DEPARTMENT OF ENERGY

10 CFR Part 431

[EERE–2016–BT–STD–0004]

RIN 1904–AD61

Energy Conservation Program: Energy Conservation Standards for Circulator Pumps

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 circulator pumps. In this notice of proposed rulemaking (''NOPR''), DOE proposes energy conservation standards for circulator pumps, and also announces a public meeting to receive comment on these proposed standards and associated analyses and results.

DATES:

Comments: DOE will accept comments, data, and information regarding this NOPR no later than February 6, 2023.

Meeting: DOE will hold a public meeting via webinar on Thursday, January 19, 2023, from 1:00 p.m. to 4:00 p.m., in Washington, DC.

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 February 6, 2023.

Interested persons are encouraged to submit comments using the Federal eRulemaking Portal at *www.regulations.gov,* under docket number EERE–2016–BT–STD–0004. Follow the instructions for submitting comments. Alternatively, interested persons may submit comments, identified by docket number EERE–EERE–2016–BT–STD–0004, by any of the following methods:

Email: Circpumps2016std0004@ee.doe.gov. Include the docket number EERE–2016–BT–STD–0004 in the subject line of the message.

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

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

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

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

The docket web page can be found at *www.regulations.gov/docket/EERE–2016–BT–STD–0004/document.* The docket web page contains instructions on how to access all documents, including public comments, in the docket. See section VII of this document for information on how to submit comments through *www.regulations.gov.*

EPCA requires the Attorney General to provide DOE a written determination of whether the proposed standard is likely to lessen competition. The U.S. Department of Justice Antitrust Division invites input from market participants and other interested persons with views on the likely competitive impact of the proposed standard. Interested persons may contact the Division at *energy.standards@usdoj.gov* on or before the date specified in the **DATES** section. Please indicate in the ''Subject'' line of your email the title and Docket Number of this proposed rulemaking.

FOR FURTHER INFORMATION CONTACT:

Mr. Jeremy Dommu, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office, EE–5B, 1000 Independence Avenue SW, Washington, DC 20585–0121. Telephone: (202) 586–9870. Email: *ApplianceStandardsQuestions@ee.doe.gov.*

Mr. Nolan Brickwood, U.S. Department of Energy, Office of the General Counsel, GC–33, 1000 Independence Avenue SW, Washington, DC 20585–0121. Telephone: (202) 586–2555. Email: *Nolan.Brickwood@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:

Table of Contents

I. Synopsis of the Proposed Rule

Title III, Part C[1] of EPCA,[2] established the Energy Conservation Program for Certain Industrial Equipment. (42 U.S.C. 6311–6317) Such equipment includes pumps. Circulator pumps, which are the subject of this proposed rulemaking, are a category of pumps.

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. 6316(a); 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. 6316(a); 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. 6316(a); 42 U.S.C. 6295(m))

In accordance with these and other statutory provisions discussed in this document, DOE proposes energy conservation standards for circulator pumps. The proposed standards, which are expressed in terms of a maximum circulator energy index ("CEI"), are shown in Table I.1. CEI represents the weighted average electric input power to the driver over a specified load profile, normalized with respect to a circulator pump serving the same hydraulic load that has a specified minimum performance level.[3] These proposed standards, if adopted, would apply to all circulator pumps listed in Table I.1 manufactured in, or imported into, the United States starting on the date 2 years after the publication of the final rule for this proposed rulemaking.

TABLE I.1—PROPOSED ENERGY CONSERVATION STANDARDS FOR CIRCULATOR PUMPS

Equipment class	Maximum CEI
(All Circulator Pumps)	1.00

[1] For editorial reasons, upon codification in the U.S. Code, Part C was redesignated Part A–1.

[2] 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.

[3] The performance of a comparable pump that has a specified minimum performance level is referred to as the circulator energy rating ("CER").

As stated in section III.C.a of this document, the proposed standards apply to circulator pumps when operated using the least consumptive control variety with which they are equipped.

CEI is defined as shown in equation (1), and consistent[4] with section 41.5.3.2 of HI 41.5–2022, ''Hydraulic Institute Program Guideline for Circulator Pump Energy Rating Program.''[5] 87 FR 57264.

$$CEI = \left[\frac{\text{CER}}{CER_{STD}}\right] \quad (1)$$

Where:

CEI = the circulator energy index (dimensionless);

CER = circulator energy rating (hp); and

CER_{STD} = for a circulator pump that is minimally compliant with DOE's energy conservation standards with the same hydraulic horsepower as the tested pump, as determined in accordance with the specifications at paragraph (i) of § 431.465.

The specific formulation for CER, in turn, varies according to circulator pump control variety, but in all cases is a function of measured pump input power when operated under certain conditions, as described in the September 2022 TP Final Rule.

Relatedly, CER_{STD} represents CER for a circulator pump that is minimally compliant with DOE's energy conservation standards with the same hydraulic horsepower as the tested pump, as determined in accordance with the specifications at paragraph (i) of § 431.465. 87 FR 57264.

A. Benefits and Costs to Consumers

Table I.2 presents DOE's evaluation of the economic impacts of the proposed standards on consumers of circulator pumps, as measured by the average life-cycle cost (''LCC'') savings and the simple payback period (''PBP'').[6] The average LCC savings are positive, and the PBP is less than the average lifetime of circulator pumps, which is estimated to be approximately 10.5 years (*see* section IV.F.6 of this document).

TABLE I.2—IMPACTS OF PROPOSED ENERGY CONSERVATION STANDARDS ON CONSUMERS OF CIRCULATOR PUMPS

Equipment class	Average LCC savings (2021$)	Simple payback period (years)
All Circulator Pumps	103.2	4.2

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

B. Impact on Manufacturers

The industry net present value (''INPV'') is the sum of the discounted cash flows to the industry from the base year through the end of the analysis period (2022–2055). Using a real discount rate of 9.6 percent, DOE estimates that the INPV for manufacturers of circulator pumps in the case without standards is $325.9 million in 2021$. Under the proposed standards, the change in INPV is estimated to range from −19.7 percent to 6.6 percent, which is approximately equivalent to a decrease of $64.3 million to an increase of 21.4 million. In order to bring products into compliance with standards, it is estimated that the industry would incur total conversion costs of $77.0 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[7]

DOE's analyses indicate that the proposed energy conservation standards for circulator pumps would save a significant amount of energy. Relative to the case without standards, the lifetime energy savings for circulator pumps purchased in the 30-year period that begins in the anticipated year of compliance with the standards (2026–2055) amount to 0.45 quadrillion British thermal units (''Btu''), or quads.[8] This represents a savings of 34 percent relative to the energy use of these products in the case without standards (referred to as the ''no-new-standards case'').

The cumulative net present value (''NPV'') of total consumer benefits of the proposed standards for circulator pumps ranges from $0.73 billion (at a 7-percent discount rate) to $1.77 billion (at a 3-percent discount rate). This NPV expresses the estimated total value of future operating-cost savings minus the estimated increased equipment and installation costs for circulator pumps purchased in 2026–2055.

In addition, the proposed standards for circulator pumps are projected to yield significant environmental benefits. DOE estimates that the proposed standards would result in cumulative emission reductions (over the same

[4] HI 41.5–2022 uses the term CER_{REF} for the analogous concept. In the September 2022 TP Final Rule, DOE discussed this decision to instead use CER_{STD} in the context of Federal energy conservation standards.

[5] HI 41.5–2022 provides additional instructions for testing circulator pumps to determine an Energy Rating value for different circulator pump control varieties.

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

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

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

period as for energy savings) of 15.8 million metric tons ("Mt")[9] of carbon dioxide ("CO_2"), 7.7 thousand tons of sulfur dioxide ("SO_2"), 23.8 thousand tons of nitrogen oxides ("NO_X"), 102 thousand tons of methane ("CH_4"), 0.2 thousand tons of nitrous oxide ("N_2O"), and 0.05 tons of mercury ("Hg").[10]

DOE estimates climate benefits from a reduction in greenhouse gases (GHG) using four different estimates of the social cost of CO_2 ("$SCCO_2$"), the social cost of methane ("$SCCH_4$"), and the social cost of nitrous oxide ("SCN_2O"). Together these represent the social cost of GHG (SCGHG).[11] DOE used interim SCGHG values developed by an Interagency Working Group on the Social Cost of Greenhouse Gases (IWG),[12] as discussed in section IV.L of this document. For presentational purposes, the climate benefits associated with the average SCGHG at a 3-percent discount rate are $0.80 billion. (DOE does not have a single central SCGHG point estimate and it emphasizes the importance and value of considering the benefits calculated using all four SCGHG estimates.)

DOE also estimates health benefits from SO_2 and NO_X emissions reductions.[13] DOE estimates the present value of the health benefits would be $0.65 billion using a 7-percent discount rate, and $1.45 billion using a 3-percent discount rate.[14] 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 circulator pumps. In the table, total benefits for both the 3-percent and 7-percent cases are presented using the average GHG social costs with 3-percent discount rate, but the Department emphasizes the importance and value of considering the benefits calculated using all four SCGHG cases. The estimated total net benefits using each of the four cases are presented in section V.C.1 of this document.

TABLE I.3—SUMMARY OF ECONOMIC BENEFITS AND COSTS OF PROPOSED ENERGY CONSERVATION STANDARDS FOR CIRCULATOR PUMPS [TSL 2]

	Billion ($2020)
3% discount rate:	
Consumer Operating Cost Savings	3.41
Climate Benefits*	0.80
Health Benefits**	1.45
Total Benefits†	5.65
Consumer Incremental Product Costs‡	1.64
Net Benefits	4.02
7% discount rate:	
Consumer Operating Cost Savings	1.68
Climate Benefits* (3% discount rate)	0.80
Health Benefits**	0.65
Total Benefits†	3.12
Consumer Incremental Product Costs‡	0.95
Net Benefits	2.18

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

* Climate benefits are calculated using four different estimates of the SC-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 of considering the benefits calculated using all four 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. The health benefits are presented at real discount rates of 3 and 7 percent. See section IV.L of this document for more details.

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

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

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

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

[13] DOE estimated the monetized value of SO_2 and NO_X emissions reductions associated with electricity savings using benefit per ton estimates from the scientific literature. *See* section IV.L.2 of this document for further discussion.

[14] 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.

† 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 SC-GHG estimates. See Table V.18 for net benefits using all four SC-GHG estimates. On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. In the absence of further intervening court orders, DOE will revert to its approach prior to the injunction and present monetized benefits where appropriate and permissible under law.

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

The benefits and costs of the proposed standards can also be expressed in terms of annualized values. The monetary values for the total annualized net benefits are (1) the reduced consumer operating costs, minus (2) the increase in product purchase prices and installation costs, plus (3) the value of the benefits of GHG and NO_X and SO_2 emission reductions, all annualized.[15] The national operating savings are domestic private U.S. consumer monetary savings that occur as a result of purchasing the covered equipment and are measured for the lifetime of circulator pumps shipped in 2026–2055. The benefits associated with reduced emissions achieved as a result of the proposed standards are also calculated based on the lifetime of circulator pumps shipped in 2026–2055.

Estimates of annualized benefits and costs of the proposed standards are shown in Table I.4. The results under the primary estimate are as follows.

Using a 7-percent discount rate for consumer benefits and costs and health benefits from reduced NOX and SO_2 emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the standards proposed in this rule is $93.5 million per year in increased equipment costs, while the estimated annual benefits are $165.8 in reduced equipment operating costs, $44.4 million in climate benefits, and $63.9 million in health benefits. In this case, the net benefit would amount to $180.5 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the proposed standards is $91.2 million per year in increased equipment costs, while the estimated annual benefits are $189.9 million in reduced operating costs, $44.4 million in climate benefits, and $80.8 million in health benefits. In this case, the net benefit would amount to $224.0 million per year.

TABLE I.4—ANNUALIZED BENEFITS AND COSTS OF PROPOSED ENERGY CONSERVATION STANDARDS FOR CIRCULATOR PUMPS

[TSL 2]

	Million (2021$/year)		
	Primary estimate	Low-net-benefits estimate	High-net-benefits estimate
3% discount rate:			
Consumer Operating Cost Savings	189.9	185.7	194.0
Climate Benefits*	44.4	44.4	44.4
Health Benefits**	80.8	80.8	80.8
Total Benefits†	315.2	311.0	319.3
Consumer Incremental Product Costs‡	91.2	91.2	91.2
Net Benefits	224.0	219.8	228.1
7% discount rate:			
Consumer Operating Cost Savings	165.8	162.6	168.7
Climate Benefits* (3% discount rate)	44.4	44.4	44.4
Health Benefits**	63.9	63.9	63.9
Total Benefits†	274.1	271.0	277.0
Consumer Incremental Product Costs‡	93.5	93.5	93.5
Net Benefits	180.5	177.4	183.4

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

* Climate benefits are calculated using four different estimates of the global SCGHG (see section IV.L of this document. For presentational purposes of this table, the climate benefits associated with the average SCGHG at a 3 percent discount rate are shown, but the Department does not have a single central SCGHG point estimate, and it emphasizes the importance and value of considering the benefits calculated using all four SCGHG 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. The health benefits are presented at real discount rates of 3 and 7 percent. *See* section IV.L of this document for more details.

[15] 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.

† 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 SCGHG with 3-percent discount rate, but the Department does not have a single central SCGHG point estimate. DOE emphasizes the importance and value of considering the benefits calculated using all four SCGHG estimates. See Table V.18 for net benefits using all four SCGHG estimates. On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. In the absence of further intervening court orders, DOE will revert to its approach prior to the injunction and present monetized benefits where appropriate and permissible under law.

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

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

D. Conclusion

DOE has tentatively concluded that the proposed standards represent the maximum improvement in energy efficiency that is technologically feasible and economically justified, and would result in the significant conservation of energy. Specifically, with regards to technological feasibility, equipment achieving these standard levels are already commercially available. As for economic justification, DOE's analysis shows that the benefits of the proposed standard exceed, to a great extent, the burdens of the proposed standards. Using a 7-percent discount rate for consumer benefits and costs and 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 circulator pumps is $93.5 million per year in increased circulator pumps costs, while the estimated annual benefits are $165.8 million in reduced circulator pumps operating costs, $44.4 million in climate benefits and $63.9 million in health benefits. The net benefit amounts to $180.5 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.[16] Accordingly, DOE evaluates the significance of energy savings on a case-by-case basis.

As previously mentioned, the proposed standards are projected to result in estimated national energy savings of 0.45 quad, the equivalent of the electricity use of 4.4 million homes in one year. The NPV of consumer benefit for these projected energy savings is $0.73 billion using a discount rate of 7 percent, and $1.77 billion using a discount rate of 3 percent. The cumulative emissions reductions associated with these energy savings are 15.8 Mt of CO_2, 23.8 thousand tons of SO_2, 7.7 thousand tons of NO_X, 0.05 tons of Hg, 102.0 thousand tons of CH_4, and 0.18 thousand tons of N_2O. The estimated monetary value of the climate benefits from the reduced GHG emissions (associated with the average SC-GHG at a 3-percent discount rate) is $0.80 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions is $0.65 billion using a 7-percent discount rate and $1.45 billion using a 3-percent discount rate. As such, DOE has initially determined the energy savings from the proposed standard levels are ''significant'' within the meaning of 42 U.S.C. 6295(o)(3)(B). A more detailed discussion of the basis for these tentative conclusions is contained in the remainder of this document and the accompanying TSD.

DOE also considered more-stringent energy efficiency levels (''ELs'') 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 circulator pumps.

A. Authority

EPCA authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. Title III, Part C of EPCA, added by Public Law 95–619, Title IV, section 441(a) (42 U.S.C. 6311–6317, as codified), established the Energy Conservation Program for Certain Industrial Equipment, which sets forth a variety of provisions designed to improve energy efficiency. This equipment includes pumps, the subject of this document. (42 U.S.C. 6311(1)(A)))

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 include definitions (42 U.S.C. 6311), test procedures (42 U.S.C. 6314), labeling provisions (42 U.S.C. 6315), energy conservation standards (42 U.S.C. 6313), and the authority to require information and reports from manufacturers (42 U.S.C. 6316; 42 U.S.C. 6296).

Federal energy efficiency requirements for covered equipment established under EPCA generally supersede State laws and regulations concerning energy conservation testing, labeling, and standards. (42 U.S.C. 6316(a) and (b); 42 U.S.C. 6297) 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. 6316(a) (applying the preemption waiver provisions of 42 U.S.C. 6297))

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 equipment. (42 U.S.C. 6295(o)(3)(A) and 42 U.S.C. 6295(r)) Manufacturers of covered equipment must use the Federal test procedures as the basis for: (1) certifying to DOE that their equipment complies with the applicable energy conservation standards adopted pursuant to EPCA (42 U.S.C. 6316(a); 42 U.S.C. 6295(s)), and (2) making representations about the efficiency of that equipment (42 U.S.C. 6314(d)).

[16] 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).

Similarly, DOE must use these test procedures to determine whether the equipment complies with relevant standards promulgated under EPCA. (42 U.S.C. 6316(a); 42 U.S.C. 6295(s))

The DOE test procedures for circulator pumps appear at title 10 of the Code of Federal Regulations (''CFR'') part 431, subpart Y, appendix D.

DOE must follow specific statutory criteria for prescribing new or amended standards for covered equipment, including circulator pumps. Any new or amended standard for a covered equipment 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. 6316(a); 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. 6316(a); 42 U.S.C. 6295(o)(3))

Moreover, DOE may not prescribe a standard: (1) for certain equipment, including circulator pumps, 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. 6316(a); 42 U.S.C. 6295(o)(3)(B)) In deciding whether a proposed standard is economically justified, DOE must determine whether the benefits of the standard exceed its burdens. (42 U.S.C. 6316(a); 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 equipment in the type (or class) compared to any increase in the price, initial charges, or maintenance expenses for the covered equipment that are likely to result from the standard;

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

(4) Any lessening of the utility or the performance of the covered equipment 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. 6316(a); 42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII))

Further, EPCA establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the energy savings during the first year that the consumer will receive as a result of the standard, as calculated under the applicable test procedure. (42 U.S.C. 6316(a); 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 covered equipment. (42 U.S.C. 6316(a); 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 equipment 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. 6316(a); 42 U.S.C. 6295(o)(4))

Additionally, EPCA specifies requirements when promulgating an energy conservation standard for covered equipment 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 equipment 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. 6316(a); 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. 6316(a); 42 U.S.C. 6295(q)(2))

B. Background

As stated, EPCA includes ''pumps'' among the industrial equipment listed as ''covered equipment'' for the purpose of Part A–1, although EPCA does not define the term ''pump.'' (42 U.S.C. 6311(1)(A)) In a final rule published January 25, 2016, DOE established a definition for ''pump,'' associated definitions, and test procedures for certain pumps. 81 FR 4086, 4090. (''January 2016 TP final rule''). ''Pump'' is defined as equipment designed to move liquids (which may include entrained gases, free solids, and totally dissolved solids) by physical or mechanical action and includes a bare pump and, if included by the manufacturer at the time of sale, mechanical equipment, driver, and controls. 10 CFR 431.462. Circulator pumps fall within the scope of this definition.

While DOE has defined ''pump'' broadly, the test procedure established in the January 2016 TP final rule is applicable only to certain categories of clean water pumps,[17] specifically those that are end suction close-coupled; end suction frame mounted/own bearings; in-line (''IL''); radially split, multi-stage, vertical, in-line diffuser casing; and submersible turbine (''ST'') pumps with the following characteristics:

- 25 gallons per minute (''gpm'') and greater (at best efficiency point (''BEP'') at full impeller diameter);
- 459 feet of head maximum (at BEP at full impeller diameter and the number of stages specified for testing);
- design temperature range from 14 to 248 °F;
- designed to operate with either (1) a 2- or 4-pole induction motor, or (2) a non-induction motor with a speed of rotation operating range that includes speeds of rotation between 2,880 and 4,320 revolutions per minute (''rpm'') and/or 1,440 and 2,160 rpm, and in either case, the driver and impeller must rotate at the same speed;
- 6-inch or smaller bowl diameter for ST pumps;
- A specific speed less than or equal to 5,000 for ESCC and ESFM pumps;
- Except for: fire pumps, self-priming pumps, prime-assist pumps, magnet driven pumps, pumps designed to be used in a nuclear facility subject to 10

[17] A ''clean water pump'' is a pump that is designed for use in pumping water with a maximum non-absorbent free solid content of 0.016 pounds per cubic foot, and with a maximum dissolved solid content of 3.1 pounds per cubic foot, provided that the total gas content of the water does not exceed the saturation volume, and disregarding any additives necessary to prevent the water from freezing at a minimum of 14 °F. 10 CFR 431.462.

CFR part 50, ''Domestic Licensing of Production and Utilization Facilities''; and pumps meeting the design and construction requirements set forth in any relevant military specifications.[18]

10 CFR 431.464(a)(1). The pump categories subject to the current test procedures are referred to as ''general pumps'' in this document. As stated, circulator pumps are not general pumps.

DOE also published a final rule establishing energy conservation standards applicable to certain classes of general pumps. 81 FR 4368 (Jan. 26, 2016) (''January 2016 ECS final rule''); *see also,* 10 CFR 431.465.

The January 2016 TP final rule and the January 2016 ECS final rule implemented the recommendations of the Commercial and Industrial Pump Working Group (''CIPWG'') established through the Appliance Standards Rulemaking Federal Advisory Committee (''ASRAC'') to negotiate standards and a test procedure for general pumps. (Docket No. EERE–2013–BT–NOC–0039) The CIPWG approved a term sheet containing recommendations to DOE on appropriate standard levels for general pumps, as well as recommendations addressing issues related to the metric and test procedure for general pumps (''CIPWG recommendations''). (Docket No. EERE–2013–BT–NOC–0039, No. 92) Subsequently, ASRAC approved the CIPWG recommendations. The CIPWG recommendations included initiation of a separate rulemaking for circulator pumps. (Docket No. EERE–2013–BT–NOC–0039, No. 92, Recommendation #5A at p. 2)

On February 3, 2016, DOE issued a notice of intent to establish the circulator pumps working group to negotiate a notice of proposed rulemaking (''NOPR'') for energy conservation standards for circulator pumps to negotiate, if possible, Federal standards and a test procedure for circulator pumps and to announce the first public meeting. 81 FR 5658. The members of the Circulator Pump Working Group (''CPWG'') were selected to ensure a broad and balanced array of interested parties and expertise, including representatives from efficiency advocacy organizations and manufacturers. Additionally, one member from ASRAC and one DOE representative were part of the CPWG. Table II.1 lists the 15 members of the CPWG and their affiliations.

TABLE II.1—ASRAC CIRCULATOR PUMP WORKING GROUP MEMBERS AND AFFILIATIONS

Member	Affiliation
Charles White	Plumbing-Heating-Cooling Contractors Association.
Gabor Lechner	Armstrong Pumps, Inc.
Gary Fernstrom	California Investor-Owned Utilities.
Joanna Mauer	Appliance Standards Awareness Project.
Joe Hagerman	U.S. Department of Energy.
Laura Petrillo-Groh	Air-Conditioning, Heating, and Refrigeration Institute.
Lauren Urbanek	Natural Resources Defense Council.
Mark Chaffee	TACO, Inc.
Mark Handzel	Xylem Inc.
Peter Gaydon	Hydraulic Institute.
Richard Gussert	Grundfos Americas Corporation.
David Bortolon	Wilo Inc.
Russell Pate	Rheem Manufacturing Company.
Don Lanser	Nidec Motor Corporation.
Tom Eckman	Northwest Power and Conservation Council (ASRAC member).

The CPWG commenced negotiations at an open meeting on March 29, 2016, and held six additional meetings to discuss scope, metrics, and the test procedure. The CPWG concluded its negotiations for test procedure topics on September 7, 2016, with a consensus vote to approve a term sheet containing recommendations to DOE on scope, definitions, metric, and the basis of the test procedure (''September 2016 CPWG Recommendations''). The September 2016 CPWG Recommendations are available in the CPWG docket. (Docket No. EERE–2016–BT–STD–0004, No. 58)

The CPWG continued to meet to address potential energy conservation standards for circulator pumps. Those meetings began on November 3–4, 2016 and concluded on November 30, 2016, with approval of a second term sheet (''November 2016 CPWG Recommendations'') containing CPWG recommendations related to energy conservation standards, applicable test procedure, labeling and certification requirements for circulator pumps (Docket No. EERE–2016–BT–STD–0004, No. 98). Whereas the September 2016 CPWG Recommendations are discussed in the September 2022 TP Final Rule, the November 2016 CPWG Recommendations are summarized in section III.A of this document. ASRAC subsequently voted unanimously to approve the September and November 2016 CPWG Recommendations during a December meeting. (Docket No. EERE–2013–BT–NOC–0005, No. 91 at p.2) [19]

In a letter dated June 9, 2017, Hydraulic Institute (''HI'') expressed its support for the process that DOE initiated regarding circulator pumps and encouraged the publishing of a NOPR and a final rule by the end of 2017. (Docket No. EERE–2016–BT–STD–0004, HI, No.103 at p. 1) In response to an early assessment review RFI published September 28, 2020 regarding the existing test procedures for general pumps (85 FR 60734, ''September 2020 Early Assessment RFI''), HI commented that it continues to support the recommendations from the CPWG. (Docket No. EERE–2020–BT–TP–0032, HI, No. 6 at p. 1) NEEA also referenced

[18] *E.g.,* MIL–P–17639F, ''Pumps, Centrifugal, Miscellaneous Service, Naval Shipboard Use'' (as amended); MIL–P–17881D, ''Pumps, Centrifugal, Boiler Feed, (Multi-Stage)'' (as amended); MIL–P–17840C, ''Pumps, Centrifugal, Close-Coupled, Navy Standard (For Surface Ship Application)'' (as amended); MIL–P–18682D, ''Pump, Centrifugal, Main Condenser Circulating, Naval Shipboard'' (as amended); and MIL–P–18472G, ''Pumps, Centrifugal, Condensate, Feed Booster, Waste Heat Boiler, And Distilling Plant'' (as amended). Military specifications and standards are available at *https://everyspec.com/MIL-SPECS.*

[19] All references in this document to the approved recommendations included in 2016 Term Sheets are noted with the recommendation number and a citation to the appropriate document in the CPWG docket (*e.g.,* Docket No. EERE–2016–BT–STD–0004, No. #, Recommendation #X at p. Y). References to discussions or suggestions of the CPWG not found in the 2016 Term Sheets include a citation to meeting transcripts and the commenter, if applicable (*e.g.,* Docket No. EERE–2016–BT–STD–0004, [Organization], No. X at p. Y).

the September 2016 CPWG Recommendations and recommended that DOE adopt test procedures for circulator pumps in the pumps rulemaking or a separate rulemaking. (Docket No. EERE–2020–BT–TP–0032, NEEA, No. 8 at p. 8)

On May 7, 2021, DOE published a request for information related to test procedures and energy conservation standards for circulator pumps. 86 FR 24516 (''May 2021 RFI'').

DOE received comments in response to the May 2021 RFI from the interested parties listed in Table II.2.

TABLE II.2—LIST OF COMMENTERS WITH WRITTEN SUBMISSIONS IN RESPONSE TO THE MAY 2021 RFI

Commenter(s)	Reference in this final rule	Docket No.	Commenter type
People's Republic of China	China	EERE–2016–BT–STD–0004–0111	Country.
Hydraulic Institute	HI	EERE–2016–BT–STD–0004–0112	Trade Association.
Grundfos Americas Corporation	Grundfos	EERE–2016–BT–STD–0004–0113	Manufacturer.
Appliance Standards Awareness Project, American Council for an Energy-Efficient Economy, Natural Resources Defense Council.	Advocates	EERE–2016–BT–STD–0004–0114	Efficiency Organization.
Northwest Energy Efficiency Alliance	NEEA	EERE–2016–BT–STD–0004–0115	Efficiency Organization.
Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison; collectively, the California Investor-Owned Utilities.	CA IOUs	EERE–2016–BT–STD–0004–0116	Utility.
Anonymous Commenter	N/A	EERE–2016–BT–STD–0004–0117	Anonymous.[20]

A parenthetical reference at the end of a comment quotation or paraphrase provides the location of the item in the public record.[21]

DOE published a notice of proposed rulemaking (NOPR) for the test procedure on December 20, 2021, presenting DOE's proposals to establish a circulator pump test procedure (86 FR 72096) (hereafter, the ''December 2021 TP NOPR''). DOE held a public meeting related to this NOPR on February 2, 2022. DOE published a final rule for the test procedure on September 19, 2022 (''September 2022 TP Final Rule''). The test procedure final rule established definitions, testing methods and a performance metric, requirements regarding sampling and representations of energy consumption and certain other metrics, and enforcement provisions for circulator pumps.

C. Deviation From Appendix A

In accordance with section 3(a) of 10 CFR part 430, subpart C, appendix A (''Appendix A''), DOE notes that it is deviating from two provisions in appendix A regarding the NOPR stage for an energy conservation standard rulemaking. First, section 6(f)(2) of appendix A specifies that the length of the public comment period for a NOPR will vary depending upon the circumstances of the particular rulemaking but will not be less than 75 calendar days. For this NOPR, DOE is providing a 60-day comment period, as required by EPCA. 42 U.S.C. 6316(a); 42 U.S.C. 6295(p). Second, section 6(a)(2) of appendix A states that if DOE determines in is appropriate to proceed with a rulemaking, then the preliminary stages of a rulemaking to issue an energy conservation standard would include either a framework document and preliminary analysis or, alternatively, an advance notice of proposed rulemaking. According to section 6(a)(2) of appendix A, DOE may also optionally issue requests for information and notices of data availability.

As stated in section II.B of this document, DOE established a working group (the CPWG) to negotiate potential energy conservation standards for circulator pumps, which culminated at a consensus agreement (the November 2016 CPWG Recommendations) recommending that energy conservation standards for circulator pumps be adopted at TSL2, the level proposed in this NOPR. The CPWG held a series of formal and informal meetings, minutes and supporting material for which are posted in Docket No. EERE–2016–BT–STD–0004.

Additionally, as stated in section II.B of this document, on May 7, 2021, DOE published a request for information related to test procedures and energy conservation standards for circulator pumps in which it initially provided a 60-day comment period. 86 FR 24516 (''May 2021 RFI''). Subsequently, in response to requests, DOE provided a 24-day extension to that initial comment period, for a total comment period of 84 days. 86 FR 28298.

DOE has relied on many of the same analytical assumptions and approaches as used in developing analysis supporting the standard level of TSL2 which was the consensus recommendation of the CWPG and which was supported by several commenters and which no commenters opposed. (HI, No. 112 at p. 6; Grundfos, No. 113 at p. 6; NEEA, No. 115 at p. 3; Advocates, No. 114 at p. 1; CA IOUs, No. 116 at p. 5)

Considering the opportunity for comment and input afforded the CWPG by the negotiation process, including the opportunity to vote on a consensus level for energy conservation standards, the 84-day comment period of the May 2021 RFI in which the CPWG-recommended standard level was discussed, and the close adherence of the methods and analysis used in this NOPR to support a proposed standard level of TSL 2, interested parties have been provided substantial opportunity to provide input. 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.

Regarding the provision in section 6(a)(2) of appendix A to issue either a framework document and preliminary analysis or, alternatively, an advance notice of proposed rulemaking as the preliminary rulemaking documents, the function of these documents is to lay out for interested parties and the public DOE's planned approach and provide opportunity for comment had already been performed by the CPWG meeting process. Interested parties were offered opportunity to not only observe and comment on but even participate in that process. As discussed in section II.B of this document, many did. Table II.1 lists the 15 members of the CPWG and their

[20] The Anonymous comment did not substantively address the subject of this rulemaking.

[21] The parenthetical reference provides a reference for information located in the docket of DOE's rulemaking to develop test procedures for circulator pumps. EERE–2016–BT–TP–0033 (Docket No. EERE–2016–BT–TP–0033, which is maintained at *www.regulations.gov*). The references are arranged as follows: (commenter name, comment docket ID number, page of that document).

affiliations. The proceedings of the working group and related ASRAC activities have been documented and available for review respectively in the rulemaking docket (EERE–2016–BT–STD–0004) and non-rulemaking, ASRAC docket (Docket No. EERE–2013–BT–NOC–0005).

As discussed in section II.B, the CPWG approved two term sheets which represented the group's consensus recommendations. The second term sheet, referred to in this NOPR as the ''November 2016 CPWG Recommendations'' contained the CPWG recommendations related to energy conservation standards, applicable test procedure, labeling and certification requirements for circulator pumps. (Docket No. EERE–2016–BT–STD–0004, No. 98) The proposals in this NOPR closely mirror the November 2016 CPWG Recommendations, which are accordingly summarized in this section.

III. General Discussion

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

A. November 2016 CPWG Recommendations

As discussed in section II.B, the CPWG approved two term sheets which represented the group's consensus recommendations. The second term sheet, referred to in this NOPR as the ''November 2016 CPWG Recommendations'' contained the CPWG recommendations related to energy conservation standards, applicable test procedure, labeling and certification requirements for circulator pumps. (Docket No. EERE–2016–BT–STD–0004, No. 98) The proposals in this NOPR closely mirror the November 2016 CPWG Recommendations, which are accordingly summarized in this section.

1. Energy Conservation Standard Level

The CPWG recommendation that each circulator pump be required to meet an applicable minimum efficiency standard. Specifically, the recommendation was that each pump must have a CEI [22] of less than or equal to 1.00. Among the numbered efficiency levels considered by the CPWG as potential standard levels, the agreed level was EL2 (*i.e.,* CEI less than or equal to 1.00).

In response to the May 2021 RFI, several stakeholders commented in support of the CPWG's recommendation of energy conservation standards at EL2. HI commented that it supported the work and recommendations of the CPWG. (HI, No. 112 at p. 6) Grundfos recommended DOE adopt EL2, the recommended standard level of the CPWG. (Grundfos, No. 113 at p. 6) NEEA commented it believes EL 2 is still appropriate and will result in significant energy savings nationally. (NEEA, No. 115 at p. 3) The Advocates commented that DOE should quickly adopt energy conservation standards for circulator pumps in accordance with the CPWG recommendations. (Advocates, No. 114 at p. 1) The CA IOUs commented that they support adopting the provisions of the CPWG term sheets, including the recommended energy conservation standard level of EL2. CA IOUs (CA IOUs, No. 116 at p.5)

No comments were received arguing against adoption of the CPWG-recommended standard level.

In the May 2021 RFI, DOE requested comment on whether any changes in the market since publication of the 2016 Term Sheets could make the CPWG's recommendation for EL 2 no longer valid. Grundfos, HI, NEEA responded stating there were little to no changes and the CPWG's recommendation of EL2 is still appropriate. (Grundfos, No. 113 at p. 10; HI, No. 112 at p. 11; NEEA, No. 115 at p. 2) HI estimated that standards at EL 2 would eliminate all permanent-split capacitor (''PSC'') motor circulator pumps which is the predominant product sold today. (*Id.*) Grundfos recommended that DOE adopt EL 2 as the standard, which would force the market to electronically commutated motor (ECM) products and remove 4% of ECMs currently available (based on CPWG data). (Grundfos, No. 113 at p. 7)

Overall, the CPWG-recommended standard level appears well supported by commenters. As described in section V.C.1, DOE is proposing in this NOPR to adopt energy conservation standards for circulator pumps at TSL 2, which

As stated in section I, CEI was defined in the September 2022 TP Final Rule consistent with the November 2016 CPWG Recommendations as shown in equation (2), and consistent with Section 41.5.3.2 of HI 41.5–2022. (87 FR 57264).

$$CEI = \left[\frac{\mathrm{CER}}{CER_{STD}}\right] \qquad \textbf{(2)}$$

Where:

CER = circulator energy rating (hp); and
CER_{STD} = circulator energy rating for a minimally compliant circulator pump serving the same hydraulic load.

The specific formulation CER, in turn, varies according to circulator pump control variety, but in all cases is a function of measured pump input power when operated under certain conditions, as described in the September 2022 TP Final Rule.

Relatedly, CER_{STD} represents CER for a circulator pump that is minimally compliant with DOE's energy conservation standards with the same hydraulic horsepower as the tested pump, as determined in accordance with the specifications at paragraph (i) of § 431.465. (87 FR 57264)

The November 2016 CPWG Recommendations contained a proposed method for calculating CER_{STD} [23] as shown in Equation (3):

[22] The CPWG recommendations predated establishment of the current metric, called ''CEI'', and instead used the analogous term ''PEI_{CIRC}''. In the December 2021 TP NOPR, DOE proposed to adopt the ''CEI'' nomenclature instead ''PEI_{CIRC}'' to ''CEI'' based, in part, on comments received, to remain consistent with terminology used in HI 41.5, and to avoid potential confusion with the nomenclature. After receiving favorable comments on its proposal, DOE adopted the CEI nomenclature in the September 2022 TP Final Rule.

[23] The CPWG recommendations predated establishment of the current term ''CER_{STD}'' and instead used the analogous term ''$PER_{CIRC,STD}$''. In the December 2021 TP NOPR, DOE proposed to adopt the ''CER_{STD}'' nomenclature instead ''$PER_{CIRC,STD}$'' because DOE believed that the terminology CER_{STD} is more reflective of Federal energy conservation standards. After receiving no opposition on its proposal, DOE adopted the CEI nomenclature in the September 2022 TP Final Rule.

$$CER_{STD} = \sum_i \omega_i \left(P_i^{in,STD}\right) \quad (3)$$

Where:

ω_i = weight at each test point i, specified in Recommendation #2B

$P_i^{in,STD}$ = reference power input to the circulator pump driver at test point i, calculated using the equations and method specified in Recommendation #2C

i = test point(s), defined as 25%, 50%, 75%, and 100% of the flow at best efficiency point (BEP).

The November 2016 CPWG Recommendations also included a recommended weighting factor of 25% for each respective test point, i. (''Recommendation #2B'').

The November 2016 CPWG Recommendations also included (''Recommendation #2C'') a recommended reference input power, $P_i^{in,STD}$ as described in equation (4).

$$P_i^{in,STD} = \frac{P_{u,i}}{\alpha_i * \frac{\eta_{WTW,100\%}}{100}} \quad (4)$$

Where:

$P_{u,i}$ = tested hydraulic power output of the pump being rated at test point i, in HP

$\eta_{WTW,100\neq}$ = reference BEP circulator pump efficiency at the recommended standard level (%), calculated using the equations and values specified in Recommendation #2D

α_i = part load efficiency factor at each test point i, specified in Recommendation #2E

i = test point(s), defined as 25%, 50%, 75%, and 100% of the flow at best efficiency point (BEP).

The November 2016 CPWG Recommendations also included a reference efficiency at BEP at the CPWG-recommended standard level, $\eta_{WTW,100\%}$, (''Recommendation #2D'') which varies by circulator pump hydraulic output power.

Specifically, for circulator pumps with BEP hydraulic output power $P_{u,100\%}$ <1 HP, the reference efficiency at BEP (ηWTW,100%) should be determined using equation (5):

$$\eta_{WTW,100\%} = A * \ln\left(P_{u,100\%} + B\right) + C \quad (5)$$

Where:

$\eta_{WTW,100\%}$ = reference BEP pump efficiency at the recommended standard level (%),

$P_{u,100\%}$ = tested hydraulic power output of the pump being rated at BEP, in HP

For the CPWG-recommended standard level, the constants A, B, and C used in equation would have the following values:

TABLE III.1—CPWG-RECOMMENDED REFERENCE PUMP WTW,100% CONSTANTS

A	B	C
10.00	.001141	67.78

For circulator pumps with BEP hydraulic output power $P_{u,100\%}$ ≥1 HP, the reference efficiency at BEP (ηWTW,100%) would have a constant value of 67.79.

Additionally, the November 2016 CPWG Recommendations included a part-load efficiency factor (α_i, as appears in equation (4)), which varies according to test point (''Recommendation #2E). Specifically, α_i would have values as listed in Table III.2.

TABLE III.2—CPWG-RECOMMENDED PART-LOAD EFFICIENCY

i	Corresponding α_i
25%	0.4843
50%	0.7736
75%	0.9417
100% [24]	1

This CPWG-recommended equation structure is used to characterize the standard level proposed in this NOPR, with certain inconsequential changes to variable names.

2. Labeling Requirements

Under EPCA, DOE has certain authority to establish labeling requirements for covered equipment. (42 U.S.C. 6315) The November 2016 CPWG Recommendations contained one recommendation regarding labeling requirements, which was that both model number and CEI [25] be included on the circulator nameplate (Docket No. EERE–2016–BT–STD–0004, No. 98 Recommendation #3 at p. 4).

In response to the May 2021 RFI, the Advocates commented in support of establishing labeling requirements for

[24] The November 2016 CPWG Recommendations did not explicitly include a value for the part-load efficiency factor, α_i, in Recommendation #2E. Nonetheless, Recommendation #2C makes clear that a value for the part-load efficiency factor, α_i, is required to calculate reference input power, which calls for a value at test point i = 100%. DOE infers the omission of $\alpha_{100\%}$ from Recommendation #2E to reflect that i = 100% corresponds to full-load, and thus imply no part-load-driven reduction in efficiency and, by extension, a load coefficient of unity. DOE is making this assumption that $\alpha_{100\%}$ = 1 explicit by including it in this table, which is otherwise identical to that of CPWG Recommendation #2E.

[25] The CPWG recommended that ''PEI'' be included in a potential labeling requirement which, as described previously, is analogous to CEI.

circulator pumps (Advocates, No. 114 at p. 1). No commenters argued against establishing labeling requirements for circulator pumps.

DOE is reviewing the potential benefits of establishing labeling requirements for circulator pumps and may share the results of such evaluation in a separate notice. Accordingly, in this NOPR, DOE is not proposing specific labeling requirements for circulator pumps, but DOE may consider such requirements for circulator pumps, including those recommended by the CPWG, in a separate rulemaking.

3. Certification Reports

Under EPCA, DOE has the authority to require information and reports from manufacturers with respect to the energy efficiency or energy use. (42 U.S.C. 6316; 42 U.S.C. 6296).

The November 2016 CPWG Recommendations contained one recommendation regarding certification reporting requirements. Specifically, the CPWG recommended that the following information should be included in both certification reports and the public CCMS database:

- Manufacturer name
- Model number
- CEI [26]
- Flow (in gallons per minute) and Head (in feet) at BEP
- Tested control setting
- Input power at measured data points

(Docket No. EERE–2016–BT–STD–0004, No. 98 Recommendation #4 at p. 4)

The CPWG also recommended that certain additional information be permitted but not mandatorily included in both certification reports and the public CCMS database. (Docket No. EERE–2016–BT–STD–0004, No. 98 Recommendation 4 at p. 1) The recommended optional information consisted of: true RMS current, true RMS voltage, real power, and the resultant power factor at measured data points. (Docket No. EERE–2016–BT–STD–0004, No. 98 Recommendation #4 at p. 4)

DOE is not proposing certification or reporting requirements for circulator pumps in this NOPR. Instead, DOE may consider proposals to address amendments to the certification requirements and reporting for circulator pumps under a separate rulemaking regarding appliance and equipment certification.

[26] CEI had not been established at the time of the November 2016 CPWG Recommendations, which instead referred to this value as ''PEI_{CIRC}''.

B. Equipment Classes and Scope of Coverage

When evaluating and establishing energy conservation standards, DOE divides covered equipment into equipment classes by the type of energy used or by capacity or other performance-related features that justify differing standards. 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. (42 U.S.C. 6316(a); 42 U.S.C. 6295(q))

In this NOPR, DOE proposes to align the scope of energy conservation standards for circulator pumps with that of the circulator pumps test procedure. 87 FR 57264. Specifically, this NOPR proposes to apply energy conservation standards to all circulator pumps that are also clean water pumps, including on-demand circulator pumps and circulators-less-volute, and excluding submersible pumps and header pumps.

This scope is consistent with the recommendations of the CPWG. DOE identified no basis to change the scope of energy conservations standard for circulator pumps relative to the scope of test procedures adopted in the September 2022 Final Rule. Accordingly, the scope of proposed energy conservation standards aligns with that of the test procedure. Comments related to scope are discussed and considered in the test procedure final rule.

Both of these proposals—scope and equipment classes—match the recommendations of the CPWG, which are summarized in this section. They are discussed further in section IV.A.1 of this document.

1. CPWG Recommendations

a. Scope

The September 2016 CPWG Recommendations addressed the scope of a circulator pumps rulemaking. Specifically, the CPWG recommended that the scope of a circulator pumps test procedure and energy conservation standards cover clean water pumps (as defined at 10 CFR 431.462) distributed in commerce with or without a volute and that are one of the following categories: wet rotor circulator pumps, dry rotor close-coupled circulator pumps, and dry rotor mechanically coupled circulator pumps. The CPWG also recommended that the scope exclude submersible pumps and header pumps. 86 FR 24516, 24520; (Docket No. EERE–2016–BT–STD–0004, No. 58, Recommendations #1A, 2A and 2B at p. 1–2) In response to the May 2021 RFI, HI and Grundfos stated that they believed all circulator pumps are included in the scope defined by the CPWG in the term sheets. (HI, No. 112 at p. 8; Grundfos, No. 113 at p. 7). DOE's proposal aligns with the scope recommended by the CPWG, consistent with the September 2022 TP Final Rule.

b. Definitions

The CPWG also recommended several definitions relevant to scope. DOE notes that, generally, definitions recommended by the CPWG rely on terms previously defined in the January 2016 TP final rule, including ''close-coupled pump,'' ''mechanically-coupled pump,'' ''dry rotor pump,'' ''single axis flow pump,'' and ''rotodynamic pump.'' 81 FR 4086, 4146–4147; 10 CFR 431.462. In addition, the recommended definition for ''submersible pump'' is the same as that already defined in a 2017 test procedure final rule for dedicated-purpose pool pumps (''August 2017 DPPP TP final rule''). 82 FR 36858, 36922 (August 7, 2017); 10 CFR 431.462.

In the September 19, 2022 TP Final Rule DOE established a number of definitions related to circulator pumps as follows. 87 FR 57264. Specifically, DOE defined: ''circulator pump'', ''wet rotor circulator pump'', ''dry rotor, two-piece circulator pump'', ''dry rotor, three-piece circulator pump'', ''horizontal motor'', ''header pump'', and ''circulator-less-volute.'' (87 FR 57264)

''Circulator pump'' was defined to include both wet- and dry-rotor designs and to include circulators-less-volute, which are distributed in commerce without a volute and for which a paired volute is also distributed in commerce. Header pumps, by contrast, are those without volutes and for which no paired volute is available in commerce. (87 FR 57264)

In the September 2022 TP Final Rule (87 FR 57264) DOE did not propose a new definition for submersible circulator pumps, instead signaling applicability of an established term, ''submersible pump'', which was defined in the 2017 test procedure final rule for dedicated-purpose pool pumps (''August 2017 DPPP TP final rule''). 82 FR 36858, 36922 (August 7, 2017):

Submersible pump means a pump that is designed to be operated with the motor and bare pump fully submerged in the pumped liquid. 10 CFR 431.462.

DOE proposes to maintain these definitions from the September 2022 TP Final Rule in the standards for circulator pumps.

c. Equipment Classes

The CPWG recommended that all circulator pumps be analyzed in a single equipment class. (Docket No. EERE–2016–BT–STD–0004, No. 98, Recommendation #1 at p. 1) DOE's proposal aligns with the recommendation of the CPWG. Equipment classes are discussed further in section IV.A.1 of this document.

d. Small Vertical In-Line Pumps

The CPWG recommended that DOE analyze and establish energy conservation standards for small vertical in-line pumps (''SVILs'') with a compliance date equivalent to the previous energy conservation standards final rule (81 FR 4367, Jan. 26, 2016) for general (and not circulator) pumps. (Docket No. EERE–2016–BT–STD–0004, No. 58, Recommendation #1B at p. 1–2) The recommendation was that the standards for SVILs be similar in required performance to those of general pumps. (Docket No. EERE–2016–BT–STD–0004, No. 58, Recommendation #1B at p. 2) In addition to energy conservation standards for SVILs, the CPWG recommended SVILs be evaluated using the same test metric as general pumps. *Id.*

In their response to the May 2021 RFI, Advocates requested that standards for small vertical in-line pumps (''SVILs'') be established that are comparable to those of commercial and industrial inline pumps, as the CPWG recommended in 2016 (Advocates, No. 114 at p. 1). Consistent with those sentiments, DOE proposed to extend commercial and industrial pump test procedures to SVILs in a separate notice of proposed rulemaking. 87 FR 21268 (Apr. 11, 2022) (April 2022 NOPR). That test procedure, if finalized, may allow evaluation of energy conservation standards for SVILs as part of a commercial and industrial pumps rulemaking process. However, subsequent to the April 2022 NOPR, DOE published a notice of data availability (NODA) in which DOE noted that during interviews conducted after the April 2022 NOPR, manufacturers provided conflicting suggestions for how DOE should conduct its SVIL analysis, including that some manufacturers suggested that potential SVIL standards should be equivalent to any future standards for circulator pumps. DOE received conflicting feedback on whether circulator pumps and SVILs would compete with, or act as substitutes for, each other. Some manufacturers stated that an SVIL would never be substituted for a circulator pump, while others said that it was possible. 87 FR 49537 (Aug. 11, 2022). In that NODA, DOE request comment on specific applications for which SVILs could be used instead of circulator pumps and how an SVIL would need to be modified for use in these applications, and potential benefits and drawbacks of setting standards for SVILs that align with circulator pumps versus setting standards for SVILs that align with in-line pumps. *Id.*

At this time, DOE has tentatively determined to maintain its approach to address energy conservation standards for circulator pumps only in this rulemaking, separately from SVILs. DOE has not received adequate data or information at this time to suggest that DOE should address standards for SVILs along with the circulator pumps within the scope of this NOPR. Accordingly, DOE is proposing not to include SVILs within the scope of the energy conservation standards considered in this NOPR. Relatedly, the September 2022 TP Final Rule did not adopt test procedures for SVILs. DOE will continue to evaluate manufacturer and stakeholder feedback related to this issue and take any additional information into consideration as it may relate to including SVILs, or a subset of SVILs, within the scope of this rulemaking.

DOE requests comment on its approach to exclude SVILs from the scope of this NOPR, and whether DOE should consider standards for any SVILs as part of this rulemaking.

C. Test Procedure

EPCA sets forth generally applicable criteria and procedures for DOE's adoption and amendment of test procedures. (42 U.S.C. 6314(a)) Manufacturers of covered equipment 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 circulator pumps are expressed in terms of circulator energy index (''CEI''). CEI represents the weighted average electric input power to the driver over a specified load profile, normalized with respect to a circulator pump serving the same hydraulic load that has a specified minimum performance level. [27] (*See* 10 CFR 431.464(c)).

[27] The performance of a comparable pump that has a specified minimum performance level is referred to as the circulator energy rating (''CER'').

a. Control Mode

Circulator pumps may be equipped with speed controls that govern their response to settings or signals. DOE's test procedure contains definitions and test methods applicable to pressure controls, temperature controls, manual speed controls, external input signal controls, and no controls (*i.e.,* full speed operation only). [28] Section B.1 of appendix D to subpart Y of 10 CFR part 431 specifies that circulator pumps without one of the identified control varieties (*i.e.,* pressure control, temperature control, manual speed control or external input signal control) are tested at full speed.

Some circulator pumps operate in only a single control mode (*i.e.,* selected variety), whereas others are capable of operating in any of several control modes. As discussed in the September 2022 TP Final Rule, circulator pump energy performance typically varies by control variety, for circulator pumps equipped with more than one control variety. In the September 2022 TP Final Rule, DOE summarized and responded to a variety of stakeholder comments which discussed advantages and disadvantages of various potential requirements regarding the control variety activated during testing. Ultimately, DOE determined not to restrict active control variety during testing. 87 FR 57264. The test procedure for circulator pumps allows the manufacturer of a circulator pump to does not require a particular control variety to limit application to a particular control variety. Section B.2 of appendix D to subpart Y of 10 CFR part 431.

In the September 2022 TP Final Rule, DOE stated that although the test procedure does not restrict active control variety during testing, whether compliance with a potential future energy conservation standard would be based on a specific control mode (or no controls), or whether certain information related to the control mode used for testing would be required as part of certification, would be addressed in an energy conservation standard rulemaking.

In this NOPR, DOE proposes to require compliance with energy conservation standards for circulator pumps while operated in the least consumptive control mode in which it is capable of operating. Because many circulator pumps equipped with control

[28] In this document, circulator pumps with ''no controls'' are also inclusive of other potential control varieties that are not one of the specifically identified control varieties. *See* section III.D.7 of this document.

modes designed to reduce energy consumption relate to full-speed operating also include the ability to operate at constant-speed, to require testing using a circulator pumps' most consumptive control mode may reduce the ability of rated CEI to characterize the degree of energy savings possible across circulator pump models. Circulator pump basic models equipped with a variety of control modes would receive the same rating as an otherwise identical basic model which could operate only at full speed, even though in practice the former may consume considerably less energy in many applications.

As stated in section III.A.3 of this document, certification requirements, including those related to active control variety, are not being proposed in this NOPR, but may be addressed in a potential future rulemaking.

DOE requests comment regarding circulator pump control variety for the purposes of demonstrating compliance with energy conservation standards.

D. Technological Feasibility

1. General

In each energy conservation standards rulemaking, DOE conducts a screening analysis based on information gathered on all current technology options and prototype designs that could improve the efficiency of the products or equipment that are the subject of the rulemaking. As the first step in such an analysis, DOE develops a list of technology options for consideration in consultation with manufacturers, design engineers, and other interested parties. DOE then determines which of those means for improving efficiency are technologically feasible. DOE considers technologies incorporated in commercially-available products or in working prototypes to be technologically feasible. Sections 6(c)(3)(i) and 7(b)(1) of appendix A to 10 CFR 431.4; 10 CFR part 430, subpart C (''Process Rule'').

After DOE has determined that particular technology options are technologically feasible, it further evaluates each technology option in light of the following additional screening criteria: (1) practicability to manufacture, install, and service; (2) adverse impacts on product utility or availability; (3) adverse impacts on health or safety, and (4) unique-pathway proprietary technologies. 10 CFR 431.4; Sections 6(b)(3)(ii)–(v) and 7(b)(2)–(5) of the Process Rule. Section IV.B of this document discusses the results of the screening analysis for circulator pumps, 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 technical support document (''TSD'').

2. Maximum Technologically Feasible Levels

When DOE proposes to adopt a new or amended standard for a type or class of covered equipment, 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. 6316(a); 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 circulator pumps, using the design parameters for the most efficient products available on the market or in working prototypes. The max-tech levels that DOE determined for this rulemaking are described in section IV.C of this proposed rule and in chapter 5 of the NOPR TSD.

E. Energy Savings

1. Determination of Savings

For each trial standard level (''TSL''), DOE projected energy savings from application of the TSL to circulator pumps purchased in the 30-year period that begins in the year of compliance with the proposed standards (2026–2055).[29] The savings are measured over the entire lifetime of circulator pumps 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 equipment would likely evolve in the absence of new energy conservation standards.

DOE used its national impact analysis (''NIA'') spreadsheet model to estimate national energy savings (''NES'') from potential new standards for circulator pumps. 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 NES in terms of primary energy savings, which is the savings in the energy that is used to generate and transmit the site electricity. DOE also calculates NES in terms of FFC energy savings. The FFC metric includes the energy consumed in extracting, processing, and transporting primary fuels (*i.e.,* coal, natural gas, petroleum fuels), and thus presents a more complete picture of the impacts of energy conservation standards.[30] DOE's approach is based on the calculation of an FFC multiplier for each of the energy types used by covered products or equipment. For more information on FFC energy savings, see section IV.H.2 of this document.

2. Significance of Savings

To adopt any new or amended standards for covered equipment, 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.[31] For example, some covered products and equipment have most of their energy consumption occur during periods of peak energy demand. The impacts of these products on the energy infrastructure can be more pronounced than products with relatively constant demand. In evaluating the significance of energy savings, DOE considers differences in primary energy and FFC effects for different covered products and equipment when determining whether energy savings are significant. Primary energy and FFC effects include the energy consumed in electricity production (depending on load shape), in distribution and transmission, and in extracting, processing, and transporting primary fuels (*i.e.,* coal, natural gas, petroleum fuels), and thus present a more complete picture of the impacts of energy conservation standards.

Accordingly, DOE evaluates the significance of energy savings on a case-by-case basis. As mentioned previously, the proposed standards are projected to result in estimated national FFC energy savings of 0.45 quads, the equivalent of the electricity use of 4.4 million homes

[29] Typically, each TSL is composed of specific efficiency levels for each equipment class. In the case of circulator pumps, because there is only one equipment class, each TSL is the same as its corresponding efficiency level. DOE conducted a sensitivity analysis that considers impacts for products shipped in a 9-year period.

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

[31] 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).

in one year. DOE has initially determined the energy savings from the proposed standard levels are ''significant'' within the meaning of 42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(3)(B).

F. Economic Justification

1. Specific Criteria

As noted previously, EPCA provides seven factors to be evaluated in determining whether a potential energy conservation standard is economically justified. (42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII)) The following sections discuss how DOE has addressed each of those seven factors in this rulemaking.

a. Economic Impact on Manufacturers and Consumers

In determining the impacts of a potential standard on manufacturers, DOE conducts an MIA, as discussed in section IV.J of this document. DOE first uses an annual cash-flow approach to determine the quantitative impacts. This step includes both a short-term assessment—based on the cost and capital requirements during the period between when a regulation is issued and when entities must comply with the regulation—and a long-term assessment over a 30-year period. The industry-wide impacts analyzed include (1) INPV, which values the industry on the basis of expected future cash flows, (2) cash flows by year, (3) changes in revenue and income, and (4) other measures of impact, as appropriate. Second, DOE analyzes and reports the impacts on different types of manufacturers, including impacts on small manufacturers. Third, DOE considers the impact of standards on domestic manufacturer employment and manufacturing capacity, as well as the potential for standards to result in plant closures and loss of capital investment. Finally, DOE takes into account cumulative impacts of various DOE regulations and other regulatory requirements on manufacturers.

For individual consumers, measures of economic impact include the changes in LCC and PBP associated with new or amended standards. These measures are discussed further in the following section. For consumers in the aggregate, DOE also calculates the national net present value of the consumer costs and benefits expected to result from particular standards. DOE also evaluates the impacts of potential standards on identifiable subgroups of consumers that may be affected disproportionately by a standard.

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

EPCA requires DOE to consider the savings in operating costs throughout the estimated average life of the covered equipment 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 equipment that are likely to result from a standard. (42 U.S.C. 6316(a); 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 equipment 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. 6316(a); 42 U.S.C. 6295(o)(2)(B)(i)(III)) As discussed in section III.E, 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. 6316(a); 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. 6316(a); 42 U.S.C. 6295(o)(2)(B)(i)(V)) It also directs the Attorney General to determine the impact, if any, of any lessening of competition likely to result from a proposed standard and to transmit such determination to the Secretary within 60 days of the publication of a proposed rule, together with an analysis of the nature and extent of the impact. (42 U.S.C. 6316(a); 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. 6316(a); 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; the estimated emissions impacts are reported in section V.B.6 of this document. DOE also estimates the economic value of emissions reductions resulting from the considered TSLs, as discussed in section IV.L of this document.

g. Other Factors

In determining whether an energy conservation standard is economically justified, DOE may consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6316(a); 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

EPCA creates a rebuttable presumption that an energy conservation standard is economically justified if the additional cost to the equipment 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. (42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(2)(B)(iii)). 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. 6316(a); 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 V.B.1 of this proposed rule.

G. Effective Date

EPCA does not prescribe a compliance lead time for energy conservation standards for pumps, *i.e.,* the number of years between the date of publication of a final standards rule and the date on which manufacturers must comply with the new standard. And, while 42 U.S.C. 62959(m)(4)(B) states that manufacturers shall not be required to apply new standards to a product with respect to which other new standards have been required during the prior 6-year period, the standards proposed in this document would be the first energy conservation standards for circulator pumps. The November 2016 CPWG Recommendations specified a compliance date of four years following publication of the final rule.

Two parties commented in response to the May 2021 RFI regarding effective date of potential energy conservation standards.

Grundfos recommended a 2-year compliance date due to the effort already made by the circulator pump industry to test circulator pumps. (Grundfos, No.113, at p. 1) NEEA, which recommended a 3-year compliance date, also mentioned the testing efforts and experience made by the circulator pump industry to test circulator pumps and argued that the industry is mature and capable of meeting the standard level recommended by the CPWG (which would have gone into effect by the end of 2021) at an earlier date. (NEEA, No. 115, at p. 3)

DOE agrees with commenters' arguments that the circulator pump industry is now more mature compared to 2016, and in this NOPR is proposing a 2-year compliance date for energy conservation standards. DOE is requesting comment on this proposal and notes that, depending on stakeholder comment, DOE may also consider a 3-year compliance date in the final rule.[32]

IV. Methodology and Discussion of Related Comments

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

DOE used several analytical tools to estimate the impact of the standards proposed in this document. The first tool is a spreadsheet that calculates the LCC savings and PBP of potential amended or new energy conservation standards. The national impacts analysis uses a second spreadsheet set that provides shipments projections and calculates national energy savings and net present value of total consumer costs and savings expected to result from potential energy conservation standards. DOE uses the third spreadsheet tool, the Government Regulatory Impact Model (''GRIM''), to assess manufacturer impacts of potential standards. These three spreadsheet tools are available on the DOE website for this rulemaking: *www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=66.* 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 circulator pumps. The key findings of DOE's market assessment are summarized in the following sections. See chapter 3 of the NOPR TSD for further discussion of the market and technology assessment.

1. Scope of Coverage and Equipment Classes

a. Scope

As stated in section III.B, DOE is proposing to align the scope of these proposed energy conservation standards with that of the circulator pumps test procedure. 87 FR 57264. In that notice, DOE finalized the scope of the circulator pumps test procedure such that it applies to circulator pumps that are

[32] DOE notes that, due to projected market trends, a change in the rulemaking's compliance date may lead to a small but non-negligible change in consumer and manufacturer benefits or impacts.

clean water pumps, including circulators-less-volute and on-demand circulator pumps, and excluding header pumps and submersible pumps. That scope is consistent with the recommendations of the CPWG (Docket No. EERE–2016–BT–STD–0004, No. 58).

In response to the May 2021 RFI, HI and Grundfos stated that they believed all circulator pumps are included in the scope defined by the CPWG in the term sheets. (HI, No. 112 at p. 8; Grundfos, No. 113 at p. 7).

DOE is proposing to apply energy conservation standards to all circulator pumps included in the CWPG recommendations, which excluded submersible pumps and header pumps. (Docket No. EERE–2016–BT–STD–0004, No. 58). The September 2022 TP Final Rule also excluded submersible pumps and header pumps. Any future evaluation of energy conservation standards would require a corresponding test procedure.

DOE requests comment regarding the proposed scope of energy conservation standards for circulator pumps.

Equipment Diagrams

In general, DOE establishes written definitions to designate which products or equipment fall within the scope of a test procedure or energy conservation standard. In the specific case of circulator pumps, certain scope-related definitions were adopted by the September 2022 TP Final Rule and codified at 10 CFR 431.462.

In response to the May 2021 RFI, China requested that DOE add schematic diagrams for each product in addition to the text definition to avoid misunderstandings (China, No. 111 at p. 1).

The definitions which serve to distinguish various varieties of circulator pumps were adopted nearly unchanged from those recommended by the CPWG at meeting 2. (Docket No. EERE–2016–BT–STD–0004–0021, p. 22) 10 CFR 431.462. CPWG membership included five manufacturers of circulator pumps, a trade association representing the US hydraulic industry, a trade association representing plumbing, heating, and cooling contractors, and other manufacturers of equipment which either use or are used by circulator pumps as components.

Given the strong representation of entities with deep experience in circulator pump design and for whom definitional ambiguity could be burdensome, it is reasonable to expect the CPWG-proposed definitions were viewed at least at the time of their recommendation as sufficiently clear.

Additionally, the development of diagrams which effectively serve as parallel equipment definitions creates the possibility of introducing confusion insofar as interpretations of such diagrams differ from those of the corresponding written definitions.

In view of the absence of identification of a specific definitional ambiguity and of the potential resulting confusion from a diagram that could be interpreted differently from corresponding written definitions at 10 CFR 431.462, DOE is not proposing to establish equipment diagrams in this NOPR.

DOE requests comment regarding the present circulator pump-related definitions, and in particular whether any clarifications are warranted.

b. Equipment Classes

When evaluating and establishing energy conservation standards, DOE may divide covered equipment into equipment classes by the type of energy used, or by capacity or other performance-related features that justify a different standard. (42 U.S.C. 6316(a); 42 U.S.C. 6295(q)) In making a determination whether capacity or another 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 deems appropriate. (*Id.*)

For circulator pumps, there are no current energy conservation standards and, thus, no preexisting equipment classes. However, the November 2016 Term Sheets contained a recommendation related to establishing equipment classes for circulator pumps. Specifically, ''Recommendation #1'' of the November 2016 CPWG Recommendations suggests grouping all circulator pumps into a single equipment class, though with numerical energy conservation standard values that vary as a function of hydraulic output power. (Docket No. EERE–2016–BT–STD–0004, No. 98 Recommendation #1 at p. 1)

In the May 2021 RFI, DOE requested comment regarding the CPWG recommendation to include all circulator pumps within a single equipment class.

HI agreed with the CPWG that circulator pumps should be evaluated within a single equipment class and no design options are known that are incompatible or that would necessitate an additional equipment class. (HI, No. 112 at p. 8). Grundfos also agreed with the CPWG recommendation of a single circulator pump class as long as C-values are defined based on motor size. (Grundfos, No. 113 at p. 6).

As stated in section III.B.1, circulator pumps may be offered in wet- or dry-rotor configurations, and if dry-rotor, in either close-coupled or mechanically coupled construction. Minor differences in attributes may exist across configurations. For example, during interviews with manufacturers DOE learned that wet-rotor pumps tended to be quieter, whereas dry-rotor pumps may be easier to service. In general, however, each respective pump variety serves similar applications. Similarly, data provided to DOE as part of the confidential submission process indicates that each variety may reach similar efficiency levels when operated with similar motor technology. Accordingly, no apparent basis exists to warrant establishing separate equipment classes by circulator pump configuration.

One additional salient design attribute of circulator pumps is housing material. Generally, circulator pumps are built using cast iron, bronze, or stainless-steel housing. Bronze and stainless steel (sometimes discussed collectively with the descriptor ''nonferrous'') carry greater corrosion resistance and are thus suitable for use in applications in which they will be exposed to corrosive elements. Typically, corrosion resistance is most important in ''open loop'' applications in which new water is constantly being replaced.

By contrast, cast iron (sometimes described as ''ferrous'' to distinguish from the ''nonferrous'' descriptor applied to bronze and stainless steel) pump housing is less resistant to corrosion than bronze or stainless steel, and as a result is generally limited to ''closed loop'' applications in which the same water remains in the hydraulic circuit, in which it will eventually become deionized and less able to corrode metallic elements of circulator pumps. Cast iron is generally less expensive to manufacture than bronze or stainless steel, and as a result bronze or stainless-steel circulator pumps are less commonly selected by consumers for applications which do not strictly require them.

Although a difference in utility exists across circulator pump housing materials, no such difference exists in ability to reach higher efficiencies. All housing materials are able to reach all efficiency levels analyzed in this NOPR. Accordingly, no apparent basis exists to warrant establishing separate equipment classes by circulator pump housing material.

DOE requests comment regarding the proposal to analyze all circulator pumps within a single equipment class.

On-Demand Circulator Pumps

On-demand circulator pumps respond to actions of the user, rather than other factors such as pressure, temperature, or time. In the September 2022 TP Final Rule, DOE adopted the following definition for on-demand circulator pumps, which is consistent with that recommended by the CPWG (Docket No. EERE–2016–BT–STD–0004, No. 98 Recommendation 4 at p. 5):

On-demand circulator pump means a circulator pump that is distributed in commerce with an integral control that:

• Initiates water circulation based on receiving a signal from the action of a user [of a fixture or appliance] or sensing the presence of a user of a fixture and cannot initiate water circulation based on other inputs, such as water temperature or a pre-set schedule.

• Automatically terminates water circulation once hot water has reached the pump or desired fixture.

• Does not allow the pump to operate when the temperature in the pipe exceeds 104 °F or for more than 5 minutes continuously.

10 CFR 431.462.

In response to the May 2021 RFI, HI commented that greater energy savings could be achieved through demand-based variable speed controls than would arise from redesign of a circulator pump's hydraulic components. (HI, No. 112 at p. 7). DOE interprets this comment to refer to other controls than user-reacting, both because of the specific naming of variable-speed (which is not necessary for user-triggered controls) and because of the context in which the comment was made. Nonetheless, it is logically possible that on-demand circulator pumps may indeed save energy relative to non-on-demand circulator pumps in certain applications.

The TP final rule (87 FR 57264) responded to a number of comments received in response to the December 2021 TP NOPR, which were discussed therein. Several commenters encouraged DOE to develop an adjustment to the CEI metric that accounted for the potential of on-demand circulator pumps to save energy in certain contexts. (EERE–2016–BT–TP–0033, No. 10 at p. 5; EERE–2016–BT–TP–0033, No. 11 at pp. 4–5). Other commenters did not support an adjusted CEI metric for on-demand circulator pumps in the test procedure final rule, but recommended evaluation of such in a potential future rulemaking. (Docket No. EERE–2016–BT–TP–0033, No. 9 at p.3; EERE–2016–BT–TP–0033, No. 7 at p. 1).

DOE ultimately did not adopt any modification to the CEI metric for on-demand circulator pumps in the final rule but stated that it would consider the appropriate scope and product categories for standards for on-demand circulator pumps in a separate energy conservation rulemaking.

As stated in section III.B, DOE is proposing to align the scope of energy conservation standards for circulator pumps consistently with that of the test procedure for circulator pumps, which includes on-demand circulator pumps. 87 FR 57264.

In developing the equipment class structure, DOE is directed to consider, among other factors, performance-related features that justify a different standard and the utility of such features to the consumer. (42 U.S.C. 6316(a); 42 U.S.C. 6295(q)) In the specific case of on-demand circulator pumps, the primary distinguishing feature (*i.e.,* ability to react to user action or presence) is not obviously performance related. It does not impede the ability of circulator pumps to reach the same performance levels as any other circulator pumps. On that basis, DOE is proposing not to establish a separate equipment class for on-demand circulator pumps in this NOPR.

It remains true, as observed by commenters, that in certain applications on-demand circulator pumps may save energy relative to non-on-demand circulator pumps through reduced aggregate operating durations. Operating duration of on-demand circulator pumps is considered in the energy use analysis, which is described in section IV.E.3 of this document.

DOE requests comment on its proposal not to establish a separate equipment class for on-demand circulator pumps.

2. Technology Options

In the preliminary market analysis and technology assessment, DOE identified 3 technology options that would be expected to improve the efficiency of circulator pumps, as measured by the DOE test procedure:

• Improved hydraulic design
• More efficient motors
• Increase number of motor speeds

Chapter 3 of the NOPR TSD details each of these technology options. The following sections summarize the stakeholder comments on these technology option by variety.

a. Hydraulic Design

The performance characteristics of a pump, such as flow, head, and efficiency, are influenced by the pump's hydraulic design. For purposes of DOE's analysis, ''hydraulic design'' is a broad term used to describe the system design of the wetted components of a pump. Although hydraulic design focuses on the specific hydraulic characteristics of the impeller and the volute/casing, it also includes design choices related to bearings, seals, and other ancillary components.

Impeller and volute/casing geometries, clearances, and associated components can be redesigned to a higher efficiency (at the same flow and head) using a combination of techniques including historical best practices and modern computer-aided design (CAD) and analysis methods. The wide availability of modern CAD packages and techniques now enables pump designers to reach designs with improved vane shapes, flow paths, and cutwater designs more quickly, all of which work to improve the efficiency of the pump as a whole.

In response to the May 2021 RFI, Grundfos stated there are only small efficiency gains to be gained through hydraulic design. (Grundfos, No. 113 at p. 6). HI responded to the May 2021 RFI explaining the savings gained through improved hydraulic design is not sufficient to meet EPCA requirements. Additionally, the energy savings does not offset the cost of modifying the hydraulic design. (HI, No. 112 at p. 7)

b. More Efficient Motors

Different constructions of motors have different achievable efficiencies. Two general motor constructions are present in the circulator pump market: induction motors, and ECMs. Induction motors include both single-phase and three-phase configurations. Single-phase induction motors may be further differentiated and include split phase, capacitor-start induction-run (CSIR), capacitor-start capacitor-run (CSCR), and PSC motors. HI stated that the majority of circulator pumps currently available on the market use PSC motors, which is a variety of induction motor (HI, No. 112 at p. 11). DOE confirmed using confidentially submitted manufacturer data that induction motor circulator pumps account for the majority of the circulator pump market.

The efficiency of an induction motor can be increased by redesigning the motor to reduce slip losses between the rotor and stator components, as well as reducing mechanical losses at seals and bearings. ECMs are generally more efficient than induction motors because their construction minimizes slip losses between the rotor and stator components. Unlike induction motors, however, ECMs require an electronic drive to function. This electronic drive consumes electricity, and variations in drive losses and mechanical designs lead to a range of ECM efficiencies. In response to the May 2021 RFI HI and NEEA stated ECMs are experiencing a slow growth in the market, with faster growth in areas where there are utility incentives. (HI, No. 112 at p. 10; NEEA, No. 115 at p. 4).

The performance standard for this rule is based upon wire-to-water efficiency, which is defined as the hydraulic output power of a circulator pump divided by its line input power and is expressed as a percentage. The achievable wire-to-water efficiency of circulator pumps is influenced by both hydraulic efficiency and motor efficiency. As part of the engineering analysis (Section IV.C), DOE assessed the range of attainable wire-to-water efficiencies for circulator pumps with induction motors, and those with ECMs, over a range of hydraulic power outputs. Because circulator pump efficiency is measured on a wire-to-water basis, it is difficult to fully separate differences due to motor efficiency from those due to hydraulic efficiency. In response to the May 2021 RFI, HI stated that improved motor efficiency and demand-based variable speed controls can achieve greater energy savings than from improved hydraulic efficiency. (HI, No. 112 at p. 7). However, in redesigning a pump model to meet today's proposed standard, manufacturers could consider both hydraulic efficiency and motor efficiency.

Higher motor capacities are generally required for higher hydraulic power outputs, and as motor capacity increases, the attainable efficiency of the motor at full load also increases. Higher horsepower motors also operate close to their peak efficiency for a wider range of loading conditions.[33]

Circulator pump manufacturers either manufacture motors in-house or purchase complete or partial motors from motor manufacturers and/or distributors. Manufacturers may select an entirely different motor or redesign an existing motor in order to improve a pump's motor efficiency.

c. Speed Reduction

Circulator pumps with the variable speed capability can reduce their energy consumption by reducing pump speed to match load requirements. As discussed in the September 2022 TP Final Rule, the CER metric is a weighted average of input powers at each test point relative to BEP flow. The circulator pump test procedure allows CER values for multi- and variable-speed circulator pumps to be calculated as the weighted average of input powers at full speed BEP flow, and reduced speed at flow points less than BEP; CER for single-speed circulator pumps is calculated based only on input power at full speed. 10 CFR 431.464(c)(2). Due to pump affinity laws, variable-speed circulator pumps will achieve reduced power consumption at flow points less than BEP by reducing their rotational speed to more closely match required system head. As such, the CER metric grants benefits on circulator pumps capable of variable speed operation.

Specifically, pump affinity laws describe the relationship of pump operating speed, flow rate, head, and hydraulic power. According to the affinity laws, flow varies proportionally with the pump's rotational speed, as described in equation (6). The affinity laws also establish that pump total head is proportional to speed squared, as described in equation (7), and pump hydraulic power is proportional to speed cubed, as described in equation (8)

$$\frac{Q_1}{Q_2} = \frac{N_1}{N_2} \qquad (6)$$

$$\frac{H_1}{H_2} = \left(\frac{N_1}{N_2}\right)^2 \qquad (7)$$

$$\frac{P_1}{P_2} = \left(\frac{N_1}{N_2}\right)^3 \qquad (8)$$

Where:

Q_1 and Q_2 = volumetric flow rate at two operating points
H_1 and H_2 = pump total head at two operating points
N_1 and N_2 = pump rotational speed at two operating points
P_1 and P_2 = pump hydraulic power at two operating points

This means that a pump operating at half speed will provide one half of the pump's full-speed flow and one eighth of the pump's full-speed power.[34] However, pump affinity laws do not account for changes in hydraulic and motor efficiency that may occur as a pump's rotational speed is reduced. Typically, hydraulic efficiency and motor efficiency will be reduced at lower operating speeds. Consequently, at reduced speeds, power consumption is not reduced as drastically as hydraulic output power. Even so, the efficiency losses at low-speed operation are typically outweighed by the

[33] U.S. DOE Building Technologies Office. *Energy Savings Potential and Opportunities for High-Efficiency Electric Motors in Residential and Commercial Equipment.* December 2013. Prepared for the DOE by Navigant Consulting. pp. 4. Available at *https://energy.gov/sites/prod/files/2014/02/f8/Motor%20Energy%20Savings%20Potential%20Report%202013-12-4.pdf DFR.*

[34] A discussion of reduced-speed pump dynamics is available at *www.regulations.gov/document?D=EERE-2015-BT-STD-0008-0099.*

exponential reduction in hydraulic output power at low-speed operation; this results in a lower input power at low-speed operation at flow points lower than BEP.

Circulator pump speed controls may be discrete or continuous, as well as manual or automatic. Circulator pumps with discrete speed controls vary the circulator pump's rotational speed in a stepwise manner. Discrete controls are found mostly on circulator pumps with induction motors and have several speed settings that are can be used to allow contractors greater installation flexibility with a single circulator pump model. For these circulator pumps, the speed is set manually with a dial or buttons by the installer or user and operate at a constant speed once the installation is complete.

Circulator pumps equipped with automatic speed controls can adjust the circulator pump's rotational speed based on a signal from differential pressure or temperature sensors, or an external input signal from a boiler. The variable frequency drives required for ECMs makes them fairly amenable to the addition of variable speed control logic; currently the vast majority of circulator pumps with automatic continuously variable speed controls also have ECM motors. However, some circulator pump models with induction motors also come equipped with automatic continuous variable speed controls. While automatic controls can reduce energy consumption by allowing circulator pump speed to dynamically respond to changes in system conditions, these controls can also reduce energy consumption by reducing speed to a single, constant value that is optimized based on system head at the required flow point. Automatic controls can be broadly categorized into two groups: pressure-based controls, and temperature-based controls.

Pressure-based controls vary the circulator pump speed based on changes in the system pressure. These pressure changes are typically induced by a thermostatically controlled zone valve that monitors the space temperature in different zones and calls for heat (*i.e.,* opens the valve) when the space/zone temperature is below the set-point, similar to a thermostat. In this type of control, a pressure sensor internal to the circulator pump determines the amount of pressure in the system and adjusts the circulator pump speed to achieve the desired system pressure.

Temperature-based controls monitor the supply and return temperature to the circulator pump and modulates the circulator pump's speed to maintain a fixed temperature drop across the system. Circulator pumps with temperature-based controls are able to serve the heat loads of a conditioned space at a lower speed, and therefore lower input power, than the differential pressure control because it can account for the differential temperature between the space and supplied hot water, delivering a constant BTU/hr load to the space when less heat is needed even in a given zone or zones.

In response to the 2021 RFI, Grundfos stated the ability to reduce speed is the most important criteria for achieving higher efficiency in circulator products. (Grundfos, No. 113 at p. 6). Reducing performance according to system need can achieve 50–60% savings (*Id.*). Grundfos explains further that the ability to run at reduced speeds is the costliest solution, but the larger savings can offset the higher costs and to help offset conversion to this technology (*Id.*). Understanding the lifetime energy saving compared to the higher initial cost is important for market adoption (*Id.*). The largest concern for the implementation is that optimization of the control mode can be problematic for an end user and requires higher level knowledge to gain maximum efficiencies (*Id.*). NEEA responded with data showing that currently, fewer than one-fifth of circulator pumps are equipped with speed control technology. (NEEA, No. 115 at p. 6). This shows the significant potential the market has for energy savings by using more pumps with the ability to operate at reduced speeds.

In the May 2021 RFI, DOE requested comment on increasing circulator pump efficiency using improved hydraulic design, more efficient motors, and/or increased number of motor speeds.

HI responded stating they are not aware of other design option that increase efficiency. (HI, No. 112 at p. 7). HI stated that the market is focused on improved motors and demand-based variable speed control and does not believe any other design changes, so far discovered, would occur (*Id.*). HI believes ECM circulator pumps with variable speed controls represent the maximum technology option. (*Id.*). The initial cost for these techniques is higher to consumers due to the higher cost of the efficient motor and incorporation of controls; however, the total life cycle cost to the consumer should be lower due to energy savings (*Id.*). The addition of ECMs and controls adds complexity to manufacturing due to scarcity of materials, reliance on non-domestic sources, automated assembly, and special tooling. Further complexity associated with ECMs are disposal and recycling programs (*Id.*). HI recommends DOE conduct manufacturer interviews to get additional updated information such as costs for design options to update the previous data request from 2016 (HI, No. 112 at p. 8). DOE received this data in the 2022 manufacturer interviews.

Grundfos responded stating the technology described is a fair description of the current state of the market. (Grundfos, No. 113 at p. 6). Grundfos explained that the most advanced products in the market are approaching the maximum possible efficiency values and any further energy use reductions would only be realized through more efficient system designs (piping/valves/etc.) and adoption of more efficient system interaction (interconnectivity to appliances, smart homes, etc.) (*Id.*).

In the May 2021 RFI, DOE requested comment on whether certain design options may not be applicable to specific equipment classes. Grundfos responded stating it does not see any limitations in design options for equipment classes. (Grundfos, No. 113 at p. 8). HI responded stating that no design options are known that are incompatible or that would necessitate an additional equipment class. (HI, No. 112 at p. 8).

Based on comments, DOE concludes that the technology options identified are sufficient to conduct the engineering analysis, which is discussed in section IV.C.

B. Screening Analysis

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

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

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

(3) *Impacts on product utility or product availability.* If it is determined that a technology would have a significant adverse impact on the utility of the product for significant subgroups of consumers or would result in the unavailability of any covered equipment type with performance characteristics

(including reliability), features, sizes, capacities, and volumes that are substantially the same as products generally available in the United States at the time, it will not be considered further.

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

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

10 CFR 431.4; 10 CFR part 430, subpart C, appendix A, sections 6(b)(3) and 7(b).

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

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

1. Screened-Out Technologies

In the May 2021 RFI, DOE requested comment regarding the screening criteria and on what impact they may have on currently identified and potential future possible technology options for circulator pumps. 86 FR 24516, 24530 (May 26, 2021).

In response, HI commented that ECMs and controls could potentially become a problem due to scarcity of necessary component materials, reliance on foreign sources, and the degree of automation and specialized tooling involved in the manufacture of ECMs. (HI, No. 112 at p. 7)

DOE interprets HI's comment to be discussing a hypothetical future scenario, and not to be stating that ECMs are unavailable today. Accordingly, ECMs have been retained as a design option for the analysis of this NOPR. DOE will monitor the market for circulator pumps with ECMs and consider removing ECMs as a design option in a future revision to the analysis if availability declines to the degree that circulator pump manufacturers are unable to obtain them, or unable to obtain them at a price level that would create a positive estimated economic proposition for purchasers of ECM-equipped circulator pumps.

DOE requests comment regarding the current and anticipated forward availability of ECMs and components necessary for their manufacture.

2. Remaining Technologies

Through a review of each technology, DOE tentatively concludes that all the other identified technologies listed in section IV.A.2 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:

- Improved hydraulic design
- More efficient motors
- Increase number of motor speeds

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.

C. Engineering Analysis

The purpose of the engineering analysis is to establish the relationship between the efficiency and cost of circulator pumps. 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 circulator pumps, DOE considers technologies and design option combinations not eliminated by the screening analysis. For each circulator pump class, DOE estimates the baseline cost, as well as the incremental cost for the circulator pump at efficiency levels above the baseline. The output of the engineering analysis is a set of cost-efficiency ''curves'' that are used in downstream analyses (*i.e.,* the LCC and PBP analyses and the NIA).

1. Representative Equipment

To assess MPC-efficiency relationships for all circulator pumps available on the market, DOE selected a set of representative units to analyze. These representative units exemplify capacities and hydraulic characteristics typical of circulator pumps currently found on the market. In general, to determine representative capacities and hydraulic characteristics, DOE analyzed the distribution of all available models and/or shipments and discussed its findings with the CPWG. The analysis focused on single speed induction motors as they represent the bulk of the baseline of the market.

To start the selection process, nominal horsepower targets based on CPWG feedback of 1/40, 1/25, 1/12,1/6, and 1 HP were selected for representative units (Docket No. EERE–2016–BT–STD–0004–0061, p. 9). At each horsepower target, pump curves were constructed from manufacturer data. Near identical pump curves were consolidated into single curves and curves that represent circulator pumps with low shipments were filtered out to remove the impact of low-selling pumps. These high sales consolidated pump curves were then grouped with similar curves to form clusters of similar circulator pumps. A representative curve was then constructed from this cluster of pumps by using the mean flow and head at each test point. Eight of these curves were constructed to form the eight representative units used in further analyses.

a. Circulator Pump Varieties

Circulator pumps varieties are used to classify different pumps in industry. Wet rotor circulator pump are commonly referred to as CP1, dry rotor, two-piece circulator pumps are commonly referred to as CP2, and dry rotor, three-piece circulator pumps are commonly referred to as CP3. The distinction of circulator varieties does not have a large impact on performance with all circulator pump varieties being capable of achieving any particular performance curve. Due to the performance similarities, the groups of pump curves used to generate representative units contain a mix of all three circulator varieties. Although DOE analyzed CP1, CP2, and CP3 circulator varieties as a single equipment class, representative units were selected such that all circulator varieties were captured in the analysis.

The parameters of each of the representative units used in this analysis are provided in Table IV.1.

TABLE IV.1—REPRESENTATIVE UNIT PARAMETERS

Representative unit	Nominal power (hp)	Flow at BEP (GPM)	Head at BEP (ft)	Phydro at BEP (hp)	Variety
1	1/40	3.073	3.043	0.002	CP1.
2	1/40	5.759	6.628	0.010	CP1.
3	1/25	10.065	9.282	0.024	CP1.
4	1/25	10.525	6.064	0.016	CP1.
5	1/12	17.941	6.510	0.030	CP1, CP2, CP3.
6	1/6	19.521	20.254	0.100	CP1, CP2, CP3.
7	1/6	36.531	10.601	0.098	CP1, CP2, CP3.
8	1	61.200	36.782	0.569	CP1, CP3.

2. Efficiency Analysis

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

In this proposed rulemaking, DOE relies on an efficiency-level approach due to the availability of robust data characterizing both performance and selling price at a variety of efficiency levels.

a. Baseline Efficiency

For each equipment 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 equipment class represents the characteristics of an 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 all representative units, DOE modeled a baseline circulator pump as one with a PSC motor.

b. 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.

For all representative units, DOE modeled a max-tech circulator pump as one with an ECM and operated on a differential temperature-based control scheme.

c. EL Analysis

DOE examined the influence of different paraments on wire-to-water efficiency including hydraulic power. Hydraulic power has a significant impact on wire to water efficiency as seen in the different representative units. To find the correlation, the relationship of power and wire to water efficiency were evaluated for both single speed induction and single speed ECM motors. Multiple relationships were tested with a logarithmic relationship being the most accurate. This logarithmic relationship can be used to set efficiency levels inclusive of all representative units across the ranges of horsepower.

To calculate wire to water efficiency at part-load conditions, wire-to-water efficiency at full-load conditions is multiplied by a part-load coefficient, represented by alpha (α). As instructed by the CPWG, a mean fit was developed for each part load test point across representative units to find a single value to use for alpha for each test point. This methodology was conducted independently for single speed induction, single speed ECM, and variable speed ECM to find unique alphas at each point for each motor type. The unique alpha values are provided in Table IV.2.

TABLE IV.2—MEAN ALPHA VALUES BY TEST POINT AND MOTOR CONFIGURATION

Motor configuration	Test point load	Mean alpha
Single Speed Induction	25	0.4671
	50	0.7674
	75	0.9425
	110	0.9835
Single Speed ECM	25	0.4845
	50	0.7730
	75	0.9408
	110	0.9841
Variable Speed ECM	25	0.5914
	50	0.8504
	75	0.9613

DOE sets EL 0 as the baseline configuration of circulator pumps representing the minimum efficiency available on the market. DOE used the logarithmic function developed when finding the relationship between hydraulic power and wire-to-water efficiency to find the lower second percentile of single speed induction circulator pumps to set as EL 0. DOE finds single speed circulator pumps with induction motors have the lowest wire-to-water efficiency and are being set as EL 0, as agreed on at CPWG meeting 8. (Docket No. EERE–2016–BT–STD–0004–0061, p. 15)

DOE set EL 1 to correspond approximately to single-speed induction motors with improved wire-to-water efficiency. EL 1 is an intermediate efficiency level between the baseline EL 0 and more efficient ECMs defined in higher efficiency levels. EL 1 was defined as the halfway between the most efficient single speed induction motors and the baseline used as EL 0.

EL 2 is set to correspond approximately to single-speed ECMs. The values for these circulator pumps are found using the same base logarithmic function that were used when finding the relationship between hydraulic power and wire-to-water efficiency. EL 2 corresponds to a CEI of 1.00, which is the level recommended by the CPWG in the November 2016 CPWG Recommendations.

EL 3 is set to correspond approximately to variable-speed ECMs with automatic proportional pressure control. The effect of a 50 percent proportional pressure control is applied using equation (9) for each part load test point. The wire-to-water efficiency at each test point is found using the alpha values for variable speed ECM values for alpha.

$$H = \left(\frac{1}{2}\right) H_{100\%} \left(\frac{Q_i}{Q_{100}} + 1\right) \quad \textbf{(9)}$$

Where:

H_i = total system head at each load point *i* (ft);

Q_i = flow rate at each load point *i* (gpm);

$Q_{100\%}$ = flow rate at 100 percent of BEP flow at maximum speed (gpm); and

$H_{100\%}$ = total pump head at 100 percent of BEP flow at maximum speed (ft).

EL 4 is the max-tech efficiency level, which represents the circulator pumps with the maximum possible efficiency. EL 4 is set as variable speed ECMs with automatic differential temperature control. The effects of the controls are calculated using equation (10). Similar to EL3, the wire-to-water efficiencies are found using the alpha values for variable speed ECMs.

$$H = \left(0.8\left(\frac{Q_i}{Q_{100}}\right)^2 + 0.2\right) H_{100\%} \quad \textbf{(10)}$$

In response to the May 2021 RFI, Grundfos stated they do not believe there are any new technologies for DOE to consider and the maximum efficiency levels are appropriate for consideration. (Grundfos, No. 113 at p. 7).

For pumps that do not fit exactly into a representative unit, the DOE developed a continuous function for wire-to-water efficiency at BEP. The technique extends the representative units for each EL to compute wire-to-water efficiency at BEP for all circulator pumps by using the logarithmic function based on hydraulic power represented in equation (11). Variable *d* can be solved by using equation (12) and the variables for a and b are presented in Table IV.3 which contains different values for each efficiency level.

$$\eta_{WTW} = a \ln\left(P_{hydro} + b\right) + d \quad \textbf{(11)}$$

$$d = -a \ln(b) \quad \textbf{(12)}$$

Where:

η_{WTW} = wire-to-water efficiency

P_{hydro} = hydraulic power (HP);

TABLE IV.3—PARAMETERS USED TO SOLVE FOR WIRE-TO-WATER EFFICIENCY

EL	a	b
0	7.065278	0.003958
1	8.727971	0.003223
2	10.002583	0.001140
3	10.002583	0.001140
4	10.002583	0.001140

3. Cost Analysis

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

• *Physical teardowns:* Under this approach, DOE physically dismantles a commercially available product, component-by-component, to develop a detailed bill of materials for the product.

• *Catalog teardowns:* In lieu of physically deconstructing a product, DOE identifies each component using parts diagrams (available from manufacturer websites or appliance repair websites, for example) to develop the bill of materials for the product.

• *Price surveys:* If neither a physical nor catalog teardown is feasible (for example, for tightly integrated products such as fluorescent lamps, which are infeasible to disassemble and for which parts diagrams are unavailable) or cost-prohibitive and otherwise impractical (*e.g.,* large commercial boilers), DOE conducts price surveys using publicly available pricing data published on major online retailer websites and/or by soliciting prices from distributors and other commercial channels.

In the present case, DOE conducted the analysis using a combination of physical teardowns and price surveys. The resulting bill of materials provides the basis for the manufacturer production cost (''MPC'') estimates.

4. Cost-Efficiency Results

The results of the engineering analysis are reported as cost-efficiency data (or ''curves'') in the form of wire-to-water efficiency versus MPC (in dollars). DOE developed 15 curves representing the 15 representative units in the analysis. The methodology for developing the curves started with determining the energy consumption for baseline equipment and MPCs for this equipment. Above the baseline, DOE implemented design options using the ratio of cost to savings, and implemented only one design option at each level. Design options were implemented until all available technologies were employed (*i.e.,* at a max-tech level).

Table IV.4, Table IV.5, Table IV.6 contain cost-efficiency results of the engineering analysis. MPCs are presented for circulator pumps with both ferrous and nonferrous housing material. Housing material does not significantly affect the energy consumption of circulator pumps, but does alter production cost. Housing material is discussed further in section IV.A.1.b. See TSD Chapter 5 for additional detail on the engineering analysis and TSD Appendix 5B for complete cost-efficiency results.

TABLE IV.4—ENGINEERING RESULTS—CP1, REP. UNITS 1–4

Rep unit	HP	Description	Construction	EL	MPC—Ferrous	MPC—Nonferrous
1	1/40	Single Speed, Induction	CP1	0	$31.34	$35.61
1	1/40	Improved Single Speed, Induction	CP1	1	31.34	35.61
1	1/40	Single Speed, ECM	CP1	2	47.91	51.87
1	1/40	Variable Speed, ECM, dP	CP1	3	59.23	63.18
1	1/40	Variable Speed, ECM, dT	CP1	4	68.28	72.24
1	1/40	Variable Speed, ECM, dT	CP1	5	68.28	72.24
2	1/40	Single Speed, Induction	CP1	0	34.44	39.13
2	1/40	Improved Single Speed, Induction	CP1	1	34.44	39.13
2	1/40	Single Speed, ECM	CP1	2	53.57	57.92
2	1/40	Variable Speed, ECM, dP	CP1	3	64.88	69.23
2	1/40	Variable Speed, ECM, dT	CP1	4	73.94	78.28
2	1/40	Variable Speed, ECM, dT	CP1	5	73.94	78.28
3	1/25	Single Speed, Induction	CP1	0	40.82	54.57
3	1/25	Improved Single Speed, Induction	CP1	1	40.82	54.57
3	1/25	Single Speed, ECM	CP1	2	65.65	78.41
3	1/25	Variable Speed, ECM, dP	CP1	3	76.96	89.72
3	1/25	Variable Speed, ECM, dT	CP1	4	86.02	98.78
3	1/25	Variable Speed, ECM, dT	CP1	5	86.02	98.78
4	1/25	Single Speed, Induction	CP1	0	40.82	54.57
4	1/25	Improved Single Speed, Induction	CP1	1	40.82	54.57
4	1/25	Single Speed, ECM	CP1	2	65.65	78.41
4	1/25	Variable Speed, ECM, dP	CP1	3	76.96	89.72
4	1/25	Variable Speed, ECM, dT	CP1	4	86.02	98.78
4	1/25	Variable Speed, ECM, dT	CP1	5	86.02	98.78

TABLE IV.5—ENGINEERING RESULTS—CP1, REP. UNITS 5–8

Rep unit	HP	Description	Construction	EL	MPC—Ferrous ($)	MPC—Nonferrous ($)
5	1/12	Single Speed, Induction	CP1	0	46.89	62.69
5	1/12	Improved Single Speed, Induction	CP1	1	46.89	62.69
5	1/12	Single Speed, ECM	CP1	2	84.51	99.17
5	1/12	Variable Speed, ECM, dP	CP1	3	95.83	110.48
5	1/12	Variable Speed, ECM, dT	CP1	4	104.88	119.54
5	1/12	Variable Speed, ECM, dT	CP1	5	104.88	119.54

TABLE IV.5—ENGINEERING RESULTS—CP1, REP. UNITS 5–8—Continued

Rep unit	HP	Description	Construction	EL	MPC—Ferrous ($)	MPC—Nonferrous ($)
6	1/6	Single Speed, Induction	CP1	0	58.59	78.32
6	1/6	Improved Single Speed, Induction	CP1	1	58.59	78.32
6	1/6	Single Speed, ECM	CP1	2	135.61	153.92
6	1/6	Variable Speed, ECM, dP	CP1	3	146.93	165.24
6	1/6	Variable Speed, ECM, dT	CP1	4	155.98	174.29
6	1/6	Variable Speed, ECM, dT	CP1	5	155.98	174.29
7	1/6	Single Speed, Induction	CP1	0	58.59	78.32
7	1/6	Improved Single Speed, Induction	CP1	1	58.59	78.32
7	1/6	Single Speed, ECM	CP1	2	135.61	153.92
7	1/6	Variable Speed, ECM, dP	CP1	3	146.93	165.24
7	1/6	Variable Speed, ECM, dT	CP1	4	155.98	174.29
7	1/6	Variable Speed, ECM, dT	CP1	5	155.98	174.29
8	1	Single Speed, Induction	CP1	0	246.65	314.15
8	1	Improved Single Speed, Induction	CP1	1	246.65	314.15
8	1	Single Speed, ECM	CP1	2	353.43	416.06
8	1	Variable Speed, ECM, dP	CP1	3	364.75	427.38
8	1	Variable Speed, ECM, dT	CP1	4	373.80	436.43
8	1	Variable Speed, ECM, dT	CP1	5	373.80	436.43

TABLE IV.6—ENGINEERING RESULTS—CP2 AND CP3

Rep unit	HP	Description	Construction	EL	MPC—Ferrous ($)	MPC—Nonferrous ($)
5	1/12	Single Speed, Induction	CP2	0	70.68	95.00
5	1/12	Improved Single Speed, Induction	CP2	1	70.68	95.00
5	1/12	Single Speed, ECM	CP2	2	116.64	139.20
5	1/12	Variable Speed, ECM, dP	CP2	3	127.95	150.52
5	1/12	Variable Speed, ECM, dT	CP2	4	137.00	159.57
5	1/12	Variable Speed, ECM, dT	CP2	5	137.00	159.57
6	1/6	Single Speed, Induction	CP2	0	110.21	142.23
6	1/6	Improved Single Speed, Induction	CP2	1	110.21	142.23
6	1/6	Single Speed, ECM	CP2	2	166.86	196.57
6	1/6	Variable Speed, ECM, dP	CP2	3	178.17	207.88
6	1/6	Variable Speed, ECM, dT	CP2	4	187.22	216.94
6	1/6	Variable Speed, ECM, dT	CP2	5	187.22	216.94
7	1/6	Single Speed, Induction	CP2	0	110.21	142.23
7	1/6	Improved Single Speed, Induction	CP2	1	110.21	142.23
7	1/6	Single Speed, ECM	CP2	2	166.86	196.57
7	1/6	Variable Speed, ECM, dP	CP2	3	178.17	207.88
7	1/6	Variable Speed, ECM, dT	CP2	4	187.22	216.94
7	1/6	Variable Speed, ECM, dT	CP2	5	187.22	216.94
5	1/12	Single Speed, Induction	CP3	0	103.19	130.25
5	1/12	Improved Single Speed, Induction	CP3	1	103.19	130.25
5	1/12	Single Speed, ECM	CP3	2	157.00	182.10
5	1/12	Variable Speed, ECM, dP	CP3	3	168.31	193.41
5	1/12	Variable Speed, ECM, dT	CP3	4	177.36	202.47
5	1/12	Variable Speed, ECM, dT	CP3	5	177.36	202.47
6	1/6	Single Speed, Induction	CP3	0	160.89	246.28
6	1/6	Improved Single Speed, Induction	CP3	1	160.89	246.28
6	1/6	Single Speed, ECM	CP3	2	224.59	303.82
6	1/6	Variable Speed, ECM, dP	CP3	3	235.91	315.13
6	1/6	Variable Speed, ECM, dT	CP3	4	244.96	324.19
6	1/6	Variable Speed, ECM, dT	CP3	5	244.96	324.19
7	1/6	Single Speed, Induction	CP3	0	160.89	246.28
7	1/6	Improved Single Speed, Induction	CP3	1	160.89	246.28
7	1/6	Single Speed, ECM	CP3	2	224.59	303.82
7	1/6	Variable Speed, ECM, dP	CP3	3	235.91	315.13
7	1/6	Variable Speed, ECM, dT	CP3	4	244.96	324.19
7	1/6	Variable Speed, ECM, dT	CP3	5	244.96	324.19
8	1	Single Speed, Induction	CP3	0	472.16	697.64
8	1	Improved Single Speed, Induction	CP3	1	472.16	697.64
8	1	Single Speed, ECM	CP3	2	604.20	813.41
8	1	Variable Speed, ECM, dP	CP3	3	615.52	824.73
8	1	Variable Speed, ECM, dT	CP3	4	624.57	833.78
8	1	Variable Speed, ECM, dT	CP3	5	624.57	833.78

5. Manufacturer Markup and Manufacturer Selling Price

To account for manufacturers' non-production costs and profit margin, DOE applies a non-production cost multiplier (the manufacturer markup) to the full MPC. The resulting MSP is the price at which the manufacturer can recover production and non-production costs. To calculate the manufacturer markups, DOE used data from 10–K reports [35] submitted to the U.S. Securities and Exchange Commission (''SEC'') by the publicly-owned circulator pump manufacturers. DOE then averaged the financial figures spanning the years 2019 to 2021 to calculate the initial estimate of markups for circulator pumps for this rulemaking. During the 2022 manufacturer interviews, DOE discussed the manufacturer markup with manufacturers and used the feedback to modify the manufacturer markup calculated through review of SEC 10–K reports.

To calculate the MSP for circulator pump equipment, DOE multiplied the calculated MPC at each efficiency level by the manufacturer markup. See chapter 12 of the NOPR TSD for more details about the manufacturer markup calculation and the MSP calculations.

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 equipment prices to cover business costs and profit margin.

For circulator pumps, the main parties in the distribution chain are (1) sales representatives (reps); (2) distributors; (3) contractors; and (4) original equipment manufacturers (OEMs). For each actor in the distribution chain, DOE developed baseline and incremental markups. Baseline markups are applied to the price of equipment 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.[36]

DOE identified distribution channels for circulator pumps and estimated their respective shares of shipments by sector (residential and commercial) based on feedback from manufacturers and the CPWG (Docket No. EERE–2016–BT–STD–0004, No. 49 at p. 51), as shown in Table IV.7.

TABLE IV.7—CIRCULATOR PUMPS DISTRIBUTION CHANNELS AND RESPECTIVE MARKET SHARES

Channel: from manufacturer	Residential shipments share (%)	Commercial shipments share (%)
Sales Rep → Contractor → End User		37
Sales Rep → Distributor → Contractor → End User	73	36
Distributor → End User		2
Sales Rep → Distributor → End User	2	
OEM → Contractor → End User	12	12
OEM → Distributor → Contractor → End User	13	13
Total	100	100

The sales representative in the distribution chain serves the role of a wholesale distributor, as they do not take commission from the sale, but buy the equipment and take title to it. The OEM channels represent sales of circulator pumps, which are included in other equipment, such as hot water boilers.

To estimate average baseline and incremental markups, DOE relied on several sources, including: (1) U.S. Census Bureau 2017 Annual Wholesale Trade Survey (for sales representatives and circulator wholesalers), (2) U.S. Census Bureau 2017 Economic Census data [37] on the residential and commercial building construction industry (for contractors), and (3) the Heating, Air Conditioning & Refrigeration Distributors International (''HARDI'') 2013 Profit Report [38] (for equipment wholesalers). In addition to markups of distribution channel costs, DOE applied state and local sales tax to derive the final consumer purchase prices for circulator pumps.

In the May 2021 RFI, DOE requested feedback on whether there have been market changes since the CPWG that would affect the distribution channels and the percentage of circulator pump shipments in each channel and sector, as shown in Table IV.7 of this document. HI commented that there have not been any market changes to warrant a different estimate (HI, No. 112 at p. 9), while Grundfos recommended manufacturer interviews for collection of relevant data (Grundfos, No. 113 at p. 8). During the 2022 manufacturer interviews, the general feedback from manufacturers was that there have not been significant market changes to justify any changes to the distribution channels shown in Table IV.7 of this document.

DOE requests comment on whether the distribution channels described above and the percentage of equipment sold through the different channels are appropriate and sufficient to describe the distribution markets for circulator pumps. Specifically, DOE requests comment and data on online sales of circulator pumps and the appropriate channel to characterize them.

[35] U.S. Securities and Exchange Commission, Annual 10–K Reports (Various Years) available at *sec.gov* (Last accessed June 15th, 2022).

[36] 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 in the short run, 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.

[37] U.S. Census Bureau, *2017 Economic Census Data*. available at *www.census.gov/programs-surveys/economic-census.html* (last accessed April 15, 2021).

[38] Heating, Air Conditioning & Refrigeration Distributors International (''HARDI''), *2013 HARDI Profit Report,* available at *hardinet.org/* (last accessed April 15, 2021). Note that the 2013 HARDI Profit Report is the latest version of the report.

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

E. Energy Use Analysis

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

To calculate the annual energy use (''AEU'') for circulator pumps, DOE multiplied the annual operating hours by the line input power (derived in the engineering analysis) at each operating point. The following sections describe how DOE estimated circulator pump energy use in the field for different applications, geographical areas, and use cases.

1. Circulator Pump Applications

DOE identified two primary applications for circulator pumps: Hydronic heating, and hot water recirculation. Hydronic heating systems are typically characterized by the use of water to move heating from sources such as hot water boilers to different rooms through pipes and radiating surfaces. Hot water recirculation systems serve the purpose of moving hot water from sources such as water heaters, through pipes, to water fixture outlets. For each of these applications, DOE developed estimates of operating hours and load profiles to characterize circulator pump energy use in the field.

Circulator pumps used in hydronic heating applications typically have cast iron housings, while those used in hot water recirculation applications have housings made of stainless steel or bronze. DOE collected sales data for circulator pumps, including their housing materials, through manufacturer interviews, and was able to estimate the market share of each application by horsepower and efficiency level. To estimate market shares by sector and horsepower rating, DOE relied primarily on industry expert input.

In the May 2021 RFI, DOE requested feedback on whether the breakdowns of circulator pumps by sector and application have changed since the CPWG proceedings. HI commented that there have not been any market changes to warrant a different estimate. (HI, No. 112 at p. 9) During the 2022 manufacturer interviews, DOE collected recent data and updated the estimated market shares by application. According to these data, the market share of circulator pumps used in hydronic heating applications is estimated at 66.6 percent, while that for hot water recirculation applications is 33.4 percent.

For details on the market breakdowns by sector and horsepower rating, for each application, see chapter 7 of the NOPR TSD.

2. Consumer Samples

To estimate the energy use of circulator pumps in field operating conditions, DOE typically develops consumer samples that are representative of installation and operating characteristics of how such equipment is used in the field, as well as distributions of annual energy use by application and market segment.

To develop a sample of circulator pump consumers, DOE used the Energy Information Administration's (EIA) 2012 commercial buildings energy consumption survey (CBECS) [39] and the 2015 residential energy consumption survey (RECS) [40]. For the commercial sector, DOE selected commercial buildings from CBECS and apartment buildings with five or more units from RECS. For the residential sector, DOE selected single family attached or detached buildings from RECS.[41] The following sections describe how DOE developed the consumer samples by application.

For hydronic heating, because there are no data in RECS and CBECS specifically on the use of circulator pumps, DOE used data on hot water boilers to develop its consumer sample. DOE adjusted the selection weight associated with the representative RECS and CBECS buildings containing boilers to effectively exclude steam boilers, which are not used with circulator pumps. To estimate the distribution of circulator pumps by geographical region, DOE also used information on each building's heated area by boilers to correlate it to circulator horsepower rating.

For hot water recirculation, there is limited information in RECS and CBECS. In the residential sector, DOE selected consumers based on building square footage and assumed that buildings greater than 3,000 square feet have a hot water recirculation system. (Docket No. EERE–2016–BT–STD–0004, No. 67 at pp. 171,172) DOE also assumed that only small (<1/12 hp) circulator pumps are installed in residential buildings. For the commercial sector, DOE first selected buildings in CBECS with instant hot water. Further, DOE assigned a circulator pump size category based on the number of floors in each building. The commercial segment of the RECS sample was defined as multi-family buildings with more than four units. Similar to the hydronic heating application, to determine a distribution by region by representative unit, DOE assigned circulator pump sizes (*i.e.,* horsepower ratings) to building types based on the number of floors in each building.

The CA IOUs commented that, specific to California, a 2017 workpaper report [42] estimates that 93 percent of the California market is hot water circulator pumps (as opposed to hydronic) (CA IOUs, No. 116 at p. 6). DOE reviewed the report cited by the CA IOUs and notes that this estimate is based on market data from a subset of circulator pump manufacturers compared to the one analyzed by DOE, which may lead to different market share estimates by application. Regardless, DOE's estimate for circulator pumps used in hot water recirculation systems in California is approximately 80 percent, which is generally consistent with the estimate cited by the CA IOUs.

For details on the consumer sample methodology, see chapter 7 of the NOPR TSD.

3. Operating Hours

DOE developed annual operating hour estimates by sector (commercial, residential) and application (hydronic heating, hot water recirculation).

a. Hydronic Heating

For hydronic heating applications in the residential sector, operating hours per year were estimated based on two sources: 2015 confidential residential

[39] U.S. Department of Energy–Energy Information Administration. 2012 Commercial Buildings Energy Consumption Survey (CBECS). 2012. (Last accessed June 1, 2022.) *https://www.eia.gov/consumption/commercial/data/2012/.*

[40] U.S. Department of Energy: Energy Information Administration. 2015 Residential Energy Consumption Survey (RECS). 2015. (Last accessed June 22, 2022.) *https://www.eia.gov/consumption/residential/data/2015/*.

[41] For the final rule, DOE anticipates using the 2018 CBECS and the 2020 RECS to develop the consumer sample, for the commercial and residential sectors, respectively.

[42] Workpaper PGECOPUM107, High Performance Circulator Pumps, S. Putnam, 2017. Last accessed July 21, 2022. Available at *https://deeresources.net/workpapers.*

field metering data from Vermont, and a 2012–2013 residential metering study in Ithaca, NY.[43] DOE used the data from these metering data to establish a relationship between heating degree days (HDDs) and circulator pump operating hours. DOE correlated monthly operating hours with corresponding HDDs to annual operating hours. DOE then used the geographic distribution of consumers, as derived from the consumer sample, to estimate weighted-average HDDs for each region. For the residential sector, this scaling factor was 0.33 HPY/HDD. For the commercial sector, the CPWG recommended a scaling factor of 0.45 HPY/HDD. (Docket No. EERE–2016–BT–STD–0004, No. 100 at pp. 122–123). The weighted average operating hours per year for the hydronic heating application were estimated at approximately 1,970 and 2,200 for the residential and commercial sector, respectively.

b. Hot Water Recirculation

For circulator pumps used in hot water recirculation applications, DOE developed operating hour estimates based on their associated control types (Docket No. EERE–2016–BT–STD–0004, No. 60 at p. 74), as shown in Table IV.8.

TABLE IV.8—CIRCULATOR PUMP OPERATING HOURS FOR HOT WATER RECIRCULATION

Control type	Sector	Fraction of consumers (%)	Operating hours per year	Notes
No Control	Residential	50	8,760	Constant Operation.
	Commercial.			
Timer	Residential	25	7,300	50 operating constantly, and 50 operating 16 hrs/day.
	Commercial.		6,570	50 operating constantly and 50 operating 12hrs/day.
Aquastat	Residential	20	1,095	3 hrs per day.
	Commercial.			
On Demand	Residential	5	61	10 minutes per day.*
	Commercial.		122	20 minutes per day.*

* Assuming that circulator pumps operate for 30 sec for each demand "push"

In the May 2021 RFI, DOE requested information on any updated or recent data sources to inform and validate the circulator pump operating hours in the residential and commercial sectors and across all applications, as well as any technology or market changes since the term sheet to warrant a different approach on the circulator pump operating hours.

NEEA commented that DOE's analysis assumptions are still reasonable and provided information from a NEEA research study,[44] which surveyed circulator pumps in hydronic heating applications. NEEA mentioned that the study's operating hour estimate, which, for residential hydronic heating systems, was 3,291 hours per year in the Pacific Northwest region, was substantially similar to those estimated by DOE for the same region. (NEEA, No. 115 at pp. 5–6). HI also mentioned the NEEA study and suggested that DOE evaluate the circulator pump operating hours approach based on recent studies and their expansion of control types within hot water recirculation (HI, No. 112 at p. 9). Grundfos commented that the operating hour estimates are generally accurate and that it was not aware of relevant studies (Grundfos, No. 113 at p. 9). Regarding specifically circulator pumps with on-demand controls, HI commented that there has not been a market change to warrant a different estimate (HI, No. 112 at p. 9), while Grundfos stated that the fraction of on-demand controls is accurate (Grundfos, No. 113 at p. 9).

DOE appreciates the data provided by NEEA and continues to use the same approach as presented in during the CPWG meetings for the hydronic heating application, and discussed earlier in this section. In addition, during the 2022 manufacturer interviews, with regard to the hot water recirculation application, manufacturers commented that there have been zero or negligible changes in market distribution of hot water recirculation control types. Therefore, DOE maintained the market breakdowns and operating hours (presented in Table IV.8) for this application.

4. Load Profiles

To estimate the power consumption of each representative unit at each efficiency level, DOE used the following methodology: For each representative unit, DOE defined a range of typical system curves representing different piping and fluid configurations and bounded the representative unit's pump curve derived in the engineering analysis within those system curves. The upper and lower boundaries of this range of system curves correspond to a maximum (Q_{max}) and minimum (Q_{min}) value of volumetric flow. The value of (Q_{max}) is capped to 150% of BEP flow at most, while the value of the value of is capped to at least 25% of BEP flow.

For single speed circulator pumps (ELs 0–2) in single zone applications, DOE-randomly selects a single operating point (Q_0) within the boundaries of the system curves such that Q_0 is between Q_{min} and Q_{max}. The AEU is then calculated by multiplying the power consumption at the volumetric flow Q_0, as derived in the engineering analysis, by the annual operating hours.

For variable-speed circulator pumps (ELs 3–4) in single-zone applications, similarly, DOE randomly selects a single operating point (Q_0) within the boundaries of the system curves, such that Q_0 is between Q_{min} and Q_{max}After the operating point is selected, the procedure to determine the AEU varies depending on the value of Q_0: If the selected operating point (Q_0) has a flow that is equal or higher than Q_{BEP}, the method is the same as the one for single speed circulator pumps in single zones. For operating points where $Q_0 < Q_{BEP}$, DOE assumes that the circulator pump reduces its speed and operates at the intersection of the corresponding system curve and the control curve of each EL (dP or dT), at a flow Q_x. The AEU is then calculated by multiplying the power consumption at the volumetric flow Q_x, as derived in the engineering

[43] Arena, L. and O. Faakye. Optimizing Hydronic System Performance in Residential Applications. 2013. U.S. Department of Energy Building Technologies Office. Last accessed July 21, 2022. *https://www.nrel.gov/docs/fy14osti/60200.pdf.*

[44] Cadeo Group. Extended Motor Products Savings Validation Research on Clean Water Pumps and Circulators. 2019. Northwest Energy Efficiency Alliance. Report No. E19–307. (Last accessed June 23, 2022.) *https://neea.org/resources/extended-motor-products-savings-validation-research-on-clean-water-pumps-and-circulators.*

analysis, by the annual operating hours, after adjusting the hours to maintain the same heat as Q_0.

For circulator pumps in multi-zone applications DOE modeled their operation by assuming that representative multi-zone systems have three zones, resulting in two additional operating points (Q_- and Q_+), which are equidistant from a randomly selected operating point, Q_0, and are within the allowable operating flow (between (Q_{min} and Q_{max}) as defined by the representative unit's characteristic system curves. (Docket #0004, No. 61 at p. 88)

For variable speed circulator pumps (ELs 3–4), DOE estimated the energy use from the variable speed controls assuming all shipments would be matched with end-use appliances that reflect variable speed field operation. DOE understands that some end-use appliances may not be able to respond to variable speed circulator pump controls and therefore, the variable speed control operation would not be realized in the field. DOE seeks comment on the fraction of the market that would not see the benefits of variable speed circulator pump controls in the field due to the limitations of the system.

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

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 circulator pumps. 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 circulator pumps in the absence of new 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 commercial and residential consumers. As stated previously, DOE developed household samples from the 2015 RECS and the 2012 CBECS, for the residential and commercial sectors, respectively. For each sample consumer, DOE determined the energy consumption for circulator pumps and the appropriate energy price. By developing a representative sample of consumers, the analysis captured the variability in energy consumption and energy prices associated with the use of circulator pumps.

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

The computer model DOE uses to calculate the LCC and PBP 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 user samples. The model calculated the LCC and PBP for a sample of 10,000 consumers per simulation run. The analytical results include a distribution of 10,000 data points showing the range of LCC savings. In performing an iteration of the Monte Carlo simulation for a given consumer, product efficiency is chosen based on its probability. By accounting for consumers who purchase more-efficient products in the no-new-standards case, DOE avoids overstating the potential benefits from increasing product efficiency.

DOE calculated the LCC and PBP for all consumers of circulator pumps as if each were to purchase a new product in the expected year of required compliance with new or amended standards. As discussed in section III.G, new and amended standards would apply to circulator pumps manufactured 2 years after the date on which any new or amended standard is published. At this time, DOE estimates publication of a final rule in 2024. Therefore, for purposes of its analysis, DOE used 2026 as the first year of compliance with standards for circulator pumps.

Table IV.9 summarizes the approach and data DOE used to derive inputs to the LCC and PBP calculations. The subsections that follow provide further discussion. Details of the LCC 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.9—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.
Installation Costs	Installation cost determined with data from RSMeans and CPWG input.
Annual Energy Use	Derived in energy use analysis. Varies by geographic location, control type, sector, and application.
Energy Prices	Based on 2021 average and marginal electricity price data from the Edison Electric Institute. Electricity prices vary by season and U.S. region.
Energy Price Trends	Based on *AEO2022* price projections.
Repair and Maintenance Costs	Varies by circulator pump variety.
Product Lifetime	CP1: 10 years average; CP2: 15 years average; CP3 20 years average.
Discount Rates	Approach involves identifying all possible debt or asset classes that might be used to purchase the considered appliances, or might be affected indirectly. Primary data source was the Federal Reserve Board's Survey of Consumer Finances.

TABLE IV.9—SUMMARY OF INPUTS AND METHODS FOR THE LCC AND PBP ANALYSIS *—Continued

Inputs	Source/method
Efficiency Distribution	Estimated based on manufacturer-provided data. An efficiency trend is applied for the no-standards case.
Compliance Date	2026.

* 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.

2. Installation Cost

Installation cost includes labor, overhead, and any miscellaneous materials and parts associated with installing a circulator pump in the place of use. DOE derived installation costs for circulator pumps based on input from the CPWG and data from RSMeans.[45] (Docket #0004, No. 67 at p. 266)

DOE assumed that circulator pumps without variable speed controls (ELs 0–2) require a labor time of 3 hours and an additional 30 minutes for circulator pumps with electronic controls (ELs 3 and 4). (Docket #0004, No. 67 at p. 266) RSMeans provides estimates on the labor hours and labor costs required to install equipment. In the NOPR, DOE derived the installation cost for circulator pumps as the product of labor hours and time required to install a circulator pump. Installation costs vary by geographic location and efficiency level. During the 2022 manufacturer interviews, manufacturers agreed with DOE's approach to estimate installation costs. Annual Energy Consumption

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

3. Annual Energy Consumption

For each sampled consumer, DOE determined the AEU for a circulator pump at different efficiency levels using the approach described previously in section IV.E. of this document.

4. Energy Prices

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

DOE derived electricity prices in 2021 using data from EEI Typical Bills and Average Rates reports. Based upon comprehensive, industry-wide surveys, this semi-annual report presents typical monthly electric bills and average kilowatt-hour costs to the customer as charged by investor-owned utilities. For the residential sector, DOE calculated electricity prices using the methodology described in Coughlin and Beraki (2018).[46] For the commercial sector, DOE calculated electricity prices using the methodology described in Coughlin and Beraki (2019).[47]

DOE's methodology allows electricity prices to vary by sector, region and season. In the analysis, variability in electricity prices is chosen to be consistent with the way the consumer economic and energy use characteristics are defined in the LCC analysis.

To estimate electricity prices in future years, DOE multiplied the 2021 regional energy prices by a projection of annual change in national-average residential or commercial energy price from *AEO2022,* which has an end year of 2050.[48] For each consumer sampled, DOE applied the projection for the geographic location in which the consumer was located. To estimate price trends after 2050, DOE assumed that the regional prices would remain at the 2050 value.

DOE used the electricity price trends associated with the AEO Reference case, which is a business-as-usual estimate, given known market, demographic, and technological trends. DOE also included AEO High Economic Growth and AEO Low Economic Growth scenarios in the analysis. The high- and low-growth cases show the projected effects of alternative economic growth assumptions on energy prices.

For a detailed discussion of the development of electricity prices, see chapter 8 of the NOPR TSD.

5. Maintenance and Repair Costs

Repair costs are associated with repairing or replacing product components that have failed in equipment; maintenance costs are associated with maintaining the operation of the equipment. Typically, small incremental increases in equipment efficiency produce no, or only minor, changes in repair and maintenance costs compared to baseline efficiency products.

DOE assumed that only certain types of CP3 circulators require annual maintenance through oil lubrication. Based on CPWG feedback, DOE assumed that 50 percent of commercial consumers have a maintenance cost of $10 per year and 25 percent of residential consumers have a maintenance cost of $20 per year, which result in an overall $5 annual maintenance cost for CP3 circulators in each of the two applications. (Docket #0004, No. 47 at pp. 324–327)

Repair costs consist of both labor and replacement part costs. DOE assumed that repair costs for CP1 circulators are negligible because consumers tend to discard such products when they fail. For CP2 and CP3 circulator pumps, DOE assumed that repairs occur every 7 years. According to CPWG feedback and manufacturer interview input, typical repairs for CP2 and CP3 include seal replacements and coupler plus motor mount replacements, respectively. DOE assumed consistent labor time with installation costs, which is 3 hours for seal replacement and 1.5 hours for coupler and motor mount replacement. Additionally, DOE assumes there is no variation in repair costs between a

[45] RSMeans. *2021 RSMeans Plumbing Cost Data.* Rockland, MA. *https://www.rsmeans.com.*

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

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

[48] U.S. Energy Information Administration. *Annual Energy Outlook 2022.* 2022. Washington, DC (Last accessed April 13, 2022.) *https://www.eia.gov/outlooks/aeo/index.php.*

baseline efficiency circulator and a higher efficiency circulator. During the 2022 manufacturer interviews, manufacturers agreed with DOE's approach to estimate maintenance and repair costs.

6. Product Lifetime

Equipment lifetime is the age when a unit of circulator equipment is retired from service. DOE estimated lifetimes and developed lifetime distributions for circulator pumps primarily based on manufacturer interviews conducted in 2016 and CPWG feedback (Docket #0004, No. 37 at p. 74). The data collected by manufacturers allowed DOE to develop a survival function, which provides a distribution of lifetimes ranging from a minimum of 3 years based on warranty covered period, to a maximum of 50 years for CP1, CP2, or CP3 respectively. DOE assumed circulator lifetimes do not vary across efficiency levels. Table IV.10 shows the average lifetimes by circulator variety.

TABLE IV.10—AVERAGE CIRCULATOR PUMP LIFETIME BY CIRCULATOR PUMP VARIETY

Circulator pump variety	Average lifetime (years)
CP1	10
CP2	15
CP3	20

During the 2022 manufacturer interviews, DOE solicited additional feedback from manufacturers on the lifetime assumptions presented in Table IV.10, and the general consensus was that there have not been significant technological changes to warrant a different estimate on the circulator pump lifetimes.

7. Discount Rates

In the calculation of the LCC, DOE applies discount rates appropriate to residential and commercial consumers to estimate the present value of future operating cost savings. The subsections below provide information on the derivation of the discount rates by sector. See chapter 7 of the SNOPR TSD for further details on the development of discount rates.

a. Residential

DOE applies weighted average discount rates calculated from consumer debt and asset data, rather than marginal or implicit discount rates.[49] The LCC analysis estimates net present value over the lifetime of the equipment, 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 Survey of Consumer Finances[50] (''SCF'') for 1995, 1998, 2001, 2004, 2007, 2010, 2013, and 2019. Using the SCF and other sources, DOE developed a distribution of rates for each type of debt and asset by income group to represent the rates that may apply in the year in which standards would take effect. DOE assigned each sample household a specific discount rate drawn from one of the distributions. The average rate across all types of household debt and equity and income groups, weighted by the shares of each type, is 4.0 percent.

b. Commercial

For commercial consumers, DOE used the cost of capital 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 the cost of capital is the weighted-average cost to the firm of equity and debt financing. This corporate finance approach is referred to as the weighted-average cost of capital. DOE used currently available economic data in developing commercial discount rates, with Damadoran Online being the primary data source.[51] The average discount rate across the commercial building types is 6.9 percent.

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 equipment efficiencies under the no-new-standards case (*i.e.,* the case without amended or new energy conservation standards).

To estimate the energy efficiency distribution of circulator pumps for the assumed compliance year (2026), DOE first analyzed detailed confidential manufacturer shipments data from 2015, broken down by efficiency level, circulator variety, and nominal horsepower. During the 2016 manufacturer interviews, DOE also collected aggregated historical circulator pump efficiency data. Based on these data, DOE developed an efficiency trend between the year for which DOE had detailed data (2015) and the expected first year of compliance. According to CPWG feedback, DOE applied an efficiency trend from baseline (EL 0) circulator pumps to circulator pumps with ECMs (ELs 2–4). (Docket #0004, No. 78 at p. 6)

In the May 2021 RFI, DOE requested information on whether any changes in the circulator pump market since 2015 have affected the market efficiency distribution of circulator pumps. NEEA discussed their energy efficiency program for circulator pumps since mid 2020 and the circulator sales data collected from circulator manufacturer representatives covering the entire Northwest at the start of 2020. NEEA stated that more than two-thirds of circulator pumps sold by participants in the Northwest are not equipped with ECM. NEEA stated that fewer than one-fifth of circulator pumps are equipped with speed control technology. (NEEA, No. 115 at pp. 2–3, 6) HI stated that small incremental growth is occurring

[49] 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.

[50] U.S. Board of Governors of the Federal Reserve System. *Survey of Consumer Finances.* 1995, 1998, 2001, 2004, 2007, 2010, 2013, 2016, and 2019. (Last accessed June 22, 2022.) *https://www.federalreserve.gov/econresdata/scf/scfindex.htm.*

[51] Damodaran, A. *Data Page: Historical Returns on Stocks, Bonds and Bills-United States.* 2021. (Last accessed April 26, 2022.) *https://pages.stern.nyu.edu/~adamodar/.*

for ECMs, but first cost is a barrier. (HI, No. 112 at p. 9–10) Grundfos suggested market changes have affected distribution of circulator pumps since 2015 and DOE should use manufacturer and market interviews to update their dataset. (Grundfos, No. 113 at p. 9)

During the 2022 manufacturer interviews, DOE collected additional aggregated historical circulator pump efficiency data (ranging from 2016 to 2021). Based on these data, DOE retained the methodology described earlier, but updated the efficiency trend, which was used to project the no-standards-case efficiency distribution at the assumed compliance year (2026) and beyond. See chapter 8 of the NOPR TSD for further information on the derivation of the efficiency distributions.

DOE seeks comment on the approach and inputs used to develop no-new standards case efficiency distribution.

9. Payback Period Analysis

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

The inputs to the PBP calculation for each efficiency level are the change in total installed cost of the equipment and the change in the first-year annual operating expenditures relative to the baseline. The PBP calculation uses the same inputs as the LCC analysis, except that discount rates are not needed.

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 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.[52] 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.

In the accounting approach, shipments are the result either of demand for the replacement of existing equipment, or of demand for equipment from new commercial and residential construction. Replacements in any projection year are based on (a) shipments in prior years, and (b) the lifetime of previously shipped equipment. Demand for new equipment is based on the rate of increase in commercial floor space (in the commercial sector), and residential housing (in the residential sector). In each year of shipments projections, retiring equipment is removed from a record of existing stock, and new shipments are added. DOE accounts for demand lost to demolitions (*i.e.,* loss of circulator pumps that will not be replaced) by assuming that a small fraction of stock is retired without being replaced in each year, based on a derived demolition rate for each sector.

DOE collected confidential historical shipments data for the period 2013—2021 from manufacturer interviews held in 2016 (during the CPWG) and 2022. Shipments data provided by manufacturers were broken down by circulator variety, nominal horsepower rating, and efficiency. Table IV.11 presents historical circulator pumps shipments. Note that due to confidentiality concerns, DOE is only able to present aggregated circulator pump shipments.

TABLE IV.11—HISTORICAL CIRCULATOR PUMP SHIPMENTS

Year	Shipments (million units)
2013	1.676
2014	1.812
2015	1.848
2016	1.735
2017	1.788
2018	2.067
2019	1.883
2020	1.829
2021	2.193

[52] 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.

1. No-New-Standards Case Shipments Projections

The no-new-standards case shipments projections are an estimate of how much of each equipment type would be shipped in the absence of any new or amended standard. DOE projected shipments in the no-new-standards case by circulator pump variety (CP1, CP2, and CP3) as well as sector & application.

In response to DOE's request for shipments data in the May 2021 RFI, both Grundfos and HI recommended DOE conduct market interviews to collect relevant sales data (Grundfos, No. 113 at p. 9) (HI, No. 112 at p. 10). HI also added that in 2021, HI updated its statistics reporting to include circulator pumps as a category, but reporting is limited due confidentiality rules. (HI, No. 112 at p. 10)

DOE also requested information on any market changes since 2015 that would justify using market drivers and saturation trends that are different than those recommended by the CPWG. HI Commented that some areas of the market have started to move toward more controlled products (boiler OEMs, and where utility incentives are available). However, HI did not believe this has impacted the CPWGs recommendations (HI, No. 112 at p. 10). Grundfos estimated that the heating market growth is near 0.0% and the hot water recirculation market is well above 1%; and combined the market growth is near 1% (Grundfos, No. 113 at p. 9).

In the no-new-standards case, DOE assumes that demand for new installations would be met by CP1 circulator pumps alone. This is based on manufacturer feedback and historical shipments trends (see chapter 9 of the NOPR TSD for details). New demand is based on AEO 2022[3] projections of commercial floorspace & new construction (for demand to the commercial sector), and projections of residential housing stock & starts (for demand to the residential sector). DOE further assumes that over time, a decreasing amount of demand for equipment in the hydronic heating application is met by circulator pumps. For each year in the analysis period (2026–2055), DOE assumes a 2 percent reduction of new demand for circulator pumps in the hydronic heating application compared to the previous year, according to Census data on new heating systems.[53]

DOE assumed that demand for replacements would be met by circulator pumps of the same variety (*e.g.,* CP2 only replaced by CP2) in each sector and application. After calculating retirements of existing pumps based on those previously shipped and equipment lifetimes, DOE assumes that some of this quantity will not be replaced due to demolition. DOE estimates the demolition rate of existing equipment stock by using the AEO 2022 projections of new commercial floorspace and floorspace growth in the commercial sector, and new housing starts and housing stock in the residential sector.

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

2. Standards-Case Shipment Projections

The standards-case shipments projections account for the effects of potential standards on shipments. DOE assumed a ''roll-up'' scenario to estimate standards-case shipments, wherein the no-new-standards-case shipments that would be below a candidate equipment standard beginning in an assumed compliance year (2026) are ''rolled up'' to the minimum qualifying equipment efficiency level at that candidate standard.

DOE seeks comment on the approach and inputs used to develop the different standards case shipments projections.

See chapter 9 of the NOPR TSD for details on the shipments analysis.

H. National Impact Analysis

The NIA assesses the NES and the NPV from a national perspective of total consumer costs and savings that would be expected to result from new or amended standards at specific efficiency levels.[54] (''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 equipment 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 circulator pumps sold from 2026 through 2055.

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

In response to the May 2021 RFI, HI and Grundfos recommends DOE include current market data in their analyses. (HI, No. 112 at p. 7; Grundfos, No. 113 at p. 6) Updated market data was collected during the 2022 manufacturer interviews. However, the data suggest similar ranges of efficiencies are available in market, so 2016 performances remained with costs updated for inflation.

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

Table IV.12 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.12—SUMMARY OF INPUTS AND METHODS FOR THE NATIONAL IMPACT ANALYSIS

Inputs	Method
Shipments	Annual shipments from shipments model.
Compliance Date of Standard	2026.
Efficiency Trends	Applied efficiency trend based on historical efficiency data
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	*AEO2022* projections (to 2050) and constant after 2050.
Energy Site-to-Primary and FFC Conversion	A time-series conversion factor based on *AEO2022.*
Discount Rate	3 percent and 7 percent.
Present Year	2021.

1. Equipment 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 the year of anticipated compliance with an amended or new standard. To project the trend in efficiency absent standards for circulator pumps over the entire shipments projection period, DOE followed the approach discussed in section IV.F.8 of this document. The

[53] Type of Heating System Used in New Single-Family Houses Completed. Available at *https://www.census.gov/construction/chars/xls/heatsystem_cust.xls* (Last accessed July 7, 2022).

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

approach is further described in chapter 8 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 (2026). In this scenario, the market shares of products in the no-new-standards case that do not meet the standard under consideration would ''roll up'' to meet the new standard level, and the market share of products above the standard would remain unchanged.

2. National Energy Savings

The national energy savings analysis involves a comparison of national energy consumption of the considered products between each 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 *AEO2022.* Cumulative energy savings are the sum of the NES for each year over the timeframe of the analysis.

Use of higher-efficiency equipment is occasionally associated with a direct rebound effect, which refers to an increase in utilization of the product due to the increase in efficiency. DOE did not find any data on the rebound effect specific to circulator pumps, and therefore did not apply a rebound effect in the calculation of the NES and the NPV.

DOE requests comment on the rebound effect specifically for circulator pumps, including the magnitude of any rebound effect and data sources specific to circulator pumps.

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 [55] 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.

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.

Due to lack of historical price data and uncertainty on the factors that may affect future circulator pump prices, DOE assumed a constant price (in $2021) when estimating circulator pump prices in future years.

The operating cost savings are energy cost savings and costs associated with repair and maintenance, which are calculated using the estimated operating cost 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 commercial and residential energy price changes in the Reference case from *AEO2022,* which has an end year of 2050. To estimate price trends after 2050, DOE used the average annual rate of change in prices from 2020 through 2050. As part of the NIA, DOE also analyzed scenarios that used inputs from variants of the *AEO2022* Reference case that have lower and higher economic growth. Those cases have lower and higher energy price trends compared to the Reference case. NIA results based on these cases are presented in appendix 10C of the NOPR TSD.

In calculating the NPV, DOE multiplies the net savings in future years by a discount factor to determine their present value. For this NOPR, DOE estimated the NPV of consumer benefits using both a 3-percent and a 7-percent real discount rate. DOE uses these discount rates in accordance with guidance provided by the Office of Management and Budget (''OMB'') to Federal agencies on the development of regulatory analysis.[56] 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 senior-only households. The analysis used subsets of the RECS 2015 sample composed of households that meet the criteria for seniors. DOE used the LCC and PBP model to estimate the impacts of the considered efficiency levels on seniors. Chapter 11 in the NOPR TSD describes the consumer subgroup analysis.

[55] For more information on NEMS, refer to *The National Energy Modeling System: An Overview 2009,* DOE/EIA–0581(2009), October 2009. Available at *www.eia.gov/forecasts/aeo/index.cfm* (last accessed July 7, 2022).

[56] United States Office of Management and Budget. *Circular A–4: Regulatory Analysis.* September 17, 2003. *https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/circulars/A4/a-4.pdf* (last accessed July 3, 2022).

J. Manufacturer Impact Analysis

1. Overview

DOE performed an MIA to estimate the financial impacts of energy conservation standards on manufacturers of circulator pumps 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 energy conservation standards might affect manufacturing employment, capacity, and competition, as well as how standards contribute to overall regulatory burden. Finally, the MIA serves to identify any disproportionate impacts on manufacturer subgroups, including small business manufacturers.

The quantitative part of the MIA primarily relies on the Government Regulatory Impact Model (''GRIM''), an industry cash flow model with inputs specific to this rulemaking. The key GRIM inputs include data on the industry cost structure, unit production costs, product shipments, manufacturer markups, and investments in R&D and manufacturing capital required to produce compliant products. The key GRIM outputs are the INPV, which is the sum of industry annual cash flows over the analysis period, discounted using the industry-weighted average cost of capital, and the impact to domestic manufacturing employment. The model uses standard accounting principles to estimate the impacts of more-stringent energy conservation standards on a given industry by comparing changes in INPV and domestic manufacturing employment between a no-new-standards case and the various standards cases (*i.e.,* TSLs). To capture the uncertainty relating to manufacturer pricing strategies following 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 circulator pump manufacturing industry based on the market and technology assessment and publicly available information. This included a top-down analysis of circulator pump 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 circulator pump manufacturing industry, including company filings of form 10–K from the SEC,[57] corporate annual reports, the U.S. Census Bureau's *Economic Census,*[58] and reports from D&B Hoovers.[59]

In Phase 2 of the MIA, DOE prepared a framework industry cash-flow analysis to quantify the potential impacts of 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 circulator pumps in order to develop other key GRIM inputs, including product and capital conversion costs, and to gather additional information on the anticipated effects of energy conservation standards on revenues, direct employment, capital assets, industry competitiveness, and subgroup impacts.

In Phase 3 of the MIA, DOE conducted structured, detailed interviews (*i.e.,* 2016 and 2022 manufacturer 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 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 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 energy conservation standard. The GRIM spreadsheet uses the inputs to arrive at a series of annual cash flows, beginning in 2022 (the base year of the analysis) and continuing to 2055. DOE calculated INPVs by summing the stream of annual discounted cash flows during this period. For manufacturers of circulator pumps, DOE used a real discount rate of 9.6 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 energy conservation standard on manufacturers. As discussed previously, DOE developed critical GRIM inputs using a number of sources, including publicly available

[57] U.S. Securities and Exchange Commission, Annual 10–K Reports (Various Years) available at *sec.gov* (Last accessed June 15th, 2022).

[58] U.S. Census Bureau, 2018–2020 Annual Survey of Manufacturers: Statistics for Industry Groups and Industries (2021) available at *www.census.gov/programs-surveys/asm.html* (Last accessed June 15th, 2022).

[59] D&B Hoovers available at *www.dnb.com* (Last Accessed June 15th, 2022).

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 equipment can affect the revenues, gross margins, and cash flow of the industry. MPCs were derived in the engineering analysis, using methods discussed in section IV.C.3 of this document. 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 2022 (the base year) to 2055 (the end year of the analysis period). See chapter 9 of the NOPR TSD for additional details.

c. Product and Capital Conversion Costs

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 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. Due to differences in design and manufacturing processes, DOE evaluated conversion costs by circular pump variety: CP1, CP2, and CP3.

To evaluate the level of product conversion costs manufacturers would likely incur to comply with energy conservation standards, DOE estimated the number of basic models that manufacturers would have to re-design to move their equipment lines to each incremental efficiency level. DOE developed the product conversion costs by estimating the amount of labor per basic model manufacturers would need for research and development to raise the efficiency of models to each incremental efficiency level. DOE anticipates that manufacturer basic model counts would decrease with use of ECMs due to the greater range of applications served by one ECM as opposed to an induction motor. DOE also assumed manufacturers would incur testing costs to establish certified ratings using DOE's test procedure for circulator pumps and applying DOE's statistical sampling plans to assess compliance.

For circulator pumps, DOE estimated the re-design effort varies by efficiency level. At EL 1, DOE anticipates a minor redesign effort as manufacturers increase their breadth of offerings to meet a standard at this level. DOE estimated a redesign effort of 18 months of engineering labor and 9 months of technician labor per model at this level. At EL 2, DOE anticipates manufacturers to integrate ECMs into their circulator pumps. This requires a significant amount of re-design as manufacturers transition from legacy AC induction motors to ECMs. DOE estimated a redesign effort of 35 months of engineering labor and 18 months of technician labor per model. At EL 3 and EL 4, DOE anticipates manufacturers to incur additional control board redesign costs as manufacturers add controls (*e.g.,* proportional pressure controls). DOE estimated a redesign effort of 54 months of engineering labor and 35 months of technician labor per model at EL 3. DOE estimated a redesign effort of 54 months of engineering labor and 54 months of technician labor per model at EL 4.

To evaluate the level of capital conversion costs manufacturers would likely incur to comply with energy conservation standards, DOE used information derived from the engineering analysis, shipments analysis, and manufacturer interviews. DOE used the information to estimate the additional investments in property, plant, and equipment that are necessary to meet energy conservation standards. In the engineering analysis evaluation of higher efficiency equipment from leading manufacturers of circulator pumps, DOE found a range of designs and manufacturing approaches. DOE attempted to account for both the range of manufacturing pathways and the current efficiency distribution of shipments in the modeling of industry capital conversion costs.

For all circulator pump varieties, DOE estimates capital conversion costs are driven by the cost for industry to expand production capacity at efficiency levels requiring use of an ECM (*i.e.,* EL 2, EL 3, and EL 4). DOE anticipates capital investments to be similar among EL 2 through EL 4 as circulator pump controls are likely to be used to increase a circulator pump beyond EL 2 and pump controls do not require additional capital investments. At all ELs, DOE anticipates manufacturers will incur costs to expand production capacity of more efficient equipment.

For CP1 type circular pumps, DOE anticipates manufacturers would choose to assemble ECMs in-house. As such, the capital conversion cost estimates for CP1 type circulator pumps include, but were not limited to, capital investments in welding and bobbin tooling, magnetizers, winders, lamination dies, testing equipment, and additional manufacturing floor space requirements.

For CP2 and CP3 type circular pumps, DOE anticipates manufacturers would purchase ECMs as opposed to assembling in-house. As such, DOE estimated the design changes to produce circulator pumps with ECMs would be driven by purchased parts (*i.e.,* ECMs). The capital conversion costs for these variety of circulator pumps are based on additional manufacturing floor space requirements to expand manufacturing capacity of ECMs.

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 Table IV.13 and 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.

TABLE IV.13—INDUSTRY PRODUCT AND CAPITAL CONVERSION COSTS PER EFFICIENCY LEVEL

	Units	Efficiency level			
		EL1	EL2	EL3	EL4
EL 1	EL 2	EL 3	EL 4		
Product Conversion Costs	2021$ millions	5.4	54.7	88.8	89.5
Capital Conversion Costs	2021$ millions	0.0	22.3	22.3	22.3

DOE seeks input on its estimates of product and capital conversion costs associated with manufacturing circulator pumps at the potential energy conservation standard.

d. Markup Scenarios

MSPs include direct manufacturing production costs (*i.e.,* labor, materials, and overhead estimated in DOE's MPCs) and all non-production costs (*i.e.,* SG&A, R&D, and interest), along with profit. To calculate the MSPs in the GRIM, DOE applied non-production cost markups to the MPCs estimated in the engineering analysis for each product class and efficiency level. Modifying these markups in the standards case yields different sets of impacts on manufacturers. 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 energy conservation standards: (1) a preservation of manufacturer markup scenario; and (2) a preservation of per-unit operating profit markup 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 manufacturer markup scenario, DOE applied a single uniform manufacturer markup across all efficiency levels for each circulator variety, which assumes that manufacturers would be able to maintain the same amount of profit as a percentage of revenues at all efficiency levels. As MPCs increase with efficiency, this scenario implies that the absolute dollar markup will increase.

To estimate the average manufacturer markup used in the preservation of manufacturer markup scenario, DOE analyzed publicly available financial information for manufacturers of circulator pump equipment. DOE then requested feedback on its initial markup estimates during manufacturer interviews. The revised markups, which are used in DOE's quantitative analysis of industry financial impacts, are presented in Table IV.14. These markups capture all non-production costs, including SG&A expenses, R&D expenses, interest expenses, and profit.

TABLE IV.14—MANUFACTURER MARKUPS FOR PRESERVATION OF MANUFACTURER MARKUP SCENARIO

Circulator pump variety	Manufacturer markup
CP1	1.60
CP2	2.30
CP3	1.90

Under the preservation of per-unit 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 this scenario, manufacturer markups are set so that operating profit one year after the compliance date of energy conservation standards is the same as in the no-new-standards case on a per-unit basis. In other words, manufacturers are not able to garner additional operating profit from the higher production costs and the investments that are required to comply with the standards; however, they are able to maintain the same per-unit operating profit in the standards case that was earned in the no-new-standards case. Therefore, operating margin in percentage terms is reduced between the no-new-standards case and standards case.

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

3. Manufacturer Interviews

Throughout the rulemaking process, DOE has sought and continues to seek feedback and insight from interested parties that would improve the information in this process. DOE interviewed manufacturers as part of the NOPR analysis. In interviews, DOE asked manufacturers to describe their major concerns regarding this rulemaking. The following section highlights manufacturer concerns that helped inform the projected potential impacts of energy conservation standards 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. This section includes a list of the key issues manufacturers identified during the interview process.

a. Cost Increases and Component Shortages

Manufacturers highlighted difficulties in procurement of parts and purchased assemblies. Manufacturers noted that increases in raw material prices, escalating shipping and transportation costs, and limited component availability over the last two years affect manufacturer production costs. As a result, manufacturers were concerned that cost estimates based on historic 5-year averages would underestimate current production costs.

b. Motor Availability

Some manufacturers raised concerns that there could be procurement issues associated with a standard necessitating the use of an ECM. Manufacturers noted that there are few ECM suppliers. Additionally, manufacturers noted that there is less ECM variety compared to induction motors, and this could add additional complexities to researching and developing circulator pumps with properly sized ECMs. This issue is particularly exacerbated for CP2 and CP3 varieties where manufacturers indicated they may be more inclined to purchase ECMs as opposed to manufacturing in-house.

c. Timing of Standard

Some manufacturers emphasized that significant engineering and development resources would be required to transition to a standard requiring use of an ECM. Specifically, manufacturers noted that any transition to a standard requiring an ECM would need to be timed to accommodate the research and design of a full portfolio of circulator pumps to fit all applications while serving current market needs. As noted in discussed in detail in section III.G, this NOPR is proposing to adopt a 2-year compliance date for energy conservation standards; however, DOE may also consider a 3-year compliance date.

K. Emissions Analysis

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

The analysis of electric power sector emissions of CO_2, NO_X, SO_2, and Hg uses emissions factors intended to represent the marginal impacts of the change in electricity consumption associated with amended or new standards. The methodology is based on results published for the *AEO,* including a set of side cases that implement a variety of efficiency-related policies. The methodology is described in appendix 13A in the NOPR TSD. The analysis presented in this notice uses projections from *AEO2022.* Power sector emissions of CH_4 and N_2O from fuel combustion are estimated using Emission Factors for Greenhouse Gas Inventories published by the Environmental Protection Agency (EPA).[60]

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

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

1. Air Quality Regulations Incorporated in DOE's Analysis

DOE's no-new-standards case for the electric power sector reflects the *AEO,* which incorporates the projected impacts of existing air quality regulations on emissions. *AEO2022* generally represents current legislation and environmental regulations, including recent government actions, that were in place at the time of preparation of *AEO2022,* including the emissions control programs discussed in the following paragraphs.[61]

SO_2 emissions from affected electric generating units (''EGUs'') are subject to nationwide and regional emissions cap-and-trade programs. Title IV of the Clean Air Act sets an annual emissions cap on SO_2 for affected EGUs in the 48 contiguous States and the District of Columbia (DC). (42 U.S.C. 7651 *et seq.*) SO_2 emissions from numerous States in the eastern half of the United States are also limited under the Cross-State Air Pollution Rule (''CSAPR''). 76 FR 48208 (Aug. 8, 2011). CSAPR requires these States to reduce certain emissions, including annual SO_2 emissions, and went into effect as of January 1, 2015.[62] *AEO2022* incorporates implementation of CSAPR, including the update to the CSAPR ozone season program emission budgets and target dates issued in 2016. 81 FR 74504 (Oct. 26, 2016). Compliance with CSAPR is flexible among EGUs and is enforced through the use of tradable emissions allowances. Under existing EPA regulations, any excess SO_2 emissions allowances resulting from the lower electricity demand caused by the adoption of an efficiency standard could be used to permit offsetting increases in SO_2 emissions by another regulated EGU.

However, beginning in 2016, SO_2 emissions began to fall as a result of the Mercury and Air Toxics Standards (''MATS'') for power plants. 77 FR 9304 (Feb. 16, 2012). In the MATS final rule, EPA established a standard for hydrogen chloride as a surrogate for acid gas hazardous air pollutants (''HAP''), and also established a standard for SO_2 (a non-HAP acid gas) as an alternative equivalent surrogate standard for acid gas HAP. The same controls are used to reduce HAP and non-HAP acid gas; thus, SO_2 emissions are being reduced as a result of the control technologies installed on coal-fired power plants to comply with the MATS requirements for acid gas. In order to continue operating, coal power plants must have either flue gas desulfurization or dry sorbent injection systems installed. Both technologies, which are used to reduce acid gas emissions, also reduce SO_2 emissions. Because of the emissions reductions under the MATS, it is unlikely that excess SO_2 emissions allowances resulting from the lower electricity demand would be needed or used to permit offsetting increases in SO_2 emissions by another regulated EGU. Therefore, energy conservation standards that decrease electricity generation would generally reduce SO_2 emissions. DOE estimated SO_2 emissions reduction using emissions factors based on *AEO2022.*

CSAPR also established limits on NO_X emissions for numerous States in the eastern half of the United States. Energy conservation standards would have little effect on NO_X emissions in those States covered by CSAPR emissions limits if excess NO_X emissions allowances resulting from the lower electricity demand could be used to permit offsetting increases in NO_X emissions from other EGUs. In such case, 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 *AEO2022* data to derive NO_X

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

[61] For further information, see the Assumptions to *AEO2022* report that sets forth the major assumptions used to generate the projections in the Annual Energy Outlook. Available at *www.eia.gov/outlooks/aeo/assumptions/* (last accessed June 21, 2022).

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

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

emissions factors for the group of States not covered by CSAPR.

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

L. Monetizing Emissions Impacts

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

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

1. Monetization of Greenhouse Gas Emissions

DOE estimates the monetized benefits of the reductions in emissions of CO_2, CH_4, and N_2O by using a measure of the 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 estimated the global social benefits of CO_2, CH_4, and N_2O reductions (*i.e.,* SC-GHGs) using the estimates presented in the Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990, published in February 2021 by the IWG. The SC-GHGs is the monetary value of the net harm to society associated with a marginal increase in emissions in a given year, or the benefit of avoiding that increase. In principle, SC-GHGs includes the value of all climate change impacts, including (but not limited to) changes in net agricultural productivity, human health effects, property damage from increased flood risk and natural disasters, disruption of energy systems, risk of conflict, environmental migration, and the value of ecosystem services. The SC-GHGs therefore, reflects the societal value of reducing emissions of the gas in question by one metric ton. The SC-GHGs is the theoretically appropriate value to use in conducting benefit-cost analyses of policies that affect CO_2, N_2O and 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 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.*[63] 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).[64] 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

[63] Marten, A. L., E. A. Kopits, C. W. Griffiths, S. C. Newbold, and A. Wolverton. Incremental CH4 and N2O mitigation benefits consistent with the US Government's SC-CO2 estimates. *Climate Policy.* 2015. 15(2): pp. 272–298.

[64] 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.

international impacts and the consideration of appropriate discount rates'' (E.O. 13783, Section 5(c)). Benefit-cost analyses following E.O. 13783 used SC-GHG estimates that attempted to focus on the U.S.-specific share of climate change damages as estimated by the models and were calculated using two discount rates recommended by Circular A–4, 3 percent and 7 percent. All other methodological decisions and model versions used in SC-GHG calculations remained the same as those used by the IWG in 2010 and 2013, respectively.

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

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

Second, the IWG found that the use of the social rate of return on capital (7 percent under current OMB Circular A–4 guidance) to discount the future benefits of reducing GHG emissions inappropriately underestimates the impacts of climate change for the purposes of estimating the SC-GHG. Consistent with the findings of the National Academies (2017) and the economic literature, the IWG continued to conclude that the consumption rate of interest is the theoretically appropriate discount rate in an intergenerational context,[65] and recommended that discount rate uncertainty and relevant aspects of intergenerational ethical considerations be accounted for in selecting future discount rates.

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

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

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. 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 this 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 to 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 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.[66] Second, the IAMs used to produce these interim estimates do not include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature and the science underlying their ''damage functions''—*i.e.,* the core parts of the IAMs that map global mean temperature changes and other physical impacts of climate change into economic (both market and nonmarket) damages—lags behind the most recent research. For example, limitations include the incomplete treatment of catastrophic and non-catastrophic impacts in the integrated assessment models, their incomplete treatment of adaptation and technological change, the incomplete way in which inter-regional and intersectoral linkages are modeled, uncertainty in the extrapolation of damages to high temperatures, and inadequate representation of the relationship between the discount rate and uncertainty in economic growth over long time horizons. Likewise, the socioeconomic and emissions scenarios used as inputs to the models do not reflect new information from the last decade of scenario generation or the full range of projections. The modeling limitations do not all work in the same direction in terms of their influence on the SC-CO_2 estimates. However, as discussed in the February 2021 TSD, the IWG has recommended that, taken together, the limitations suggest that the interim SC-GHG estimates used in this final rule likely underestimate the damages from GHG emissions. DOE concurs with this assessment.

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

a. Social Cost of Carbon

The SC-CO_2 values used for this NOPR were generated using the values presented in the 2021 update from the IWG's February 2021 SC-GHG TSD. Table IV.15 shows the updated sets of SC-CO_2 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 14–A 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.[67]

TABLE IV.15—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

[66] 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: <*https://www.whitehouse.gov/briefing-room/blog/2021/02/26/a-return-to-science-evidence-based-estimates-of-the-benefits-of-reducing-climate-pollution/*.

[67] 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.

TABLE IV.15—ANNUAL SC-CO_2 VALUES FROM 2021 INTERAGENCY UPDATE, 2020–2050—Continued
[2020$ per metric ton CO_2]

Year	Discount rate and statistic			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
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

In calculating the potential global benefits resulting from reduced CO_2 emissions, DOE used the values from the February 2021 SC-GHG TSD, adjusted to 2021$ using the implicit price deflator for gross domestic product (''GDP'') from the Bureau of Economic Analysis. DOE derived values from 2051 to 2070 based on estimates published by EPA.[68] 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 circulator pumps 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. If further analysis of monetized climate benefits beyond 2070 becomes available prior to the publication of the final rule, DOE will include that analysis in the final rule.

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. 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 generated using the values presented in the February 2021 SC-GHG TSD. Table IV.16 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 14–A 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.16—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
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. 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.[69] DOE used EPA's values for $PM_{2.5}$-related benefits associated with NO_X and SO_2 and for ozone-related benefits associated with NO_X for 2025 2030, and 2040, calculated with discount rates of 3 percent and 7 percent. DOE used linear interpolation to define values for the years not given in the 2025 to 2040 period; for years beyond 2040 the values are held constant. DOE derived values specific to the sector for circulator pumps using a

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

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

method described in appendix 14B of the NOPR TSD.

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

M. Utility Impact Analysis

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

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

N. Employment Impact Analysis

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

One method for assessing the possible effects on the demand for labor of such shifts in economic activity is to compare sector employment statistics developed by the Labor Department's Bureau of Labor Statistics (''BLS''). BLS regularly publishes its estimates of the number of jobs per million dollars of economic activity in different sectors of the economy, as well as the jobs created elsewhere in the economy by this same economic activity. Data from BLS indicate that expenditures in the utility sector generally create fewer jobs (both directly and indirectly) than expenditures in other sectors of the economy.[70] 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'').[71] 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 (2026–2031), where these uncertainties are reduced. For more details on the employment impact analysis, see chapter 16 of the NOPR TSD.

O. Other Topics

a. Acceptance Test Grades

In response to the May 2021 RFI, China commented that in the context of discussing updates to industry standards, DOE had not provided pump test acceptance grades and corresponding tolerances. (China, No. 111 at p. 1) DOE interprets the comment to regard minimum energy conservation standards, as acceptance tests *per se* have not been discussed as part of this rulemaking process. Energy conservation standards, however, are proposed as part of this NOPR. The rationale for selecting the proposed standard level is discuss in section V.C.1 of this document.

V. Analytical Results and Conclusions

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

A. Trial Standard Levels

In general, DOE typically evaluates potential 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 equipment classes, to the extent that there are such interactions, and market cross elasticity from consumer purchasing decisions

[70] See U.S. Department of Commerce—Bureau of Economic Analysis. *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II).* 1997. U.S. Government Printing Office: Washington, DC. Available at *www.bea.gov/scb/pdf/regional/perinc/meth/rims2.pdf* (last accessed last accessed July 6, 2021).

[71] 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.

that may change when different standard levels are set.

In the analysis conducted for this NOPR, DOE analyzed the benefits and burdens of four TSLs for circulator pumps. As discussed previously, because there is only one proposed equipment class for circulator pumps, DOE developed TSLs that align with their corresponding ELs (*i.e.,* TSL 1 corresponds to EL 1, etc). Table V.1 presents the TSLs and the corresponding efficiency levels that DOE has identified for potential energy conservation standards for circulator pumps. TSL 4 represents the maximum technologically feasible (''max-tech'') energy efficiency.

TABLE V.1—TRIAL STANDARD LEVELS FOR CIRCULATOR PUMPS BY EFFICIENCY LEVEL

TSL	EL
1	1
2	2
3	3
4	4

B. Economic Justification and Energy Savings

1. Economic Impacts on Individual Consumers

DOE analyzed the economic impacts on circulator pump consumers by looking at the effects that potential 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.2 through Table V.3 show the LCC and PBP results for the TSLs considered for circulator pumps. In the table, 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 of this document). Because some consumers purchase products with higher efficiency in the no-new-standards case, the average savings are less than the difference between the average LCC of the baseline product and the average LCC at each TSL. The savings refer only to consumers who are affected by a standard at a given TSL. Those who already purchase a product with efficiency at or above a given TSL are not affected. Consumers for whom the LCC increases at a given TSL experience a net cost.

TABLE V.2—AVERAGE LCC AND PBP RESULTS FOR CIRCULATOR PUMPS

TSL	Efficiency level	Average costs (2021$)				Simple payback)years)	Average lifetime (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
	Baseline	598.4	40.8	363.3	961.8		10.6
1	1	598.4	34.8	311.1	909.6	0.0	10.6
2	2	678.4	21.7	200.0	878.4	4.2	10.6
3	3	757.5	11.3	111.4	869.0	5.4	10.6
4	4	784.5	7.8	82.0	866.6	5.6	10.6

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

TABLE V.3—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR CIRCULATOR PUMPS

TSL	Efficiency level	Life-cycle cost savings	
		Average LCC savings * ($2021)	Percent of consumers that experience net cost
1	1	125.2	0.0
2	2	103.2	29.2
3	3	105.3	46.4
4	4	97.6	49.7

* 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 senior-only households. Table V.4 compares the average LCC savings and PBP at each efficiency level for seniors with similar metrics for the entire consumer sample for circulator pumps. In most cases, the average LCC savings and PBP for 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.4—COMPARISON OF LCC SAVINGS AND PBP FOR SENIORS AND ALL CONSUMERS

TSL	Senior-only households	All consumers
Average LCC Savings (2021$)		
1	116.3	125.2
2	116.7	103.2
3	104.1	105.3
4	92.4	97.6
Payback Period (years)		
1	0	0
2	3.5	4.2
3	5.3	5.4
4	5.6	5.6

c. Rebuttable Presumption Payback

As discussed in section IV.F.9, 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 circulator pumps. 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.5 presents the rebuttable-presumption payback periods for the considered TSLs for circulator pumps. 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.5—REBUTTABLE-PRESUMPTION PAYBACK PERIODS

TSL	Rebuttable PBP (years)
1	
2	2.8
3	4.2
4	4.5

2. Economic Impacts on Manufacturers

DOE performed an MIA to estimate the impact of energy conservation standards on manufacturers of circulator pumps. 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. Economic Impacts on Manufacturers

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 energy conservation standards on manufacturers of circulator pumps, as well as the conversion costs that DOE estimates manufacturers of circulator pumps would incur at each TSL.

The impact of potential energy conservation standards was analyzed under two markup scenarios: (1) the preservation of manufacturer markup scenario and (2) the preservation of per-unit operating profit markup scenario, as discussed in section IV.C.5 of this document. The preservation of manufacturer markup scenario provides the upper bound while the preservation of operating profits scenario results in the lower (or more severe) bound to impacts of potential standards on industry.

Each of the modeled scenarios results in a unique set of cash flows and corresponding INPV for each TSL. INPV is the sum of the discounted cash flows to the industry from the base year through the end of the analysis period (2022–2055). The ''change in INPV'' results refer to the difference in industry value between the no-new-standards case and standards case at each TSL. To provide perspective on the short-run cash flow impact, DOE includes a comparison of free cash flow between the no-new-standards case and the standards case at each TSL in the year before standards would take effect. This figure provides an understanding of the magnitude of the required conversion costs relative to the cash flow generated by the industry.

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

The results in Table V.6 of this NOPR show potential INPV impacts for circulator pump manufacturers. The table presents the range of potential impacts reflecting both the less severe set of potential impacts (preservation of manufacturer markup) and the more severe set of potential impacts (preservation of per-unit operating profit). In the following discussion, the INPV results refer to the difference in industry value between the no-new-standards case and each standards case that results from the sum of discounted cash flows from 2022 (the base year) through 2055 (the end of the analysis period).

To provide perspective on the near-term cash flow impact, DOE discusses the change in free cash flow between the no-new-standards case and the standards case at each efficiency level in the year before new standards take effect. These figures provide an understanding of the magnitude of the required conversion costs at each TSL relative to the cash flow generated by the industry in the no-new-standards case.

TABLE V.6—MANUFACTURER IMPACT ANALYSIS FOR CIRCULATOR PUMPS

	Units	No-new-standards case	Trial standard level			
			1 *	2	3	4
INPV	2021$ millions	325.9	322.6	261.6–347.3	228.9–351.4	219.9–376.7
Change in INPV	2021$ millions		(3.2)	(64.3)–21.4	(97.0)–25.5	(106.0)–50.8
	%		(1.0)	(19.7)–6.6	(29.8)–7.8	(32.5)–15.6
Free Cash Flow (2025)	2021$ millions	25.6	23.3	(9.6)	(27.1)	(27.5)

TABLE V.6—MANUFACTURER IMPACT ANALYSIS FOR CIRCULATOR PUMPS—Continued

	Units	No-new-standards case	Trial standard level			
			1 *	2	3	4
Change in Free Cash Flow	2021$ millions		(2.2)	(35.1)	(52.7)	(53.0)
	%		(8.8)	(137.5)	(206.0)	(207.5)
Product Conversion Costs	2021$ millions		5.4	54.7	88.8	89.5
Capital Conversion Costs	2021$ millions			22.3	22.3	22.3
Total Conversion Costs	2021$ millions		5.4	77.0	111.1	111.8

Note: Parenthesis indicate negative values.
* Both manufacturer markup scenarios for TSL 1 yield INPV impacts that are not differentiable at the granularity of this table. As such, these impacts are expressed as one value.

At TSL 1, DOE estimates INPV impacts for circulator pump manufacturers to decrease by 1 percent, or a decrease of $3.2 million. At this level, DOE estimates that industry free cash flow would decrease by approximately 8.8 percent to negative $2.2 million, compared to the no-new-standards-case value of $23.3 million in the year before compliance (2025).

DOE estimates 58 percent circulator pump shipments meet or exceed the efficiency standards at TSL 1. DOE does not expect the modest increases in efficiency requirements at this TSL to require large capital investments. DOE does anticipate manufacturers to make slight investments in R&D to re-design some of their equipment offering to meet a standard at this level. Overall, DOE estimates that manufacturers would incur $5.4 million in product conversion costs to bring their equipment portfolios into compliance with a standard set to TSL 1. At TSL 1, manufacturers have basic models that meet or exceed this efficiency level.

At TSL 1, the shipment-weighted average MPC for all circulator pumps does not change relative to the no-new-standards case shipment-weighted average MPC in 2026. Under the preservation of manufacturer markup scenario, DOE applies the same markup as the no-new-standards scenario allowing manufacturers to maintain the same amount of profit as a percentage of revenues (*i.e.,* as MPCs increase, the absolute dollar markup increases). However, because the shipment-weighted average MPC does not increase at TSL 1 compared to the no-new-standards case, manufacturers are unable recover the conversion cost investment through additional profit on equipment offerings. Under the preservation of per-unit 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 or higher MPCs. Therefore, the $5.4 million in conversion costs incurred by manufacturers cause a negative change in INPV at TSL 1 in both manufacturer markup scenarios.

At TSL 2, DOE estimates impacts on INPV for circulator pump manufacturers to range from a decrease of 19.7 percent to an increase of 6.6 percent, or a decrease of $64.3 million to an increase of $21.4 million. At this level, DOE estimates that industry free cash flow would decrease by approximately 137.5 percent to −$9.6 million, compared to the no-new-standards-case value of $25.6 million in the year before compliance (2025).

TSL 2 would set the energy conservation standard at EL 2 for all circulator pumps. DOE estimates 19 percent of circulator pump shipments meet or exceed the efficiency standards at TSL 2. Product and capital conversion costs would increase at this TSL as manufacturers update designs and production equipment to meet a standard that would likely require manufacturers to use ECMs. DOE anticipates manufacturers would need to make a significant investment to purchase production equipment to be able to produce ECMs in-house for CP1 variety. For CP2 and CP3 varieties, DOE anticipates that most manufacturers would choose to source ECMs from third parties resulting in a smaller level of investment of production equipment for these circulator pump varieties. DOE's capital conversion cost estimates include capital investments in welding and bobbin tooling, magnetizers, winders, lamination dies, testing equipment, and additional manufacturing floor space. DOE anticipates manufacturers to incur product conversion costs to redesign basic models to incorporate ECMs.

Overall, DOE estimates that manufacturers would incur $54.7 million in product conversion costs and $22.3 million in capital conversion costs to bring their equipment portfolios into compliance with a standard set to TSL 2. At TSL 2, capital and product conversion costs are a key driver of the decrease in free cash flow. These upfront investments result in a lower free cash flow in the year before the compliance date.

At TSL 2, the shipment-weighted average MPC for all circulator pumps increases by 43.7 percent relative to the no-new-standards case shipment-weighted average MPC in 2026. In the preservation of manufacturer markup scenario, manufacturers can fully pass on this significant cost increase to customers. In this manufacturer markup scenario, the additional revenue generated from the significant increase in shipment-weighted average MPC outweighs the $77.0 million in conversion costs, causing a positive change in INPV at TSL 2.

Under the preservation of per-unit 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 or higher MPCs. In this scenario, the 43.7 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 $77.0 million in conversion costs incurred by manufacturers cause a negative change in INPV at TSL 2 under the preservation of per-unit operating profit markup scenario.

At TSL 3, DOE estimates impacts on INPV for circulator pump manufacturers to range from a decrease of 29.8 percent to an increase of 7.8 percent, or a decrease of $97.0 million to an increase of $25.5 million. At this level, DOE estimates that industry free cash flow would decrease by approximately 206.0 percent to −$27.1 million, compared to the no-new-standards-case value of $25.6 million in the year before compliance (2025).

DOE estimates 12 percent of circulator pump base case shipments meet or exceed the efficiency standards at TSL

3. Product conversion costs would increase at this TSL as manufacturers improve designs to incorporate added controls necessitated at this TSL. DOE anticipates capital conversion costs to remain similar to those at TSL 2 as conversion costs are more representative of design changes.

Overall, DOE estimates that manufacturers would incur $88.8 million in product conversion costs and $22.3 million in capital conversion costs to bring their equipment portfolios into compliance with a standard set to TSL 3. At TSL 3, product conversion costs are a key driver of the decrease in free cash flow. These upfront investments result in a lower free cash flow in the year before the compliance date.

At TSL 3, the shipment-weighted average MPC for all circulator pumps increases by 60.7 percent relative to the no-new-standards case shipment-weighted average MPC in 2026. In the preservation of manufacturer markup scenario, manufacturers can fully pass on this significant cost increase to customers. In this manufacturer markup scenario, the additional revenue generated from the significant increase in shipment-weighted average MPC outweighs the $111.1 million in conversion costs, causing a positive change in INPV at TSL 3.

Under the preservation of per-unit 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 or higher MPCs. In this scenario, the 60.7 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 $111.1 million in conversion costs incurred by manufacturers cause a negative change in INPV at TSL 3 under the preservation of per-unit operating profit markup scenario.

At TSL 4, DOE estimates impacts on INPV for circulator pump manufacturers to range from a decrease of 32.5 percent to an increase of 15.6 percent, or a decrease of $106.0 million to an increase of $50.8 million. At this level, DOE estimates that industry free cash flow would decrease by approximately 207.5 percent to −$27.5 million, compared to the no-new-standards-case value of $25.6 million in the year before compliance (2025).

DOE estimates 2 percent of circulator pump base case shipments meet or exceed the efficiency standards at TSL 4. Product conversion costs would modestly increase at this TSL as manufacturers update designs to incorporate added controls. DOE anticipates capital conversion costs to remain similar to those at TSL 2 and TSL 3.

Overall, DOE estimates that manufacturers would incur $89.5 million in product conversion costs and $22.3 million in capital conversion costs to bring their equipment portfolios into compliance with a standard set to TSL 4. At TSL 4, product conversion costs continue to be a key driver of the decrease in free cash flow. These upfront investments result in a lower free cash flow in the year before the compliance date.

At TSL 4, the shipment-weighted average MPC for all circulator pumps increases by 75.8 percent relative to the no-new-standards case shipment-weighted average MPC in 2026. In the preservation of manufacturer markup scenario, manufacturers can fully pass on this significant cost increase to customers. In this manufacturer markup scenario, the additional revenue generated from the significant increase in shipment-weighted average MPC outweighs the $111.8 million in conversion costs, causing a positive change in INPV at TSL 4.

Under the preservation of per-unit 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 or higher MPCs. In this scenario, the 75.8 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 $111.8 million in conversion costs incurred by manufacturers cause a negative change in INPV at TSL 4 under the preservation of per-unit operating profit markup scenario.

b. Direct Impacts on Employment

To quantitatively assess the potential impacts of energy conservation standards on direct employment in the circulator pump industry, DOE typically uses 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. This analysis includes both production and non-production employees employed by circulator pump manufacturers. DOE used statistical data from the U.S. Census Bureau's 2020 Annual Survey of Manufacturers [72] (''ASM''), the results of the engineering analysis, and interviews with manufacturers to determine the inputs necessary to calculate industry-wide labor expenditures and domestic employment levels. Labor expenditures related to manufacturing of the product are a function of 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 the GRIM are converted to domestic production worker employment levels by dividing production labor expenditures by the average fully burden wage per production worker. DOE calculated the fully burdened wage by multiplying the industry production worker hourly blended wage (provided by the ASM) by the fully burdened wage ratio. The fully burdened wage ratio factors in paid leave, supplemental pay, insurance, retirement and savings, and legally required benefits. DOE determined the fully burdened ratio from the Bureau of Labor Statistic's employee compensation data.[73] The estimates of production workers in this section cover workers, including line-supervisors who are directly involved in fabricating and assembling a product within the manufacturing facility. Workers performing services that are closely associated with production operations, such as materials handling tasks using forklifts, are also included as production labor.

Non-production worker employment levels were determined by multiplying the industry ratio of production worker employment to non-production employment against the estimated production worker employment explained above. Estimates of non-production workers in this section cover above the line supervisors, sales, sales delivery, installation, office functions, legal, and technical employees.

The total direct employment impacts calculated in the GRIM are the sum of the changes in the number of domestic production and non-production workers resulting from the energy conservation standards for circulator pumps, as compared to the no-new-standards case. Typically, more efficient equipment is more complex and labor intensive to produce. Per-unit labor requirements and production time requirements trend

[72] U.S. Census Bureau, 2018–2020 Annual Survey of Manufacturers: Statistics for Industry Groups and Industries (2021) (Available at *www.census.gov/data/tables/time-series/econ/asm/2018-2020-asm.html*).

[73] U.S. Bureau of Labor Statistics. *Employer Costs for Employee Compensation*. June 16, 2022. Available at: *www.bls.gov/news.release/pdf/ecec.pdf*.

higher with more stringent energy conservation standards.

DOE estimates that 65 percent of circulator pumps sold in the United States are currently manufactured domestically. In the absence of energy conservation standards, DOE estimates that there would be 104 domestic production workers in the circulator pump industry in 2026, the year of compliance.

DOE's analysis forecasts that the industry will domestically employ 171 production and non-production workers in the circulator pump industry in 2026 in the absence of energy conservation standards. Table V.7 presents the range of potential impacts of energy conservation standards on U.S. production workers of circulator pumps.

TABLE V.7—POTENTIAL CHANGES IN THE TOTAL NUMBER OF CIRCULATOR PUMP PRODUCTION WORKERS IN DIRECT EMPLOYMENT IN 2026

	No-new-standards case	Trial standard level			
		1	2	3	4
Number of Domestic Production Workers	104	104	75–149	84–167	92–183
Number of Domestic Non-Production Workers	67	67	96	107	118
Total Domestic Direct Employment **	171	171	171–245	191–274	210–301
Potential Changes in Direct Employment		0	0–74	20–103	39–130

* Numbers in parentheses indicate negative numbers.
** This field presents impacts on domestic direct employment, which aggregates production and non-production workers.

In manufacturer interviews, several manufacturers that produce high-efficiency circulator pumps would require additional engineers to redesign circulator pumps and production processes. Additionally, higher efficiency pump manufacturing is more labor intensive, and would require additional labor expenditures. DOE understands circulator pumps with ECMs are primarily manufactured outside the U.S. However, during manufacturer interviews, manufacturers indicated that they would likely expand their ECM production capacities in the U.S. in the presence of a standard at TSL 2 or higher. Therefore, DOE modeled a low-end employment range that assumes half of domestic production would be relocated to foreign countries due to the energy conservation standard. The high-end of the range represents no change in the percentage of models manufactured in the U.S.

Due different variations in manufacturing labor practices, actual direct employment could vary depending on manufacturers' preference for high capital or high labor practices in response to standards. DOE notes that the employment impacts discussed here are independent of the indirect employment impacts to the broader U.S. economy, which are documented in chapter 15 of the accompanying TSD.

DOE requests comment on its estimates of domestic employment for circulator pump manufacturing in the presence of an energy conservation standards.

c. Impacts on Manufacturing Capacity

During manufacturer interviews, industry feedback indicated that manufacturers' current production capacity was strained due to upstream supply chain constraints. Additionally, manufacturers expressed that additional production lines would be required during the conversion period if standards were set at a level requiring ECMs. However, many manufacturers noted that their portfolios have expanded in recent years to accommodate more circulator pumps using ECMs. Furthermore, manufacturers indicated that a circulator pump utilizing an ECM could support a wider range of applications compared to a circulator pump utilizing an induction motor.

d. Impacts on Subgroups of Manufacturers

As discussed in section IV.J.2 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 201. To be categorized as a small business under NAICS code 333914, ''Measuring, Dispensing, and Other Pumping Equipment Manufacturing'' a circulator pump manufacturer and its affiliates may employ a maximum of 750 employees. The 750-employee threshold includes all employees in a business's parent company and any other subsidiaries. Based on this classification, DOE identified three 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. DOE requests information regarding the impact of cumulative regulatory burden on manufacturers of circulator pumps associated with multiple DOE standards or product-specific regulatory actions of other Federal agencies.

DOE evaluates equipment-specific regulations that will take effect approximately 3 years before or after the 2026 compliance date of any energy conservation standards for circulator pumps. DOE is aware that circulator pump manufacturers produce other equipment or products that circulator pump manufacturers produce including dedicated-purpose pool pumps [74] and commercial and industrial pumps.[75] None of these products or equipment have proposed or adopted energy conservation standards that require compliance within 3 years of the proposed energy conservation standards for circulator pumps in this NOPR. If DOE proposes or finalizes any energy conservation standards for these products or equipment prior to finalizing energy conservation standards for circulator pumps, DOE will include the energy conservation standards for these products or equipment as part of the cumulative regulator burden for this circulator pump rulemaking.

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 standards.

a. Significance of Energy Savings

To estimate the energy savings attributable to potential standards for circulator pumps, DOE compared their energy consumption under the no-new-standards case to their anticipated energy consumption under each TSL. The savings are measured over the entire lifetime of products purchased in the 30-year period that begins in the year of anticipated compliance with amended standards (2026–2055). Table V.8 presents DOE's projections of the national energy savings for each TSL considered for circulator pumps. The savings were calculated using the approach described in section IV.H of this document.

TABLE V.8—CUMULATIVE NATIONAL ENERGY SAVINGS FOR CIRCULATOR PUMPS; 30 YEARS OF SHIPMENTS
[2026–2055]

	Trial standard level			
	1	2	3	4
	quads			
Primary energy	0.07	0.43	0.78	0.92
FFC energy	0.07	0.45	0.81	0.96

OMB Circular A–4 [76] 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.[77] The review timeframe established in EPCA is generally not synchronized with the product lifetime, product manufacturing cycles, or other factors specific to circulator pumps. 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.9. The impacts are counted over the lifetime of circulator pumps purchased in 2026–2034.

TABLE V.9—CUMULATIVE NATIONAL ENERGY SAVINGS FOR CIRCULATOR PUMPS; 9 YEARS OF SHIPMENTS
[2026–2034]

	Trial standard level			
	1	2	3	4
	quads			
Primary energy	0.03	0.15	0.26	0.30
FFC energy	0.03	0.16	0.27	0.31

[74] *www.regulations.gov/docket/EERE-2022-BT-STD-0001.*

[75] *www.regulations.gov/docket/EERE-2021-BT-STD-0018.*

[76] U.S. Office of Management and Budget. *Circular A–4: Regulatory Analysis.* September 17, 2003. *https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/circulars/A4/a-4.pdf* (last accessed July 3, 2022).

[77] 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 circulator pumps. In accordance with OMB's guidelines on regulatory analysis,[78] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. Table V.10 shows the consumer NPV results with impacts counted over the lifetime of products purchased in 2026–2055.

TABLE V.10—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR CIRCULATOR PUMPS; 30 YEARS OF SHIPMENTS

[2026–2055]

Discount rate	Trial standard level			
	1	2	3	4
	million $2021			
3 percent	575.1	1,770.7	1,994.1	2,069.3
7 percent	293.9	731.6	626.6	579.5

The NPV results based on the aforementioned 9-year analytical period are presented in Table V.11. The impacts are counted over the lifetime of products purchased in 2026–2055. As mentioned previously, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology or decision criteria.

TABLE V.11—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR CIRCULATOR PUMPS; 9 YEARS OF SHIPMENTS

[2026–2034]

Discount rate	Trial standard level			
	1	2	3	4
	million $2021			
3 percent	285.2	813.4	917.2	951.6
7 percent	180.1	429.0	377.7	355.1

The previous results reflect the assumption of a constant price for circulator pumps over the analysis period (see section IV.H.3 of this document). As part of the NIA, DOE also conducted a sensitivity analysis that considered two scenarios that use inputs from variants of the AEO 2022 Reference case: The AEO 2022 High Economic Growth scenario, which has a higher energy price trend relative to the reference case, and the AEO 2022 Low Economic Growth scenario, which has a lower energy price trend relative to the reference case, as well as a higher price learning rate. The higher learning rate in this scenario accelerates the adoption of more efficient circulator pump options in the no-new-standards case (relative to the reference scenario) decreasing the available energy savings attributable to a standard. The results of these alternative cases are presented in appendix 10C of the NOPR TSD.

c. Indirect Impacts on Employment

It is estimated that that energy conservation standards for circulator pumps 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 (2026–2031), where these uncertainties are reduced.

The results suggest that the proposed standards would be likely to have a negligible impact on the net demand for labor in the economy. The net change in jobs is so small that it would be imperceptible in national labor statistics and might be offset by other, unanticipated effects on employment. Chapter 16 of the NOPR TSD presents detailed results regarding anticipated indirect employment impacts.

4. Impact on Utility or Performance of Products

As discussed in section III.F.1.d of this document, DOE has tentatively concluded that the standards proposed in this NOPR would not lessen the utility or performance of circulator pumps 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.F.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

[78] U.S. Office of Management and Budget. *Circular A–4: Regulatory Analysis.* September 17, 2003. *https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/circulars/A4/a-4.pdf* (last accessed July 3, 2022).

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 circulator pumps is expected to yield environmental benefits in the form of reduced emissions of certain air pollutants and greenhouse gases. Table V.12 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.12—CUMULATIVE EMISSIONS REDUCTION FOR CIRCULATOR PUMPS SHIPPED IN 2026–2055

	Trial standard level			
	1	2	3	4
Power Sector Emissions:				
CO_2 (million metric tons)	2.35	14.69	26.50	31.26
CH_4 (thousand tons)	0.20	1.22	2.20	2.60
N_2O (thousand tons)	0.03	0.17	0.31	0.37
SO_2 (thousand tons)	1.24	7.68	13.83	16.31
NO_X (thousand tons)	1.23	7.67	13.82	16.30
Hg (tons)	0.01	0.05	0.09	0.10
Upstream Emissions:				
CO_2 (million metric tons)	0.17	1.07	1.93	2.28
CH_4 (thousand tons)	15.98	100.77	182.23	215.12
N_2O (thousand tons)	0.00	0.01	0.01	0.01
SO_2 (thousand tons)	2.56	16.16	29.22	34.49
NO_X (thousand tons)	0.01	0.08	0.14	0.16
Hg (tons)	0.00	0.00	0.00	0.00
Total FFC Emissions:				
CO_2 (million metric tons)	2.52	15.76	28.43	33.54
CH_4 (thousand tons)	16.18	101.99	184.44	217.72
N_2O (thousand tons)	0.03	0.18	0.32	0.38
SO_2 (thousand tons)	3.80	23.84	43.05	50.79
NO_X (thousand tons)	1.25	7.75	13.96	16.47
Hg (tons)	0.01	0.05	0.09	0.10

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 circulator pumps. Section IV.L of this document discusses the SC-CO_2 values that DOE used. Table V.13 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.13—PRESENT VALUE OF CO_2 EMISSIONS REDUCTION FOR CIRCULATOR PUMPS SHIPPED IN 2026–2055

TSL	SC-CO_2 case			
	Discount rate and statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	million $2021			
1	26.1	108.0	167.2	328.9
2	157.6	661.3	1,027.3	2,012.1
3	282.0	1,187.1	1,845.8	3,611.3
4	331.7	1,397.7	2,173.9	4,251.6

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 circulator pumps. Table V.14 presents the value of the CH_4 emissions reduction at each TSL, and Table V.15 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.14—PRESENT VALUE OF METHANE EMISSIONS REDUCTION FOR CIRCULATOR PUMPS SHIPPED IN 2026–2055

TSL	SC-CH_4 case			
	Discount rate and statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	million $2021			
1	7.5	21.4	29.6	56.9
2	46.1	133.1	184.6	353.1
3	82.6	239.9	333.0	636.1
4	97.3	282.9	392.7	749.8

TABLE V.15—PRESENT VALUE OF NITROUS OXIDE EMISSIONS REDUCTION FOR CIRCULATOR PUMPS SHIPPED IN 2026–2055

TSL	SC-N_2O Case			
	Discount rate and statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	million $2021			
1	0.1	0.4	0.7	1.1
2	0.7	2.6	4.0	6.9
3	1.2	4.7	7.2	12.5
4	1.4	5.5	8.5	14.7

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 circulator pumps. The dollar-per-ton values that DOE used are discussed in section IV.L of this document. Table V.16 presents the present value for NO_X emissions reduction for each TSL calculated using 7-percent and 3-percent discount rates, and Table V.17 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.16–PRESENT VALUE OF NO_X EMISSIONS REDUCTION FOR CIRCULATOR PUMPS SHIPPED IN 2026–2055

TSL	3% Discount rate	7% Discount rate
	million $2021	
1	165.4	75.9
2	1,006.0	444.3
3	1,802.9	788.4
4	2,121.4	924.2

TABLE V.17—PRESENT VALUE OF SO_2 EMISSIONS REDUCTION FOR CIRCULATOR PUMPS SHIPPED IN 2026–2055

TSL	3% Discount rate	7% Discount rate
	million $2021	
1	73.5	34.9
2	444.2	202.7
3	795.0	359.1
4	935.0	420.8

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.18 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 circulator pumps, and are measured for the lifetime of products shipped in 2026–2055. The benefits associated with reduced GHG emissions resulting from the adopted standards are global benefits, and are also calculated based on the lifetime of circulator pumps shipped in 2026–2055.

TABLE V.18—CONSUMER NPV COMBINED WITH PRESENT VALUE OF BENEFITS FROM CLIMATE AND HEALTH BENEFITS

Category	TSL 1	TSL 2	TSL 3	TSL 4
3% discount rate for NPV of Consumer and Health Benefits (billion 2021$)				
5% Average SC-GHG case	0.8	3.4	5.0	5.6
3% Average SC-GHG case	0.9	4.0	6.0	6.8
2.5% Average SC-GHG case	1.0	4.4	6.8	7.7
3% 95th percentile SC-GHG case	1.2	5.6	8.9	10.1
7% discount rate for NPV of Consumer and Health Benefits (billion 2021$)				
5% Average SC-GHG case	0.4	1.6	2.1	2.4
3% Average SC-GHG case	0.5	2.2	3.2	3.6
2.5% Average SC-GHG case	0.6	2.6	4.0	4.5
3% 95th percentile SC-GHG case	0.8	3.8	6.0	6.9

C. Conclusion

When considering new or amended energy conservation standards, the standards that DOE adopts for any type (or class) of covered equipment 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. 6316(a); 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. 6316(a); 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 standards for circulator pumps 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.

1. Benefits and Burdens of TSLs Considered for Circulator Pumps Standards

Table V.19 and Table V.20 summarize the quantitative impacts estimated for each TSL for circulator pumps. The national impacts are measured over the lifetime of circulator pumps purchased in the 30-year period that begins in the anticipated year of compliance with standards (2026–2055). 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.19—SUMMARY OF ANALYTICAL RESULTS FOR CIRCULATOR PUMP TSLS: NATIONAL IMPACTS

Category	TSL 1	TSL 2	TSL 3	TSL 4
Cumulative FFC National Energy Savings:				

TABLE V.19—SUMMARY OF ANALYTICAL RESULTS FOR CIRCULATOR PUMP TSLS: NATIONAL IMPACTS—Continued

Category	TSL 1	TSL 2	TSL 3	TSL 4
Quads	0.07	0.45	0.81	0.96
Cumulative FFC Emissions Reduction:				
CO_2 (*million metric tons*)	2.5	15.8	28.4	33.5
CH_4 (*thousand tons*)	16.2	102.0	184.4	217.7
N_2O (*thousand tons*)	0.03	0.18	0.32	0.38
SO_2 (*thousand tons*)	3.8	23.8	43.1	50.8
NO_X (*thousand tons*)	1.2	7.7	14.0	16.5
Hg (*tons*)	0.01	0.05	0.09	0.10
Present Value of Benefits and Costs (3% discount rate, billion 2021$):				
Consumer Operating Cost Savings	0.58	3.41	6.03	7.05
Climate Benefits *	0.13	0.80	1.43	1.69
Health Benefits **	0.24	1.45	2.60	3.06
Total Benefits †	0.94	5.65	10.06	11.79
Consumer Incremental Product Costs ‡	0.00	1.64	4.03	4.98
Consumer Net Benefits	0.58	1.77	1.99	2.07
Total Net Benefits	0.94	4.02	6.02	6.81
Present Value of Benefits and Costs (7% discount rate, billion 2021$):				
Consumer Operating Cost Savings	0.29	1.68	2.94	3.43
Climate Benefits *	0.13	0.80	1.43	1.69
Health Benefits **	0.11	0.65	1.15	1.34
Total Benefits †	0.53	3.12	5.52	6.46
Consumer Incremental Product Costs ‡	0.00	0.95	2.32	2.85
Consumer Net Benefits	0.29	0.73	0.63	0.58
Total Net Benefits	0.53	2.18	3.21	3.61

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

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

** 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 SC-GHG estimates. See Table V.18 for net benefits using all four SC-GHG estimates. On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. In the absence of further intervening court orders, DOE will revert to its approach prior to the injunction and present monetized benefits where appropriate and permissible under law.

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

TABLE V.20—SUMMARY OF ANALYTICAL RESULTS FOR CIRCULATOR PUMP TSLS: MANUFACTURER AND CONSUMER IMPACTS

Category	TSL 1	TSL 2	TSL 3	TSL 4
Manufacturer Impacts:				
Industry NPV (*million* 2021$) (No-new-standards case INPV = 325.9)	322.6	261.6–347.3	228.9–351.4	219.91–376.7
Industry NPV (*% change*)	(3.2)	(19.7)–6.6	(29.8)–7.8	(32.5)–15.6
Consumer Average LCC Savings (2021$):				
All Circulators	125.2	103.2	105.3	97.6
Consumer Simple PBP (years):				
All Circulators	0.0	4.2	5.4	5.6
Percent of Consumers that Experience a Net Cost:				
All Circulators	0.0	29.2	46.4	49.7

Parentheses indicate negative (−) values.

DOE first considered TSL 4, which represents the max-tech efficiency level, and would require differential temperature-based control schemes to be implemented in the field to deliver savings. TSL 4 would save an estimated 0.96 quads of energy, an amount DOE considers significant. Under TSL 4, the NPV of consumer benefit would be

$0.58 billion using a discount rate of 7 percent, and $2.07 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 4 are 33.5 Mt of CO_2, 50.8 thousand tons of SO_2, 16.5 thousand tons of NO_X, 0.10 tons of Hg, 217.7 thousand tons of CH_4, and 0.38 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions (associated with the average SC–GHG at a 3-percent discount rate) at TSL 4 is $1.69 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 4 is $1.34 billion using a 7-percent discount rate and $3.06 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 $3.61 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 4 is $6.81 billion. DOE notes that it provides the estimated total NPV as additional information, but primarily relies upon the NPV of consumer benefits in its analysis for determining whether a proposed standard level is economically justified.

At TSL 4, the average LCC impact is a savings of $97.6. The simple payback period is 5.6 years. The fraction of consumers experiencing a net LCC cost approximately 50 percent of consumers.

At TSL 4, the projected change in INPV ranges from a decrease of $106.0 million to an increase of $50.8 million, which corresponds to decrease of 32.5 percent and an increase of 15.6 percent, respectively. DOE estimates that industry must invest $111.8 million to comply with standards set at TSL 4. This investment is primarily driven by converting all existing products to include differential-temperature based controls and the associate product conversion costs that would be needed to support such a transition. DOE estimates that only two percent of circulator pump shipments would meet the efficiency levels analyzed at TSL 4.

DOE also notes that the estimated energy and economic savings from TSL 4 are highly dependent on the end-use systems in which the circulator pumps are installed (*e.g.,* hydronic heating or water heating applications). Circulator pumps are typically added to systems when installed in the field and can be replaced separately than the end-use appliance in which they are paired. Depending on the type of controls that the end-use appliance contains, the circulator pumps may not see the field savings benefits from the technologies incorporated in TSL 4 because the end-use system cannot accommodate full variable-speed operation. In particular, some systems will not achieve any additional savings from differential temperature controls as compared to a single speed ECM with no controls (*i.e.,* TSL 2). While the analysis includes the best available assumptions on the distribution of system curves and single-zone versus multi-zone applications, variation in those assumptions could have a large impact on savings potential and resulting economics providing uncertainty in the savings associated with TSL 4.

The Secretary tentatively concludes that at TSL 4 for circulator pump, 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 economic burden on many consumers, and the impacts on manufacturers, including the large conversion costs, profit margin impacts that could result in a large reduction in INPV, and the lack of manufacturers currently offering products meeting the efficiency levels required at this TSL, including small businesses. Almost a majority of circulator pump customers (49.7 percent) would experience a net cost and manufacturers would have to significantly ramp up production of more efficient models since only 2 percent of shipments currently meet TSL efficiency levels. In addition, the Secretary is also tentatively concerned about the uncertainty regarding the potential energy savings as compared to the field savings due to the lack of end-use appliances not being able to respond to differential temperature controls from the circulator pump. Consequently, the Secretary has tentatively concluded that TSL 4 is not economically justified.

DOE then considered TSL 3, which represents efficiency level three, and would require automatic proportional pressure controls to be added to the circulator pump. Automatic proportional pressure controls are used to simulate variable flow aiding in energy use reductions from the pump. TSL 3 would save an estimated 0.81 quads of energy, an amount DOE considers significant. Under TSL 3, the NPV of consumer benefit would be $0.63 billion using a discount rate of 7 percent, and $1.99 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 3 are 28.4 Mt of CO_2, 43.1 thousand tons of SO_2, 14.0 thousand tons of NO_X, 0.09 tons of Hg, 184.4 thousand tons of CH_4, and 0.32 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions (associated with the average SC-GHG at a 3-percent discount rate) at TSL 3 is $1.43 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 3 is $1.15 billion using a 7-percent discount rate and $2.60 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 $3.21 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 4 is $6.02 billion. DOE notes that it provides the estimated total NPV as additional information, but primarily relies upon the NPV of consumer benefits in its analysis determining whether a proposed standard level is economically justified.

At TSL 3, the average LCC impact is a savings of $105.3. The simple payback period is 5.4 years. The fraction of consumers experiencing a net LCC cost is 46.4 percent.

At TSL 3, the projected change in INPV ranges from a decrease of $97.0 million to an increase of $25.5 million, which corresponds to a decrease of 29.8 percent and an increase of 7.8 percent, respectively. DOE estimates that industry must invest $111.1 million to comply with standards set at TSL 3. DOE estimates that approximately 12 percent of circulator pump shipments would meet the efficiency levels analyzed at TSL 3.

Similar to TSL 4, DOE also notes that the estimated energy and economic savings from TSL 3 are highly dependent on the systems in which the circulator pumps are installed. Depending on the type of controls that the end-use appliance contains, the circulator pumps may not see the field savings benefits from the technologies incorporated in TSL 3 because the end-use system cannot accommodate full variable-speed operation from the automatic proportional pressure controls. In particular, some systems will not achieve any additional savings from proportional pressure controls as compared to a single speed ECM with no controls (*i.e.,* TSL 2). While the analysis includes the best available assumptions on the distribution of system curves and single-zone versus multi-zone applications, variation in those assumptions could have a large impact on savings potential and resulting economics providing uncertainty in the benefits for TSL 3.

The Secretary tentatively concludes that at TSL 3 for circulator pump, 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 economic burden on many consumers, and the impacts on manufacturers, including the large conversion costs, profit margin impacts that could result in a large reduction in INPV, and the lack of manufacturers currently offering products meeting the efficiency levels required at this TSL, including small businesses. Almost a majority of circulator pump customers (46.4 percent) would experience a net cost. While most manufacturers offer a product that would meet TSL 3 efficiencies and include automatic pressure- or temperature-based controls, these are manufactured at low production volume. All manufacturers would still need to incur significant product conversion expenses and make capital investments to extend both automatic pressure- and temperature-based controls to all circulator pumps distributed in commerce. In addition, the Secretary is also tentatively concerned about the uncertainty regarding the potential energy savings as compared to the field savings due to the lack of end-use appliances not being able to respond to automatic proportional pressure control from the circulator pump. Consequently, the Secretary has tentatively concluded that TSL 3 is not economically justified.

DOE then considered TSL 2, which represents efficiency level two and includes single speed ECMs in the circulator pump. Single-speed ECMs do not depend on the controls of the end-use appliance in order to realize the energy-savings benefits of the variable speed motor. In addition, TSL 2 is the proposed standard level recommended by the CPWG. TSL 2 would save an estimated 0.45 quads of energy, an amount DOE considers significant. Under TSL 2, the NPV of consumer benefit would be $0.73 billion using a discount rate of 7 percent, and $1.77 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 2 are 15.8 Mt of CO_2, 23.8 thousand tons of SO_2, 7.7 thousand tons of NO_X, 0.05 tons of Hg, 102.0 thousand tons of CH_4, and 0.18 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions (associated with the average SC-GHG at a 3-percent discount rate) at TSL 2 is $0.80 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 2 is $0.65 billion using a 7-percent discount rate and $1.45 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 $2.18 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 3 is $4.02 billion. DOE notes that it provides the estimated total NPV as additional information, but primarily relies upon the NPV of consumer benefits in its analysis for determining whether a proposed standard level is economically justified.

At TSL 2, the average LCC impact is a savings of $103.2. The simple payback period is 4.2 years. The fraction of consumers experiencing a net LCC cost is 29.2 percent.

At TSL 2, the projected change in INPV ranges from a decrease of $64.3 million to an increase of $21.4 million, which corresponds to decrease of 19.7 percent and an increase of 6.6 percent, respectively. DOE estimates that industry must invest $77.0 million to comply with standards set at TSL 2. DOE estimates that approximately 19 percent of circulator pump shipments would meet the efficiency levels analyzed at TSL 2. At TSL 2, most manufacturers have current circulator pump offerings at this level.

A standard set at TSL 2 essentially guarantees energy savings in all applications currently served by an induction motor, as the savings accrue from motor efficiency alone rather than from a particular control strategy that must be properly matched to the system in the field. In comparison, TSL 3 and 4 include an ECM motor like in TSL 2, but TSL 3 and 4 also include the associated variable speed controls that must be properly matched in the field. TSL 2 also allows and encourages uptake of circulators with controls, as manufacturers may choose to prioritize variable speed ECM as opposed to single speed ECM. This could increase the potential savings from TSL 2 from those captured in the analysis, while providing consumers and manufacturers with flexibility to select the motor and/or control strategy most appropriate to their given application.

After considering the analysis and weighing the benefits and burdens, the Secretary has tentatively concluded that a standard set at TSL 2 for circulator pumps would be economically justified. At this TSL, the average LCC is positive. An estimated 29.2 percent, less than a third, of circulator pump consumers experience a net cost. The FFC national energy savings are significant and the NPV of consumer benefits is positive using both a 3-percent and 7-percent discount rate. Manufacturers supported the CPWG recommendation of establishing standards set at TSL 2. Therefore, DOE anticipates that manufacturers will be able to absorb the capital and product conversion costs to manufacture more efficient equipment. Notably, the benefits to consumers significantly outweigh the cost to manufacturers.

In addition, TSL 2 is consistent with the recommendations voted on by the CPWG and approved by the ASRAC. (*See* Docket No. EERE–2016–BT–STD–0004, No. 98) DOE has encouraged the negotiation of new standard levels as a means for interested parties, representing diverse points of view, to analyze and recommend energy conservation standards to DOE. Such negotiations may often expedite the rulemaking process. In addition, standard levels recommended through a negotiation may increase the likelihood for regulatory compliance, while decreasing the risk of litigation.

As stated, DOE conducts the walk-down analysis to determine the TSL that represents the maximum improvement in energy efficiency that is technologically feasible and economically justified as required under EPCA. The walk-down is not a comparative analysis, as a comparative analysis would result in the maximization of net benefits instead of energy savings that are technologically feasible and economically justified, which would be contrary to the statute. 86 FR 70892, 70908. Although DOE has not conducted a comparative analysis to select the proposed energy conservation standards, DOE notes that despite the average consumer LCC savings being similar between TSL 2 ($103.2), TSL 3 ($105.3) and TSL 4 ($97.6), TSL 2 has a much lower fraction of consumers who experience a net cost (29.2%) than TSL 3 (46.4%) and TSL 4 (49.7%). In terms of industry investment to comply with each standard level, TSL 2 ($77.0 million) has considerably lower impact than TSL 3 ($111.1 million) and TSL 4 ($111.8 million). Finally, when comparing the cumulative NPV of consumer benefit using a 7% discount rate, TSL 2 ($0.73 billion) has a higher benefit value than both TSL 3 ($0.63 billion) and TSL 4 ($0.58 billion), while for a 3% discount rate, TSL 2 ($1.77 billion) is below TSL 3 ($1.99 billion) and TSL 4 (2.07 billion).

Therefore, based on the previous considerations, DOE proposes to adopt the energy conservation standards for circulator pumps at TSL 2. The proposed energy conservation standards for circulator pumps, which are expressed as CEI, are shown in Table V.21. As stated in section III.A.1, this proposed standard level of a maximum CEI of 1.00, or TSL 2, is equivalent to the standard level recommended by the CPWG in the November 2016 CWPG Recommendations, in which was described both as EL 2 and as a CEI value of 1.00.

TABLE V.21—PROPOSED ENERGY CONSERVATION STANDARDS FOR CIRCULATOR PUMPS

Equipment class	Maximum CEI
(All Circulator Pumps)	1.00

2. Annualized Benefits and Costs of the Proposed Standards

The benefits and costs of the proposed standards can also be expressed in terms of annualized values. The annualized net benefit is (1) the annualized national economic value (expressed in 2021$) of the benefits from operating products that meet the proposed standards (consisting primarily of operating cost savings from using less energy, minus increases in product purchase costs, and (2) the annualized monetary value of the climate and health benefits from emission reductions.

Table V.22 shows the annualized values for circulator pumps under TSL 2, expressed in 2021$. The results under the primary estimate are as follows.

Using a 7-percent discount rate for consumer benefits and costs and 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 $93.5 million per year in increased equipment costs, while the estimated annual benefits are $165.8 in reduced equipment operating costs, $44.4 million in climate benefits, and $63.9 million in health benefits. In this case, the net benefit would amount to $180.5 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the proposed standards is $91.2 million per year in increased equipment costs, while the estimated annual benefits are $189.9 million in reduced operating costs, $44.4 million in climate benefits, and $80.8 million in health benefits. In this case, the net benefit would amount to $224.0 million per year.

TABLE V.22—ANNUALIZED BENEFITS AND COSTS OF PROPOSED ENERGY CONSERVATION STANDARDS FOR CIRCULATOR PUMPS (TSL 2)

	Million (2021$/year)		
	Primary estimate	Low-net-benefits estimate	High-net-benefits estimate
3% discount rate:			
Consumer Operating Cost Savings	189.9	185.7	194.0
Climate Benefits*	44.4	44.4	44.4
Health Benefits**	80.8	80.8	80.8
Total Benefits†	315.2	311.0	319.3
Consumer Incremental Product Costs‡	91.2	91.2	91.2
Net Benefits	224.0	219.8	228.1
7% discount rate:			
Consumer Operating Cost Savings	165.8	162.6	168.7
Climate Benefits* (3% discount rate)	44.4	44.4	44.4
Health Benefits**	63.9	63.9	63.9
Total Benefits†	274.1	271.0	277.0
Consumer Incremental Product Costs‡	93.5	93.5	93.5
Net Benefits	180.5	177.4	183.4

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

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

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

† Total benefits include consumer, climate, and health benefits. 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. DOE emphasizes the importance and value of considering the benefits calculated using all four SC-GHG estimates.

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

D. Reporting, Certification, and Sampling Plan

Manufacturers, including importers, must use product-specific certification templates to certify compliance to DOE. As discussed previously, DOE is not proposing to amend the product-specific certification requirements for pumps (10 CFR 429.59) to address circulator pumps in this NOPR. DOE may consider certification reporting requirements for circulator pumps in a separate rulemaking.

VI. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866 and 13563

Executive Order (''E.O.'') 12866, ''Regulatory Planning and Review,'' as supplemented and reaffirmed by E.O. 13563, ''Improving Regulation and Regulatory Review, 76 FR 3821 (Jan. 21, 2011), requires agencies, to the extent permitted by law, to (1) propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify); (2) tailor regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations; (3) select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity); (4) to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt; and (5) identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public. DOE emphasizes as well that E.O. 13563 requires agencies to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible. In its guidance, the Office of Information and Regulatory Affairs (''OIRA'') in the 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 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 (Feb. 19, 2003). 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.

1. Description of Reasons Why Action Is Being Considered

The January 2016 TP final rule and the January 2016 ECS final rule implemented the recommendations of the Commercial and Industrial Pump Working Group (''CIPWG'') established through the Appliance Standards Rulemaking Federal Advisory Committee (''ASRAC'') to negotiate standards and a test procedure for general pumps. (Docket No. EERE–2013–BT–NOC–0039) The CIPWG approved a term sheet containing recommendations to DOE on appropriate standard levels for general pumps, as well as recommendations addressing issues related to the metric and test procedure for general pumps (''CIPWG recommendations''). (Docket No. EERE–2013–BT–NOC–0039, No. 92) Subsequently, ASRAC approved the CIPWG recommendations. The CIPWG recommendations included initiation of a separate rulemaking for circulator pumps. (Docket No. EERE–2013–BT–NOC–0039, No. 92, Recommendation #5A at p. 2)

On February 3, 2016, DOE issued a notice of intent to establish the circulator pumps working group to negotiate a notice of proposed rulemaking (''NOPR'') for energy conservation standards for circulator pumps to negotiate, if possible, Federal standards and a test procedure for circulator pumps and to announce the first public meeting. 81 FR 5658. The CPWG met to address potential energy conservation standards for circulator pumps. Those meetings began on November 3–4, 2016 and concluded on November 30, 2016, with approval of a term sheet (''November 2016 CPWG Recommendations'') containing CPWG recommendations related to energy conservation standards, applicable test procedure, labeling and certification requirements for circulator pumps. (Docket No. EERE–2016–BT–STD–0004, No. 98) As such, DOE has undertaken this rulemaking to consider establishing energy conservation standards for circulator pumps.

2. Objectives of, and Legal Basis for, Rule

EPCA authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. Title III, Part C of EPCA, added by Public Law 95–619, Title IV, section 441(a) (42 U.S.C. 6311–6317, as codified), established the Energy Conservation Program for Certain Industrial Equipment, which sets forth a variety of provisions designed to improve energy efficiency. This equipment includes pumps, the subject of this document. (42 U.S.C. 6311(1)(A))

3. Description on Estimated Number of Small Entities Regulated

For manufacturers of circulator pumps, the Small Business Administration (''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. In 13 CFR 121.201, the SBA sets a threshold of 750 employees or fewer for an entity to be considered as a small business for this category. The equipment covered by this rule are classified under North American Industry Classification System (''NAICS'') code 333914,[79] ''Measuring, Dispensing, and Other Pumping Equipment Manufacturing.''

DOE used publicly available information to identify small businesses that manufacture circulator pumps covered in this rulemaking. DOE identified ten companies that are OEMs of circulator pumps covered by this rulemaking. DOE screened out companies that do not meet the definition of a ''small business'' or are foreign-owned and operated. DOE identified three small, domestic OEMs using subscription-based business information tools to determine the number of employees and revenue of the potential small businesses.

DOE seeks input on its estimate that there are three small business manufacturers of circulator pumps.

4. Description and Estimate of Compliance Requirements Including Differences in Cost, if Any, for Different Groups of Small Entities

This NOPR proposes to adopt energy conservation standards for circulator pumps. To determine the impact on the small OEMs, product conversion costs and capital conversion costs were estimated. Product conversion costs are investments in research, development, testing, marketing, and other non-capitalized costs necessary to make product designs comply with energy conservation standards. Capital conversion costs are one-time investments in plant, property, and equipment made in response to new standards.

DOE estimates there is one small business that does not have any circulator pump models that would meet the proposed standard. The other two businesses both offer circulator pumps that would meet the proposed standard. DOE applied the conversion cost methodology described in section IV.J.2.c of this document to arrive at its estimate of product and capital conversion costs. DOE assumes that all circulator pump manufacturers would spread conversion costs over the two-year compliance timeframe, as standards are expected to require compliance approximately two years after the publication of a final rule. Using publicly available data, DOE estimated the average annual revenue for each of the small businesses. Table VI.1 displays DOE's estimates.

TABLE VI.1—ESTIMATE OF SMALL BUSINESS COMPLIANCE COSTS

Small business manufacturer	Basic models needing re-designed	Conversion costs (2021$ millions)	2 Years of revenue estimate (2021$ millions)	Compliance costs as a percent of 2-year revenue (%)
Manufacturer A	32	44.5	316	14
Manufacturer B	3	3.3	10	32
Manufacturer C	1	1.3	4	33

Additionally, these manufacturers could choose to discontinue their least efficient models and ramp up production of existing, compliant models rather than redesign each of their noncompliant models. Therefore, DOE estimates actual conversion costs could be lower than the estimates developed under the assumption that manufacturers would redesign all noncompliant models. Lastly, DOE notes that all three small businesses are privately owned. Therefore, the exact revenues of these small businesses may vary from DOE's estimates.

DOE seeks input on its estimates of the potential impact to small business manufacturers of circulator pumps. Additionally, DOE requests comment on if any small businesses might exit the circulator pump market in response to the proposed standards, if finalized, or at any other analyzed standard levels and how small businesses would finance, if necessary, the estimated conversion costs.

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 being considered in this action.

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 a range of different efficiency levels and their respective impacts to both manufacturers and consumers. DOE examined energy conservation standards set at lower efficiency levels. While lower TSLs would reduce the impacts on small businesses, it would come at the expense of a reduction in energy savings. TSL 1 is estimated to require manufacturers to incur investments that are approximately 93 percent smaller than the investments estimated to be incurred at TSL 2. However, compared to TSL 2, TSL 1 achieves 84 percent less energy savings and 60 percent less consumer net benefits using a 7 percent discount rate.

A manufacturer/importer whose annual gross revenue from all its operations does not exceed $8 million also may apply for an exemption from all or part of any 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, the Department of Energy Organization Act empowers the Secretary of Energy to adjust a rule issued under the EPCA to prevent ''special hardship, inequity, or unfair distribution of burdens'' that may be imposed on a manufacturer/importer as a result of such a rule (42 U.S.C. 7194). The Department of Energy Office of Hearings and Appeals decides whether to grant requests for exceptions.

Based on the presented discussion, DOE believes that TSL 2 would deliver the highest energy savings while mitigating the potential burdens placed on circulator pump manufacturers, including small business manufacturers. Accordingly, DOE does not propose one of the other TSLs considered in the

[79] The size standards are listed by NAICS code and industry description and are available at: *www.sba.gov/document/support-table-size-standards* (Last accessed on May 1, 2022).

analysis, or the other policy alternatives 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. 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 1003 for additional details.

C. Review Under the Paperwork Reduction Act

Under the procedures established by the Paperwork Reduction Act of 1995 (''PRA''), a person is not required to respond to a collection of information by a Federal agency unless that collection of information displays a currently valid OMB Control Number.

OMB Control Number 1910–1400, Compliance Statement Energy/Water Conservation Standards for Appliances, is currently valid and assigned to the certification reporting requirements applicable to covered equipment, including circulator pumps.

DOE's certification and compliance activities ensure accurate and comprehensive information about the energy and water use characteristics of covered products and covered equipment sold in the United States. Manufacturers of all covered products and covered equipment must submit a certification report before a basic model is distributed in commerce, annually thereafter, and if the basic model is redesigned in such a manner to increase the consumption or decrease the efficiency of the basic model such that the certified rating is no longer supported by the test data. Additionally, manufacturers must report when production of a basic model has ceased and is no longer offered for sale as part of the next annual certification report following such cessation. DOE requires the manufacturer of any covered product or covered equipment to establish, maintain, and retain the records of certification reports, of the underlying test data for all certification testing, and of any other testing conducted to satisfy the requirements of part 429, part 430, and/or part 431. Certification reports provide DOE and consumers with comprehensive, up-to date efficiency information and support effective enforcement.

DOE is not proposing certification or reporting requirements for circulator pumps in this NOPR. Instead, DOE may consider proposals to address amendments to the certification requirements and reporting for circulator pumps under a separate rulemaking regarding appliance and equipment certification. DOE will address changes to OMB Control Number 1910–1400 at that time, as necessary. Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the PRA, unless that collection of information displays a currently valid OMB Control Number.

D. Review Under the National Environmental Policy Act of 1969

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

E. Review Under Executive Order 13132

E.O. 13132, ''Federalism,'' 64 FR 43255 (Aug. 10, 1999), imposes certain requirements on Federal agencies formulating and implementing policies or regulations that preempt State law or that have federalism implications. The Executive order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and to carefully assess the necessity for such actions. The Executive order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. DOE has examined this proposed rule and has tentatively determined that it would not have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the equipment that is 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. 6316(a) and (b); 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.*

This rule does not contain a Federal intergovernmental mandate, nor is it expected to require expenditures of $100 million or more in any one year by the private sector.

As a result, the analytical requirements of UMRA do not apply.

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 energy conservation standards for circulator pumps, 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.[80] 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.[81]

VII. Public Participation

A. Participation in the Webinar

[80] The 2007 ''Energy Conservation Standards Rulemaking Peer Review Report'' is available at the following website: *energy.gov/eere/buildings/downloads/energy-conservation-standards-rulemaking-peer-review-report-0* (last accessed July 21, 2022).

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

The time and date of the webinar meeting are listed in the DATES section at the beginning of this document. Webinar registration information, participant instructions, and information about the capabilities available to webinar participants will be published on DOE's website: *www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=66.* Participants are responsible for ensuring their systems are compatible with the webinar software.

B. Procedure for Submitting Prepared General Statements for Distribution

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

C. Conduct of the Public Meeting

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

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

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

A transcript of the webinar will be included in the docket, which can be viewed as described in the *Docket* section at the beginning of this document. 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 its approach to exclude SVILs from the scope of this NOPR, and whether DOE should consider standards for any SVILs as part of this rulemaking.

(2) DOE requests comment regarding circulator pump control variety for the purposes of demonstrating compliance with energy conservation standards.

(3) DOE requests comment regarding the proposed scope of energy conservation standards for circulator pumps.

(4) DOE requests comment regarding the present circulator pump-related definitions, and in particular whether any clarifications are warranted.

(5) DOE requests comment regarding the proposal to analyze all circulator pumps within a single equipment class.

(6) DOE requests comment on its proposal not to establish a separate equipment class for on-demand circulator pumps.

(7) DOE requests comment regarding the current and anticipated forward availability of ECMs and components necessary for their manufacture.

(8) DOE requests comment on whether the distribution channels described above and the percentage of equipment sold through the different channels are appropriate and sufficient to describe the distribution markets for circulator pumps. Specifically, DOE requests comment and data on online sales of circulator pumps and the appropriate channel to characterize them.

(9) DOE seeks comment on the approach and inputs used to develop no-new standards case efficiency distribution.

(10) DOE seeks comment on the approach and inputs used to develop no-new standards case shipments projections.

(11) DOE seeks comment on the approach and inputs used to develop the different standards case shipments projections.

(12) DOE requests comment on the rebound effect specifically for circulator pumps, including the magnitude of any rebound effect and data sources specific to circulator pumps.

(13) DOE seeks input on its estimates of product and capital conversion costs associated with manufacturing circulator pumps at the potential energy conservation standard.

(14) DOE requests comment on its estimates of domestic employment for circulator pump manufacturing in the presence of an energy conservation standards.

(15) DOE seeks input on its estimate that there are three small business manufacturers of circulator pumps.

(16) DOE seeks input on its estimates of the potential impact to small business manufacturers of circulator pumps. Additionally, DOE requests comment on if any small businesses might exit the circulator pump market in response to the proposed standards, if finalized, or at any other analyzed standard levels and how small businesses would finance, if necessary, the estimated conversion costs.

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

VIII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this notice of proposed rulemaking and announcement of public meeting.

List of Subjects in 10 CFR Part 431

Administrative practice and procedure, Confidential business information, Energy conservation test procedures, Reporting and recordkeeping requirements.

Signing Authority

This document of the Department of Energy was signed on November 21, 2022, 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 November 22, 2022.

Treena V. Garrett,

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

For the reasons set forth in the preamble, DOE proposes to amend part 431 of chapter II, subchapter D, of title 10 of the Code of Federal Regulations, as set forth below:

PART 431—ENERGY EFFICIENCY PROGRAM FOR CERTAIN COMMERCIAL AND INDUSTRIAL EQUIPMENT

■ 1. The authority citation for part 431 continues to read as follows:

Authority: 42 U.S.C. 6291–6317; 28 U.S.C. 2461 note.

■ 2. Amend § 431.465 by revising the section heading and adding paragraph (i) to read as follows:

§ 431.465 Circulator pumps energy conservation standards and their compliance dates.

* * * * *

(i) Each circulator pump that is manufactured starting on [*date 2 years after publication of the final in the* **Federal Register**] and that meets the criteria in paragraphs (i)(1) through (i)(2) of this section must have a circulator energy index (''CEI'') rating (as determined in accordance with the test procedure in § 431.464(c)(2)) of not more than 1.00 using the instructions in paragraph (i)(3) of this section and with a control mode as specified in paragraph (i)(4) of this section:

(1) Is a clean water pump as defined in § 431.462.

(2) Is not a submersible pump or a header pump, each as defined in § 431.462.

(3) The relationships in this paragraph (i)(3) are necessary to calculate maximum CEI.

(i) Calculate CEI according to the following equation, as specified in section F.1 of appendix D to subpart Y of part 431:

$$CEI = \frac{CER}{CER_{STD}}$$

Where:

CEI = the circulator energy index (dimensionless);

CER = the circulator energy rating, determined in accordance with section F.1 of appendix D to subpart Y of part 431 (hp); and

CER_{STD} = the CER for a circulator pump that is minimally compliant with DOE's energy conservation standards with the same hydraulic horsepower as the rated pump, determined in accordance with paragraph (i)(3)(ii) of this section (hp).

(ii) Calculate CER_{STD} according to the following equation:

$$CER_{STD} = \sum_i \omega_i \left(P_i^{in,STD}\right)$$

Where:

CER_{STD} = the CER for a circulator pump that is minimally compliant with DOE's energy conservation standards with the same hydraulic horsepower as the rated pump, determined in accordance with paragraph (i)(3)(ii) of this section (hp);

i = the index variable of the summation notation used to express CER_{STD} as described in the following table, in which i is expressed as a percentage of circulator pump flow at best efficiency point, determined in accordance with the test procedure in § 431.464(c)(2):

i
25%
50%
75%
100%

(dimensionless); and

ω_i = the weighting factor at each corresponding test point, *i*, as described in the following table:

i	Corresponding ω_i
25%	.25
50%	.25
75%	.25
100%	.25

(dimensionless); and

$P_i^{in,STD}$ = the reference power input to the circulator pump driver at test point *i*, calculated using the equations and method specified in paragraph (i)(3)(iii) of this section (hp).

(iii) Calculate $P_i^{in,STD}$ according to the following equation:

$$P_i^{in,STD} = \frac{P_{u,i}}{\alpha_i * \frac{\eta_{WTW,100\%}}{100}}$$

Where:

$P_i^{in,STD}$ = the reference power input to the circulator pump driver at test point *i* (hp);

$P_{u,i}$ = circulator pump basic model rated hydraulic horsepower determined in accordance with 10 CFR 429.59(a)(2)(i) (hp);

α_i = part load efficiency factor at each test point as described in the following table:

i	Corresponding α_i
25%	0.4843
50%	0.7736
75%	0.9417
100%	1

(dimensionless); and

$\eta_{WTW,100\neq}$ = reference circulator pump wire-to-water efficiency at best efficiency point at the applicable energy conservation standard level, as described in the following table as a function of circulator pump basic model rated hydraulic horsepower, $P_{u,100\neq}$ (%):

$P_{u,100\%}$	$\eta_{WTW,100\%}$
<1	A*ln($P_{u,100\%}$+B)+C.
≥1	67.79%.

Where A, B, and C are mathematical constants as specified in the following table:

A	B	C
10.00	.001141	67.78

(4) A circulator pump subject to energy conservation standards as described in this paragraph (i) must achieve the maximum CEI as described in paragraph (i)(3)(i) of this section and in accordance with the test procedure in § 431.464(c)(2) in the least consumptive control mode in which it is capable of operating.

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