSE 1017-certified mixing valve in accordance with the provisions in section 4.3 and adjust the valve to deliver water at 125 °F ±5 °F when the water heater is operating at its highest storage tank temperature setpoint. Maintain this setting throughout the entirety of the test.

5.2 * * *

5.2.1 *Determination of Storage Tank Volume.* For water heaters and separate storage tanks used for testing circulating water heaters, determine the storage capacity, V_{st}, of the water heater or separate storage tank under test, in gallons (liters), by subtracting the tare weight, W_t, (measured while the tank is empty) from the gross weight of the storage tank when completely filled with water at the supply water temperature specified in section 2.3 of this appendix, W_f, (with all air eliminated and line pressure applied as described in section 2.6 of this appendix) and dividing the resulting net weight by the density of water at the measured temperature.

* * * * *

■ 8. Amend § 430.32 by revising paragraph (d) to read as follows:

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

* * * * *

(d) *Water Heaters.*

(1) Prior to [*date 5 years after date of publication of the final rule in the* **Federal Register**], the uniform energy factor of water heaters shall not be less than the following:

Product class	Rated storage volume and input rating (if applicable)	Draw pattern	Uniform energy factor *
Gas-fired Storage Water Heater	≥20 gal and ≤55 gal	Very Small	$0.3456 - (0.0020 \times V_r)$
		Low	$0.5982 - (0.0019 \times V_r)$
		Medium	$0.6483 - (0.0017 \times V_r)$
		High	$0.6920 - (0.0013 \times V_r)$
	>55 gal and ≤100 gal	Very Small	$0.6470 - (0.0006 \times V_r)$
		Low	$0.7689 - (0.0005 \times V_r)$
		Medium	$0.7897 - (0.0004 \times V_r)$
		High	$0.8072 - (0.0003 \times V_r)$
Oil-fired Storage Water Heater	≤50 gal	Very Small	$0.2509 - (0.0012 \times V_r)$
		Low	$0.5330 - (0.0016 \times V_r)$
		Medium	$0.6078 - (0.0016 \times V_r)$
		High	$0.6815 - (0.0014 \times V_r)$
Electric Storage Water Heaters	≥20 gal and ≤55 gal	Very Small	$0.8808 - (0.0008 \times V_r)$
		Low	$0.9254 - (0.0003 \times V_r)$
		Medium	$0.9307 - (0.0002 \times V_r)$
		High	$0.9349 - (0.0001 \times V_r)$
	>55 gal and ≤120 gal	Very Small	$1.9236 - (0.0011 \times V_r)$
		Low	$2.0440 - (0.0011 \times V_r)$
		Medium	$2.1171 - (0.0011 \times V_r)$
		High	$2.2418 - (0.0011 \times V_r)$
Tabletop Water Heater	≥20 gal and ≤120 gal	Very Small	$0.6323 - (0.0058 \times V_r)$
		Low	$0.9188 - (0.0031 \times V_r)$
		Medium	$0.9577 - (0.0023 \times V_r)$
		High	$0.9884 - (0.0016 \times V_r)$
Instantaneous Gas-fired Water Heater	<2 gal and >50,000 Btu/h	Very Small	0.80
		Low	0.81
		Medium	0.81
		High	0.81
Instantaneous Electric Water Heater	<2 gal	Very Small	0.91
		Low	0.91
		Medium	0.91
		High	0.92
Grid-enabled Water Heater	>75 gal	Very Small	$1.0136 - (0.0028 \times V_r)$
		Low	$0.9984 - (0.0014 \times V_r)$
		Medium	$0.9853 - (0.0010 \times V_r)$
		High	$0.9720 - (0.0007 \times V_r)$

* V_r is the rated storage volume (in gallons), as determined pursuant to 10 CFR 429.17.

(2) On or after [*date 5 years after date of publication of the final rule in the* **Federal Register**], the uniform energy factor of water heaters shall not be less than the following:

Product class	Rated storage volume and input rating (if applicable)	Draw pattern	Uniform energy factor *
Gas-fired Storage Water Heater	<20 gal	Very Small	$0.2062 - (0.0020 \times V_{eff})$
		Low	$0.4893 - (0.0027 \times V_{eff})$
		Medium	$0.5758 - (0.0023 \times V_{eff})$
		High	$0.6586 - (0.0020 \times V_{eff})$
	≥20 gal and ≤55 gal	Very Small	$0.3925 - (0.0020 \times V_{eff})$
		Low	$0.6451 - (0.0019 \times V_{eff})$
		Medium	$0.7046 - (0.0017 \times V_{eff})$
		High	$0.7424 - (0.0013 \times V_{eff})$
	>55 gal and ≤100 gal	Very Small	$0.6470 - (0.0006 \times V_{eff})$
		Low	$0.7689 - (0.0005 \times V_{eff})$
		Medium	$0.7897 - (0.0004 \times V_{eff})$
		High	$0.8072 - (0.0003 \times V_{eff})$
	>100 gal	Very Small	$0.1482 - (0.0007 \times V_{eff})$
		Low	$0.4342 - (0.0017 \times V_{eff})$
		Medium	$0.5596 - (0.0020 \times V_{eff})$
		High	$0.6658 - (0.0019 \times V_{eff})$
Oil-fired Storage Water Heater	≤50 gal	Very Small	$0.2909 - (0.0012 \times V_{eff})$
		Low	$0.5730 - (0.0016 \times V_{eff})$
		Medium	$0.6478 - (0.0016 \times V_{eff})$
		High	$0.7215 - (0.0014 \times V_{eff})$
	>50 gal	Very Small	$0.1580 - (0.0009 \times V_{eff})$
		Low	$0.4390 - (0.0020 \times V_{eff})$
		Medium	$0.5389 - (0.0021 \times V_{eff})$
		High	$0.6172 - (0.0018 \times V_{eff})$
Very Small Electric Storage Water Heater	<20 gal	Very Small	$0.5925 - (0.0059 \times V_{eff})$
		Low	$0.8642 - (0.0030 \times V_{eff})$

Product class	Rated storage volume and input rating (if applicable)	Draw pattern	Uniform energy factor *
		Medium	$0.9096 - (0.0020 \times V_{eff})$
		High	$0.9430 - (0.0012 \times V_{eff})$
Small Electric Storage Water Heater	≥20 gal and ≤35 gal	Very Small	$0.8808 - (0.0008 \times V_{eff})$
		Low	$0.9254 - (0.0003 \times V_{eff})$
Electric Storage Water Heaters	>20 and ≤55 gal (excluding small electric storage water heaters).	Very Small	2.30
		Low	2.30
		Medium	2.30
		High	2.30
	>55 gal and ≤120 gal	Very Small	2.50
		Low	2.50
		Medium	2.50
		High	2.50
	>120 gal	Very Small	$0.3574 - (0.0012 \times V_{eff})$
		Low	$0.7897 - (0.0019 \times V_{eff})$
		Medium	$0.8884 - (0.0017 \times V_{eff})$
		High	$0.9575 - (0.0013 \times V_{eff})$
Tabletop Water Heater	<20 gal	Very Small	$0.5925 - (0.0059 \times V_{eff})$
		Low	$0.8642 - (0.0030 \times V_{eff})$
	≥20 gal and ≤120 gal	Very Small	$0.6323 - (0.0058 \times V_{eff})$
		Low	$0.9188 - (0.0031 \times V_{eff})$
Instantaneous Gas-fired Water Heater	<2 gal and ≤50,000 Btu/h	Very Small	0.64
		Low	0.64
		Medium	0.64
		High	0.64
	<2 gal and >50,000 Btu/h	Very Small	0.89
		Low	0.91
		Medium	0.91
		High	0.93
	≥2 gal and ≤200,000 Btu/h	Very Small	$0.2534 - (0.0018 \times V_{eff})$
		Low	$0.5226 - (0.0022 \times V_{eff})$
		Medium	$0.5919 - (0.0020 \times V_{eff})$
		High	$0.6540 - (0.0017 \times V_{eff})$
Instantaneous Oil-fired Water Heater	<2 gal and ≤210,000 Btu/h	Very Small	0.61
		Low	0.61
		Medium	0.61
		High	0.61
	≥2 gal and ≤210,000 Btu/h	Very Small	$0.2780 - (0.0022 \times V_{eff})$
		Low	$0.5151 - (0.0023 \times V_{eff})$
		Medium	$0.5687 - (0.0021 \times V_{eff})$
		High	$0.6147 - (0.0017 \times V_{eff})$
Instantaneous Electric Water Heater	<2 gal	Very Small	0.91
		Low	0.91
		Medium	0.91
		High	0.92
	≥2 gal	Very Small	$0.8086 - (0.0050 \times V_{eff})$
		Low	$0.9123 - (0.0020 \times V_{eff})$
		Medium	$0.9252 - (0.0015 \times V_{eff})$
		High	$0.9350 - (0.0011 \times V_{eff})$
Grid-Enabled Water Heater	>75 gal	Very Small	$1.0136 - (0.0028 \times V_{eff})$
		Low	$0.9984 - (0.0014 \times V_{eff})$
		Medium	$0.9853 - (0.0010 \times V_{eff})$
		High	$0.9720 - (0.0007 \times V_{eff})$
Gas-fired Circulating Water Heater	≤200,000 Btu/h	Very Small	$0.8000 - (0.0011 \times V_{eff})$
		Low	$0.8100 - (0.0011 \times V_{eff})$
		Medium	$0.8100 - (0.0011 \times V_{eff})$
		High	$0.8100 - (0.0011 \times V_{eff})$
Oil-fired Circulating Water Heater	≤210,000 Btu/h	Very Small	$0.6100 - (0.0011 \times V_{eff})$
		Low	$0.6100 - (0.0011 \times V_{eff})$
		Medium	$0.6100 - (0.0011 \times V_{eff})$
		High	$0.6100 - (0.0011 \times V_{eff})$
Electric Circulating Water Heater	≤12 kW; for heat pump type units ≤24 A at ≤250 V.	Very Small	$0.9100 - (0.0011 \times V_{eff})$
		Low	$0.9100 - (0.0011 \times V_{eff})$
		Medium	$0.9100 - (0.0011 \times V_{eff})$
		High	$0.9200 - (0.0011 \times V_{eff})$

* V_{eff} is the Effective Storage Volume (in gallons), as determined pursuant to 10 CFR 429.17.

* * * * *

[FR Doc. 2023–15306 Filed 7–27–23; 8:45 am]

BILLING CODE 6450–01–P