This document, concerning Refrigerators, Refrigerator-Freezers, and Freezers is an action issued by the Department of Energy. Though it is not intended or expected, should any discrepancy occur between the document posted here and the document published in the Federal Register, the Federal Register publication controls. This document is being made available through the Internet solely as a means to facilitate the public's access to this document.

[6450-01-P]

DEPARTMENT OF ENERGY

10 CFR Part 430

[EERE-2017-BT-STD-0003]

RIN 1904-AD80

Energy Conservation Program: Energy Conservation Standards for Refrigerators, Refrigerator-Freezers, and Freezers

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 refrigerators, refrigerator-freezers, and freezers. EPCA also requires the U.S. Department of Energy ("DOE" or "the Department") to periodically determine whether more stringent standards would be technologically feasible and economically justified, and would result in significant energy savings. In this notice of proposed rulemaking ("NOPR"), DOE proposes amended energy conservation standards for refrigerators, refrigerator-freezers, and freezers, 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 [**INSERT DATE 60 DAYS AFTER DATE OF PUBLICATION IN THE *FEDERAL REGISTER***].

Meeting: DOE will hold a public meeting via webinar on Tuesday, March 14, 2023, from 1:00 p.m. to 4:00 p.m., in Washington, DC. See section VII, "Public Participation," for webinar registration information, participant instructions and information about the capabilities available to webinar participants. Comments regarding the likely competitive impact of the proposed standard should be sent to the Department of Justice contact listed in the **ADDRESSES** section on or before [**INSERT DATE 30 DAYS AFTER DATE OF PUBLICATION IN THE *FEDERAL REGISTER***].

ADDRESSES: Interested persons are encouraged to submit comments using the Federal eRulemaking Portal at *www.regulations.gov*, under by docket number EERE-2017-BT-STD-0003. Follow the instructions for submitting comments. Alternatively, interested persons may submit comments, identified by docket number EERE-2017-BT-STD-0003, by any of the following methods:

Email: ConsumerRefrigFreezer2017STD0003@ee.doe.gov. Include the docket number EERE-2017-BT-STD-0003 in the subject line of the message.

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

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

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

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

The docket web page can be found at *www.regulations.gov/docket/EERE-2017-BT-STD-0003*. The docket web page contains instructions on how to access all documents, including public comments, in the docket. See section VII of this document for information on how to submit comments through *www.regulations.gov*.

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

FOR FURTHER INFORMATION CONTACT:

Mr. Lucas Adin, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office, EE-5B, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. Telephone: (202) 287-5904. Email: *ApplianceStandardsQuestions@ee.doe.gov*.

Mr. Matthew Schneider, U.S. Department of Energy, Office of the General Counsel, GC-33, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. Telephone: (240) 597-6265. E-mail: *matthew.schneider@hq.doe.gov*.

For further information on how to submit a comment, review other public comments and the docket, or participate in the public meeting, contact the Appliance and Equipment Standards Program staff at (202) 287-1445 or by email: *ApplianceStandardsQuestions@ee.doe.gov*.

SUPPLEMENTARY INFORMATION:

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I. Synopsis of the Proposed Rule

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

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

In accordance with these and other statutory provisions discussed in this document, DOE proposes amended energy conservation standards for refrigerators, refrigerator-freezers, and freezers. The proposed standards, which are expressed in kWh/yr, are shown in Table I.1. These proposed standards, if adopted, would apply to all refrigerators, refrigerator-freezers, and freezers listed in Table I.1 manufactured in, or

[1] All references to EPCA in this document refer to the statute as amended through the Energy Act of 2020, Pub. L. 116-260 (Dec. 27, 2020), which reflect the last statutory amendments that impact Parts A and A-1 of EPCA.
[2] For editorial reasons, upon codification in the U.S. Code, Part B was redesignated Part A.

imported into, the United States starting on the date 3 years after the publication of the final rule for this proposed rule.

Table I.1 Proposed Energy Conservation Standards for Refrigerators, Refrigerator-freezers, and Freezers

Product class	Equations for maximum energy use (kWh/yr)	
	Based on AV (ft^3)	Based on av (L)
1. Refrigerator-freezers and refrigerators other than all-refrigerators with manual defrost	6.79AV + 191.3	0.240av + 191.3
1A. All-refrigerators - manual defrost	5.77AV + 164.6	0.204av + 164.6
2. Refrigerator-freezers—partial automatic defrost	(6.79AV + 191.3)*K2	(0.240av + 191.3)*K2
3. Refrigerator-freezers—automatic defrost with top-mounted freezer	6.86AV + 198.6 + 28I	0.242av + 198.6 + 28I
3-BI. Built-in refrigerator-freezer—automatic defrost with top-mounted freezer	8.24AV + 238.4 + 28I	0.291av + 238.4 + 28I
3A. All-refrigerators - automatic defrost	(6.01AV + 171.4)*K3A	(0.212av + 171.4)*K3A
3A-BI. Built-in All-refrigerators - automatic defrost	(7.22AV + 205.7)*K3ABI	(0.255av + 205.7)*K3ABI
4. Refrigerator-freezers—automatic defrost with side-mounted freezer	6.89AV + 241.2 + 28I	0.243av + 241.2 + 28I
4-BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer	8.79AV + 307.4 + 28I	0.310av + 307.4 + 28I
5. Refrigerator-freezers—automatic defrost with bottom-mounted freezer	(7.61AV + 272.6)*K5 + 28I	(0.269av + 272.6)*K5 + 28I
5-BI. Built-In Refrigerator-freezers—automatic defrost with bottom-mounted freezer	(8.65AV + 309.9)*K5BI + 28I	(0.305av + 309.9)*K5BI + 28I
5A. Refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service	(7.26AV + 329.2)*K5A	(0.256av + 329.2)*K5A

5A-BI. Built-in refrigerator-freezer - automatic defrost with bottom-mounted freezer with through-the-door ice service	(8.21AV + 370.7)*K5ABI	(0.290av + 370.7)*K5ABI
6. Refrigerator-freezers—automatic defrost with top-mounted freezer with through-the-door ice service	7.14AV + 280.0	0.252av + 280.0
7. Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service	(6.92AV + 305.2)*K7	(0.244av + 305.2)*K7
7-BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer	(8.82AV + 384.1)*K7BI	(0.311av + 384.1)*K7BI
8. Upright freezers with manual defrost	5.57AV + 193.7	0.197av + 193.7
9. Upright freezers with automatic defrost	7.76AV + 205.5 + 28I	0.274av + 205.5 + 28I
9-BI. Built-In Upright freezers with automatic defrost	9.37AV + 247.9 + 28I	0.331av + 247.9 + 28I
10. Chest freezers and all other freezers except compact freezers	7.29AV + 107.8	0.257av + 107.8
10A. Chest freezers with automatic defrost	10.24AV + 148.1	0.362av + 148.1
11. Compact refrigerator-freezers and refrigerators other than all-refrigerators with manual defrost	7.68AV + 214.5	0.271av + 214.5
11A. Compact all-refrigerators - manual defrost	6.66AV + 186.2	0.235av + 186.2
12. Compact refrigerator-freezers—partial automatic defrost	(7.68AV + 214.5)*K12	(0.271av + 214.5)*K12
13. Compact refrigerator-freezers—automatic defrost with top-mounted freezer	10.62AV + 305.3 + 28I	0.375av + 305.3 + 28I
13A. Compact all-refrigerators - automatic defrost	(8.25AV + 233.4)*K13A	(0.291av + 233.4)*K13A
14. Compact refrigerator-freezers—automatic defrost with side-mounted freezer	6.14AV + 411.2 + 28I	0.217av + 411.2 + 28I

15. Compact refrigerator-freezers—automatic defrost with bottom-mounted freezer	10.62AV + 305.3 + 28I	0.375av + 305.3 + 28I
16. Compact upright freezers with manual defrost	7.35AV + 191.8	0.260av + 191.8
17. Compact upright freezers with automatic defrost	9.15AV + 316.7	0.323av + 316.7
18. Compact chest freezers	7.86AV + 107.8	0.278av + 107.8
AV = Total adjusted volume, expressed in ft^3, as determined in appendices A and B of subpart B of 10 C.F.R. part 430. av = Total adjusted volume, expressed in Liters. I = 1 for a product with an automatic icemaker and = 0 for a product without an automatic icemaker. Door Coefficients (*e.g.,* K3A) are as defined in Table I.2.		

Table I.2 Description of Door Coefficients for Proposed Maximum Energy Use Equations for Refrigerators, Refrigerator-freezers, and Freezers

Door Coefficient	Products with a Transparent Door	Products without a Transparent Door with a Door-in-Door	Products without a Transparent Door or Door-in-Door with Added External Doors
K2	N/A	N/A	1 + 0.02 * (N_d - 1)
K3A	1.10	N/A	N/A
K3ABI			
K13A			
K5		1.06	1 + 0.02 * (N_d - 2)
K5BI			
K5A			1 + 0.02 * (Nd - 3)
K5ABI			
K7			1 + 0.02 * (Nd - 2)
K7BI			
K12	N/A	N/A	1 + 0.02 * (N_d - 1)
N_d is the number of external doors			

1. Benefits and Costs to Consumers

Table I.3 presents DOE's evaluation of the economic impacts of the proposed standards on consumers of refrigerators, refrigerator-freezers, and freezers, as measured by the average life-cycle cost ("LCC") savings and the simple payback period ("PBP").[3] The average LCC savings are positive for all product classes for which a standard is proposed, and the PBP is less than the average lifetime of refrigerators, refrigerator-freezers, and freezers, which varies by product class (see section IV.F.7 of this document).

Table I.3 Impacts of Proposed Energy Conservation Standards on Consumers of Refrigerators, Refrigerator-Freezers, and Freezers (TSL 5)

Product Class	Average LCC Savings *2021$*	Simple Payback Period *years*
PC 3	36.04	5.3
PC 5	49.73	4.8
PC 5BI	39.94	5.7
PC 5A	115.76	5.7
PC 7	101.33	5.0
PC 9	69.26	3.9
PC 10	N/A	N/A
PC 11A (residential)	9.97	2.1
PC 11A (commercial)	3.42	3.2
PC 17	21.90	5.0
PC 18	17.59	4.2

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

2. Impact on Manufacturers[4]

The industry net present value ("INPV") is the sum of the discounted cash flows to the industry from the NOPR publication year through the end of the analysis period

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

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

(2023–2056). Using a real discount rate of 9.1 percent, DOE estimates that the INPV for manufacturers of refrigerators, refrigerator-freezers, and freezers, in the case without amended standards is $4.97 billion. Under the proposed standards, the change in INPV is estimated to range from -20.2 percent to -16.0 percent, which is approximately -$1.0 billion to -$792.8 million. In order to bring products into compliance with amended standards, it is estimated that the industry would incur total conversion costs of $1.32 billion.

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.

3. National Benefits and Costs

DOE's analyses indicate that the proposed energy conservation standards for refrigerators, refrigerator-freezers, and freezers would save a significant amount of energy. Relative to the case without amended standards, the lifetime energy savings for refrigerators, refrigerator-freezers, and freezers purchased in the 30-year period that begins in the anticipated year of compliance with the amended standards (2027–2056) amount to 5.3 quadrillion British thermal units ("Btu"), or quads.[5] This represents a savings of 12 percent relative to the energy use of these products in the case without amended standards (referred to as the "no-new-standards case").

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

The cumulative net present value ("NPV") of total consumer benefits of the proposed standards for refrigerators, refrigerator-freezers, and freezers ranges from $6.6 billion (at a 7-percent discount rate) to $20.4 billion (at a 3-percent discount rate). This NPV expresses the estimated total value of future operating-cost savings minus the estimated increased product costs for refrigerators, refrigerator-freezers, and freezers purchased in 2027–2056.

In addition, the proposed standards for refrigerators, refrigerator-freezers, and freezers are projected to yield significant environmental benefits. DOE estimates that the proposed standards would result in cumulative emission reductions (over the same period as for energy savings) of 179.2 million metric tons ("Mt")[6] of carbon dioxide ("CO_2"), 83.1 thousand tons of sulfur dioxide ("SO_2"), 274.4 thousand tons of nitrogen oxides ("NO_X"), 1,204.7 thousand tons of methane ("CH_4"), 1.9 thousand tons of nitrous oxide ("N_2O"), and 0.5 tons of mercury ("Hg").[7]

DOE estimates the value of climate benefits from a reduction in greenhouse gases (GHG) using four different estimates of the social cost of CO_2 ("SC-CO_2"), the social cost of methane ("SC-CH_4"), and the social cost of nitrous oxide ("SC-N_2O"). Together these represent the social cost of GHG (SC-GHG).[8] DOE used interim SC-GHG values

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

[7] DOE calculated emissions reductions relative to the no-new-standards case, which reflects key assumptions in the *Annual Energy Outlook 2022* ("*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.

[8] 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

developed by an Interagency Working Group on the Social Cost of Greenhouse Gases (IWG).[9] The derivation of these values is discussed in section IV.L of this document. For presentational purposes, the climate benefits associated with the average SC-GHG at a 3-percent discount rate are estimated to be \$8.1 billion. DOE does not have a single central SC-GHG point estimate and it emphasizes the importance and value of considering the benefits calculated using all four SC-GHG estimates.

DOE estimated the monetary health benefits of SO_2 and NO_X emissions reductions, also discussed in section IV.L of this document. DOE estimated the present value of the health benefits would be \$5.3 billion using a 7-percent discount rate, and \$14.2 billion using a 3-percent discount rate.[10] DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions.

Table I.4 summarizes the economic benefits and costs expected to result from the proposed standards for refrigerators, refrigerator-freezers, and freezers. There are other important unquantified effects, including certain unquantified climate benefits,

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social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. As reflected in this rule, DOE has reverted to its approach prior to the injunction and presents monetized greenhouse gas abatement benefits where appropriate and permissible under law.

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

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

unquantified public health benefits from the reduction of toxic air pollutants and other emissions, unquantified energy security benefits, and distributional effects, among others.

Table I.4 Summary of Monetized Benefits and Costs of Proposed Energy Conservation Standards for Refrigerators, Refrigerator-freezers, and Freezers (TSL 5)

	Billion 2021$
3% discount rate	
Consumer Operating Cost Savings	32.7
Climate Benefits*	8.1
Health Benefits**	14.2
Total Benefits†	55.1
Consumer Incremental Product Costs‡	12.3
Net Benefits	42.7
7% discount rate	
Consumer Operating Cost Savings	13.6
Climate Benefits* (3% discount rate)	8.1
Health Benefits**	5.3
Total Benefits†	27.0
Consumer Incremental Product Costs	6.9
Net Benefits	20.1

Note: This table presents the costs and benefits associated with product name shipped in 2027–2056. These results include benefits to consumers which accrue after 2056 from the products shipped in 2027–2056.
* Climate benefits are calculated using four different estimates of the social cost of carbon (SC-CO_2), methane (SC-CH_4), and nitrous oxide (SC-N_2O) (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate) (see section IV.L of this document). Together these represent the global SC-GHG. For presentational purposes of this table, the climate benefits associated with the average SC-GHG at a 3 percent discount rate are shown, but the Department does not have a single central SC-GHG point estimate. On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22-30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana v. Biden*, No. 21-cv-1074-JDC-KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from "adopting, employing, treating as binding, or relying upon" the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize

the benefits of reducing greenhouse gas emissions. As reflected in this rule, DOE has reverted to its approach prior to the injunction and presents monetized greenhouse gas abatement benefits where appropriate and permissible under law.
** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. *See* section IV.L of this document for more details.
† Total and net benefits include those consumer, climate, and health benefits that can be quantified and monetized. For presentation purposes, total and net benefits for both the 3-percent and 7-percent cases are presented using the average SC-GHG with a 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.

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

The national operating savings are domestic private U.S. consumer monetary savings that occur as a result of purchasing the covered products and are measured for the lifetime of refrigerators, refrigerator-freezers, and freezers shipped in 2027–2056. The benefits associated with reduced emissions achieved as a result of the proposed standards are also calculated based on the lifetime of refrigerators, refrigerator-freezers, and freezers shipped in 2027–2056. Total benefits for both the 3-percent and 7-percent cases are presented using the average GHG social costs with a 3-percent discount rate.

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

Estimates of SC-GHG values are presented for all four discount rates in section IV.L of this document.

Table I.5 presents the total estimated monetized benefits and costs associated with the proposed standard, expressed in terms of annualized values. The results under the primary estimate are as follows.

Using a 7-percent discount rate for consumer benefits and costs and health benefits from reduced NOx and SO_2 emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the standards proposed in this rule is $730.0 million per year in increased equipment costs, while the estimated annual monetized benefits are $1.4 billion in reduced equipment operating costs, $467.9 million in climate benefits, and $563.3 million in health benefits. In this case, the net monetized benefit would amount to $1.7 billion per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the proposed standards is $707.4 million per year in increased equipment costs, while the estimated annual monetized benefits are $1.9 billion in reduced operating costs, $467.9 million in climate benefits, and $815.2 million in health benefits. In this case, the net monetized benefit would amount to $2.5 billion per year.

Table I.5 Annualized Monetized Benefits and Costs of Proposed Energy Conservation Standards for Refrigerators, Refrigerator-freezers, and Freezers (TSL 5)

	Million 2021$/year		
	Primary Estimate	**Low-Net-Benefits Estimate**	**High-Net-Benefits Estimate**
	3% discount rate		
Consumer Operating Cost Savings	1,878.6	1,745.5	2,030.6
Climate Benefits*	467.9	453.4	482.4
Health Benefits**	815.2	790.3	840.1
Total Benefits†	3,161.7	2,989.3	3,353.1
Consumer Incremental Product Costs‡	707.4	774.3	681.3
Net Benefits	2,454.3	2,215.0	2,671.9
	7% discount rate		
Consumer Operating Cost Savings	1,431.7	1,339.6	1,534.2
Climate Benefits* (3% discount rate)	467.9	453.4	482.4
Health Benefits**	563.3	547.4	579.1
Total Benefits†	2,462.9	2,340.4	2,595.7
Consumer Incremental Product Costs	730.0	788.4	706.3
Net Benefits	1,732.9	1,552.0	1,889.4

Note: This table presents the costs and benefits associated with refrigerators, refrigerator-freezers, and freezers shipped in 2027−2056. These results include benefits to consumers which accrue after 2056 from the products shipped in 2027−2056. The Primary, Low Net Benefits, and High Net Benefits Estimates utilize projections of energy prices from the *AEO 2022* Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental equipment costs reflect a medium decline rate in the Primary Estimate, a low decline rate in the Low Net Benefits Estimate, and a high decline rate in the High Net Benefits Estimate. The methods used to derive projected price trends are explained in section IV.H.3 of this document. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

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

reducing greenhouse gas emissions. As reflected in this rule, DOE has reverted to its approach prior to the injunction and presents monetized greenhouse gas abatement benefits where appropriate and permissible under law.
** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. The health benefits are presented at real discount rates of 3 and 7 percent. See section IV.L of this document for more details.
† Total benefits for both the 3-percent and 7-percent cases are presented using the average SC-GHG with a 3-percent discount rate, but the Department does not have a single central SC-GHG point estimate.

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.

4. 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 regard to technological feasibility, products achieving these proposed standard levels are already commercially available for all covered product classes. As for economic justification, DOE's analysis shows that the benefits of the proposed standard exceed, to a great extent, the burdens of the proposed standards.

Using a 7-percent discount rate for consumer benefits and costs and NOx and SO_2 reduction benefits, and a 3-percent discount rate case for GHG social costs, the estimated cost of the proposed standards for refrigerators, refrigerator-freezers, and freezers is $730.0 million per year in increased product costs, while the estimated annual monetized benefits are $1.4317 billion in reduced product operating costs, $467.9 million in climate benefits and $563.3 million in health benefits. The net monetized benefit amounts to $1.7329 billion per year.

The significance of energy savings offered by a new or amended energy conservation standard cannot be determined without knowledge of the specific circumstances surrounding a given rulemaking.[12] For example, some covered products and equipment have substantial energy consumption occur during periods of peak energy demand. The impacts of these products on the energy infrastructure can be more pronounced than products with relatively constant demand. Accordingly, DOE evaluates the significance of energy savings on a case-by-case basis.

As previously mentioned, the proposed standards are projected to result in estimated national energy savings of 5.3 quads (FFC), the equivalent of the electricity use of 57 million homes in one year. In addition, they are projected to reduce GHG emissions. Based on these findings, DOE has initially determined the energy savings from the proposed standard levels are "significant" within the meaning of 42 U.S.C. 6295(o)(3)(B). A more detailed discussion of the basis for this tentative conclusion is contained in the remainder of this document and the accompanying technical support document ("TSD").

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

Based on consideration of the public comments DOE receives in response to this document and related information collected and analyzed during the course of this

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

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 refrigerators, refrigerator-freezers, and freezers.

A. Authority

EPCA authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. Title III, Part B of EPCA established the Energy Conservation Program for Consumer Products Other Than Automobiles. These products include refrigerators, refrigerator-freezers, and freezers, the subject of this document. (42 U.S.C. 6292(a)(1)) EPCA prescribed initial energy conservation standards for these products (42 U.S.C. 6295(b)(1)-(2)), and directed DOE to conduct three cycles of future rulemakings during which the Department was tasked with determining whether to amend these standards. (42 U.S.C. 6295(b)(3)(A)(i), (b)(3)(B), and (b)(4)). DOE has completed these rulemakings. EPCA further provides that, not later than six years after the issuance of any final rule establishing or amending a standard, DOE must publish either a notice of determination that standards for the product do not need to be amended, or a NOPR including new proposed energy conservation standards (proceeding to a final rule, as appropriate). (42 U.S.C. 6295(m)(1))

The energy conservation program under EPCA consists essentially of four parts: (1) testing, (2) labeling, (3) the establishment of Federal energy conservation standards, and (4) certification and enforcement procedures. Relevant provisions of EPCA specifically include definitions (42 U.S.C. 6291), test procedures (42 U.S.C. 6293), labeling provisions (42 U.S.C. 6294), energy conservation standards (42 U.S.C. 6295), and the authority to require information and reports from manufacturers (42 U.S.C. 6296).

Federal energy efficiency requirements for covered products established under EPCA generally supersede State laws and regulations concerning energy conservation testing, labeling, and standards. (42 U.S.C. 6297(a)-(c)) DOE may, however, grant waivers of Federal preemption for particular State laws or regulations, in accordance with the procedures and other provisions set forth under EPCA. (See 42 U.S.C. 6297(d))

Subject to certain criteria and conditions, DOE is required to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating cost of each covered product. (42 U.S.C. 6295(o)(3)(A) and 42 U.S.C. 6295(r)) Manufacturers of covered products must use the prescribed DOE test procedure as the basis for certifying to DOE that their products comply with the applicable energy conservation standards adopted under EPCA and when making representations to the public regarding the energy use or efficiency of those products. (42 U.S.C. 6293(c) and 42 U.S.C. 6295(s)) Similarly, DOE must use these test procedures to determine whether the products comply with standards adopted pursuant to EPCA. (42 U.S.C. 6295(s)). The DOE test procedures for consumer refrigerators, refrigerator-freezers, and freezers appear at 10 CFR part 430, subpart B, appendix A, Uniform Test Method for Measuring the Energy Consumption of Refrigerators, Refrigerator-Freezers, and Miscellaneous Refrigeration Products ("appendix A") and 10 CFR part 430, subpart B, appendix B, Uniform Test Method for Measuring the Energy Consumption of Freezers ("appendix B").

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

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

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

(2) The savings in operating costs throughout the estimated average life of the covered products in the type (or class) compared to any increase in the

price, initial charges, or maintenance expenses for the covered products that are likely to result from the standard;

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

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

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

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

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

(42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII))

Further, EPCA establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the energy savings during the first year that the consumer will receive as a result of the standard, as calculated under the applicable test procedure. (42 U.S.C. 6295(o)(2)(B)(iii))

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

Additionally, EPCA specifies requirements when promulgating an energy conservation standard for a covered product that has two or more subcategories. DOE must specify a different standard level for a type or class of product that has the same function or intended use, if DOE determines that products within such group: (A) consume a different kind of energy from that consumed by other covered products within such type (or class); or (B) have a capacity or other performance-related feature which other products within such type (or class) do not have and such feature justifies a higher or lower standard. (42 U.S.C. 6295(q)(1)) In determining whether a performance-related feature justifies a different standard for a group of products, DOE must consider such factors as the utility to the consumer of the feature and other factors DOE deems appropriate. *Id*. Any rule prescribing such a standard must include an explanation of the basis on which such higher or lower level was established. (42 U.S.C. 6295(q)(2))

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

DOE's current test procedures for refrigerators, refrigerator-freezers, and freezers address standby mode and off mode energy use. In this proposed rule, DOE intends to incorporate such energy use into any amended energy conservation standards that it may adopt.

B. Background

1. Current Standards

In a final rule published on September 15, 2011 ("September 2011 Final Rule"), DOE prescribed the current energy conservation standards for consumer refrigerators, refrigerator-freezers, and freezers manufactured on and after September 15, 2014. 76 FR 57516. These standards are set forth in DOE's regulations at 10 CFR 430.32(a) and are repeated in Table I.2 of this document.

Table II.1 Current Federal Energy Conservation Standards for Consumer Refrigerators, Refrigerator-Freezers, and Freezers

Product class	**Equations for maximum energy use (kWh/yr)**	
	Based on AV (ft^3)	**Based on av (L)**
1. Refrigerator-freezers and refrigerators other than all-refrigerators with manual defrost	7.99AV + 225.0	0.282av + 225.0
1A. All-refrigerators—manual defrost	6.79AV + 193.6	0.240av + 193.6
2. Refrigerator-freezers—partial automatic defrost	7.99AV + 225.0	0.282av + 225.0
3. Refrigerator-freezers—automatic defrost with top-mounted freezer without an automatic icemaker	8.07AV + 233.7	0.285av + 233.7
3-BI. Built-in refrigerator-freezer—automatic defrost with top-mounted freezer without an automatic icemaker	9.15AV + 264.9	0.323av + 264.9

3I. Refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic icemaker without through-the-door ice service	8.07AV+ 317.7	0.285av + 317.7
3I-BI. Built-in refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic icemaker without through-the-door ice service	9.15AV+ 348.9	0.323av + 348.9
3A. All-refrigerators—automatic defrost	7.07AV+ 201.6	0.250av + 201.6
3A-BI. Built-in All-refrigerators—automatic defrost	8.02AV+ 228.5	0.283av + 228.5
4. Refrigerator-freezers—automatic defrost with side-mounted freezer without an automatic icemaker	8.51AV+ 297.8	0.301av + 297.8
4-BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer without an automatic icemaker	10.22AV+ 357.4	0.361av + 357.4
4I. Refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker without through-the-door ice service	8.51AV+ 381.8	0.301av + 381.8
4I-BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker without through-the-door ice service	10.22AV+ 441.4	0.361av + 441.4
5. Refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker	8.85AV+ 317.0	0.312av + 317.0
5-BI. Built-In Refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker	9.40AV+ 336.9	0.332av + 336.9
5I. Refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker without through-the-door ice service	8.85AV+ 401.0	0.312av + 401.0
5I-BI. Built-In Refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker without through-the-door ice service	9.40AV+ 420.9	0.332av + 420.9
5A. Refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service	9.25AV+ 475.4	0.327av + 475.4
5A-BI. Built-in refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service	9.83AV+ 499.9	0.347av + 499.9
6. Refrigerator-freezers—automatic defrost with top-mounted freezer with through-the-door ice service	8.40AV+ 385.4	0.297av + 385.4
7. Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service	8.54AV+ 432.8	0.302av + 432.8

7-BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service	10.25AV + 502.6	0.362av + 502.6
8. Upright freezers with manual defrost	5.57AV + 193.7	0.197av + 193.7
9. Upright freezers with automatic defrost without an automatic icemaker	8.62AV + 228.3	0.305av + 228.3
9I. Upright freezers with automatic defrost with an automatic icemaker	8.62AV + 312.3	0.305av + 312.3
9-BI. Built-In Upright freezers with automatic defrost without an automatic icemaker	9.86AV + 260.9	0.348av + 260.9
9I-BI. Built-in upright freezers with automatic defrost with an automatic icemaker	9.86AV + 344.9	0.348av + 344.9
10. Chest freezers and all other freezers except compact freezers	7.29AV + 107.8	0.257av + 107.8
10A. Chest freezers with automatic defrost	10.24AV + 148.1	0.362av + 148.1
11. Compact refrigerator-freezers and refrigerators other than all-refrigerators with manual defrost	9.03AV + 252.3	0.319av + 252.3
11A.Compact all-refrigerators—manual defrost	7.84AV + 219.1	0.277av + 219.1
12. Compact refrigerator-freezers—partial automatic defrost	5.91AV + 335.8	0.209av + 335.8
13. Compact refrigerator-freezers—automatic defrost with top-mounted freezer	11.80AV + 339.2	0.417av + 339.2
13I. Compact refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic icemaker	11.80AV + 423.2	0.417av + 423.2
13A. Compact all-refrigerators—automatic defrost	9.17AV + 259.3	0.324av + 259.3
14. Compact refrigerator-freezers—automatic defrost with side-mounted freezer	6.82AV + 456.9	0.241av + 456.9
14I. Compact refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker	6.82AV + 540.9	0.241av + 540.9
15. Compact refrigerator-freezers—automatic defrost with bottom-mounted freezer	11.80AV + 339.2	0.417av + 339.2
15I. Compact refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker	11.80AV + 423.2	0.417av + 423.2

16. Compact upright freezers with manual defrost	8.65AV + 225.7	0.306av + 225.7
17. Compact upright freezers with automatic defrost	10.17AV + 351.9	0.359av + 351.9
18. Compact chest freezers	9.25AV + 136.8	0.327av + 136.8
AV = Total adjusted volume, expressed in ft^3, as determined in appendices A and B of subpart B of this part. av = Total adjusted volume, expressed in Liters.		

2. History of Standards Rulemaking for Consumer Refrigerators, Refrigerator-Freezers, and Freezers

On November 15, 2019, DOE published a request for information ("RFI") to collect data and information to help DOE determine whether any new or amended standards for consumer refrigerators, refrigerator-freezers, and freezers would result in a significant amount of additional energy savings and whether those standards would be technologically feasible and economically justified. 84 FR 62470 ("November 2019 RFI").

Comments received following the publication of the November 2019 RFI helped DOE identify and resolve issues related to the subsequent preliminary analysis.[13] DOE published a notice of public meeting and availability of the preliminary TSD on October 15, 2021 ("October 2021 Preliminary Analysis"). 86 FR 57378. DOE subsequently held a public meeting on December 1, 2021, to discuss and receive comments on the preliminary TSD. The preliminary TSD that presented the methodology and results of

[13] Comments submitted in response to the RFI are available at *www.regulations.gov/document/EERE-2017-BT-STD-0003-0021/comment.*

the preliminary analysis is available at: *www.regulations.gov/document/EERE-2017-BT-STD-0003-0021*.

DOE received nine docket comments in response to the October 2021 Preliminary Analysis from the interested parties listed in Table II.2.

Table II.2 October 2021 Preliminary Analysis Written Comments

Organization(s)	Reference in this NOPR	Organization Type
Association of Home Appliance Manufacturers	AHAM	Trade Organization
Appliance Standards Awareness Project, American Council for an Energy-Efficient Economy, National Consumer Law Center (On behalf of its low-income clients)	Joint Advocates	Efficiency Organization
California Investor-Owned Utilities	CA IOUs	Utility Supplier
Shorey Consulting	Shorey	Consultant
ComEd Energy Solutions Center, Northwest Energy Efficiency Alliance	ComEd and NEEA	Joint Commenters
GE Appliances, a Haier company	GEA	Manufacturer
Samsung Electronics America, Inc.	Samsung	Manufacturer
Sub-Zero Group, Inc.	Sub-Zero	Manufacturer
Whirlpool Corporation	Whirlpool	Manufacturer
Anonymous	Anonymous	Individual

A parenthetical reference at the end of a comment quotation or paraphrase provides the location of the item in the public record.[14]

[14] The parenthetical reference provides a reference for information located in the docket of DOE's rulemaking to develop energy conservation standards for refrigerators, refrigerator-freezers, and freezers. (Docket No. EERE-2017-BT-STD-0003, which is maintained at *https://www.regulations.gov/document/EERE-2017-BT-STD-0003*). The references are arranged as follows: (commenter name, comment docket ID number, page of that document).

3. Test Procedure

EPCA sets forth generally applicable criteria and procedures for DOE's adoption and amendment of test procedures. (42 U.S.C. 6293) Manufacturers of covered products must use these test procedures to certify to DOE that their product complies with energy conservation standards and to quantify the efficiency of their product. DOE must finalize new or amended test procedures that impact measured energy use or efficiency at least 180 days prior to publication of a NOPR proposing new or amended energy conservation standards. (Section 8(d) of 10 CFR part 430, subpart C, appendix A ("Process Rule"))

DOE's current energy conservation standards for consumer refrigerators, refrigerator-freezers, and freezers are expressed in terms of annual energy use ("AEU") in kilowatt-hours per year ("kWh/yr") as measured by the current test procedures at appendix A and appendix B, as applicable. (10 CFR 430.32(a)) The current test procedure incorporates by reference the Association of Home Appliance Manufacturers ("AHAM") industry test procedure updated in 2019, AHAM Standard HRF-1, "Energy and Internal Volume of Refrigerating Appliances," ("HRF-1-2019"). 10 CFR 430.3(i)(4). The current test procedure was finalized in a final rule published on October 12, 2021 ("October 2021 TP Final Rule"). 86 FR 56790. The October 2021 TP Final Rule amended the test procedure by incorporating the latest industry test standard (HRF-1-2019). However, DOE did not adopt the change in icemaker energy use included in the 2019 revision of HRF-1. 86 FR 56793. While DOE had proposed to implement this change in the in the proposed test procedure rulemaking (84 FR 70842, 70848-70850 (December 23, 2019)), DOE indicated in the October 2021 TP Final Rule that it would not require the calculations until the compliance dates of any amended energy conservation standards for these products, which incorporated the amended automatic icemaker energy consumption. 86 FR 56793. DOE concluded that the test procedure would not alter the measured energy use of consumer refrigeration products. *Id*.

The analysis presented in this NOPR is based on the test procedure as finalized in the October 2021 TP Final Rule, except for the calculation of the change in energy use attributed to icemaker energy use. The change in icemaker energy use is discussed further in section III.B of this document. DOE is proposing implementation of the revised icemaker energy use calculation in this NOPR. The value of the revised icemaker energy use and the plans to implement this change coincident with the date of future energy conservation standards were discussed at length and included in the most recent test procedure final rule, consistent with the Process Rule.

4. Off Mode and Standby Mode

Pursuant to the amendments contained in the Energy Independence and Security Act of 2007 ("EISA 2007"), Pub. L. 110-140, any final rule for new or amended energy conservation standards promulgated after July 1, 2010, is required to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) Specifically, when DOE adopts a standard for a covered product after that date, it must, if justified by the criteria for adoption of standards under EPCA (42 U.S.C. 6295(o)), incorporate standby mode and off mode energy use into a single standard, or, if that is not feasible, adopt a separate standard for such energy use for that product. (42 U.S.C. 6295(gg)(3)(A)-(B)) DOE's current test procedures for consumer refrigerators, refrigerator-freezers, and freezers measure the energy use of these products during extended time periods that include periods when the compressor and other key components are cycled off. All of the energy these products use during the "off cycles" is already included in the measurements. A given refrigeration product being tested could include auxiliary features that draw power in a standby or off mode. In such instances, the DOE test procedures generally instruct manufacturers to set certain auxiliary features to the lowest power position during testing. *See* section 5.5.2(e) of AHAM Standard HRF-1-2008. In this lowest power position, any standby or off mode energy use of such auxiliary features would be included in the energy measurement. As a result, DOE's current energy conservation standards, and any amended energy conservation standards would account for standby mode and off mode energy use in the AEU metric.

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 the provision in appendix A regarding the pre-NOPR stages for an energy conservation standards rulemaking. Section 6(a)(2) of appendix A states that if the Department determines it is appropriate to proceed with a rulemaking, the preliminary stages of a rulemaking to issue or amend an energy conservation standard that DOE will undertake will be a framework document and preliminary analysis, or an advance notice of proposed rulemaking. For the reasons that follow, DOE finds it necessary and appropriate to deviate from this step in appendix A and to instead publish this NOPR without conducting these preliminary stages. DOE finds that there would be little benefit in repeating the preliminary stages of this proposed rule. The earlier stages of a rulemaking are intended to introduce the various analyses DOE conducts during the rulemaking process, present preliminary results, and request initial feedback from interested parties to seek early input. As DOE is using similar analytical methods in this NOPR to previous amendments to the standard for refrigerators, refrigerator-freezers and freezers, publication of a framework document, preliminary analysis, or ANOPR would be largely redundant of previously published documents. Stakeholders have previously provided numerous rounds of input on these methodologies in the most recent rulemaking. However, as discussed in section IV of this NOPR, DOE has updated analytical inputs in its analyses where appropriate and welcomes submission of additional data, information, and comments.

Section 6(f)(2) of appendix A provides that the length of the public comment period for the NOPR will be at least 75 days. For this NOPR, DOE finds it necessary and appropriate to provide a 60-day comment period. As stated previously, the analytical methods used for this NOPR are similar to those used in previous rulemaking notices. Consequently, DOE has determined it is necessary and appropriate to provide a 60-day comment period, which the Department has determined provides sufficient time for interested parties to review the NOPR and develop comments.

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. Product Classes and Scope of Coverage

When evaluating and establishing energy conservation standards, DOE divides covered products into product 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. 6295(q))

When establishing the product classes, DOE is proposing to revise the class structure by eliminating the classes that add icemakers and through-the-door ice dispensers while maintaining the same AEU calculations. The product class discussion in section IV of this document explores this issue further.

B. Test Procedure

EPCA sets forth generally applicable criteria and procedures for DOE's adoption and amendment of test procedures. (42 U.S.C. 6293) Manufacturers of covered products must use these test procedures to certify to DOE that their product complies with energy conservation standards and to quantify the efficiency of their product. DOE’s current energy conservation standards for refrigerators, refrigerator-freezers, and freezers are expressed in terms of AEU, expressed in kWh/year. (*See* 10 CFR 430.32(a).)

AHAM stated it would have been preferable for DOE to conduct its analysis with the final test procedure that DOE published before the preliminary analysis and that will be used to demonstrate compliance with a possible amended standard and that, in this case, the revised test procedure does not change measured efficiency so much that they would expect that the entire analysis would need to be redone as a result of the new test procedure. (AHAM, Public Meeting Transcript, No. 30 at p. 1) [15]

[15] A notation in the form “AHAM, No. 31 at pp. 6-7” identifies a written comment: (1) Made by the Association of Home Appliance Manufacturers; (2) recorded in document number 27 that is filed in the docket of this test procedure rulemaking (Docket No. EERE-2014-BT-STD-0003) and available for review at *www.regulations.gov*; and (3) which appears on pages 6 and 7 of document number 31.

DOE responds that it conducted the preliminary analysis consistent with the test procedure currently used to demonstrate compliance with standards. Specifically, the icemaker energy use adder used in the preliminary analysis was 84 kWh/yr. For the NOPR analysis, DOE adopted the revised test procedure finalized in the October 2021 TP final rule (to be used to demonstrate compliance with a possible amended standard) which included a revised icemaker energy use adder of 28 kWh/yr, that is more closely aligned with AHAM's HRF-1-2019 – which represents the industry standard. As discussed in the October 2021 TP final rule, DOE determined it would not require testing with the amended icemaking energy use adder until the compliance dates of the next amended energy conservation standards for refrigeration products. This NOPR proposes that product class representations made on or after the compliance date of revised standards would require use of the 28 kWh/year value.

The California IOUs stated the existing test procedures in appendices A and B do a poor job predicting efficiency at ambient conditions below 90 F and that they would benefit significantly by including an additional ambient test condition to properly inform consumers about what products work well in a real-world use cycle. From their testing, the California IOUs stated that not testing at both 90 °F and 60 °F leaves a significant gap in representative performance evaluation of an average use cycle based on the significant unit-to-unit variation and rank order impact changes shown by the DOE and CA IOU product testing. They therefore asked DOE to reconsider their conclusion in the October 2021 Test Procedure Final Rule to not require testing at two ambient conditions, per IEC 62552, in the DOE consumer refrigeration test procedure. (California IOUs, No. 33, pp. 6-9)

ComEd and NEEA agreed with the sentiment from California IOUs that testing should require a set of lower ambient temperatures along with the 90-degree temperature mark and recommended that DOE consider adopting the IEC Refrigerator Test Procedure, which their analysis suggests will permit more representative energy values to be calculated than the current DOE test procedure of user interactions with refrigerators. Along with Samsung, they also recommended that DOE collect more field data on refrigerator energy use to understand how to improve the representativeness of the test procedure. (ComEd Energy Solutions Center & Northwest Energy Efficiency Alliance, No. 37, pp. 9-10; Samsung, No. 32, p. 3)

In another comment, ComEd and NEEA cited average usage of models in ambient temperatures lower than 90 degrees and cited how requiring a lower test point would create an incentive for manufacturers to focus on the broad range of ambient temperatures. (ComEd Energy Solutions Center & Northwest Energy Efficiency Alliance, No. 37, pp. 2-4) ComEd and NEEA also pointed to energy savings that could result from testing products at a lower ambient temperature. (ComEd Energy Solutions Center & Northwest Energy Efficiency Alliance, No. 37, pp. 4-7)

DOE responds that it has already finalized the test procedure without requiring additional lower ambient testing based both on data provided by a manufacturer and on its own test data, which indicated that the current test procedure conducted in a 90 ºF ambient temperature does not underestimate the benefit of variable-speed technology. 86 FR 56790, 56790-56825 (October 12, 2021) DOE appreciates the additional data, which

DOE will consider when considering revisions to the test procedure as required by the 7-year lookback provision. (42 U.S.C. 6314(a)(1)(A))

ComEd and NEEA further recommended that DOE adopt an optional method of testing for ice makers and undertake further testing and analysis. They stated they also believe that considerable variation exists in the efficiency of the ice making process itself and that the test method should include a way to quantify this aspect. They strongly urged DOE to reword the test method regarding the setup of ice makers to specify the base method as one in which the appliance makes ice and deactivates the icemaking process itself when the ice bucket is full (or an equivalent set of actions to achieve this) to reduce circumvention. (ComEd Energy Solutions Center & Northwest Energy Efficiency Alliance, No. 37, pp. 8-9)

In response, DOE notes that it has considered the test burden associated with measurement of the energy use associated with icemaking (rather than using the fixed icemaking energy use adder) as part of the most recent concluded test procedure rulemaking. DOE concluded that the benefits of a direct measurement of icemaking energy use would not outweigh the additional test burden associated with making the measurement, due in part to the updated understanding that the magnitude of ice usage is significantly less than initially thought. 84 FR 70842, 70848-70849 (December 23, 2019). DOE did not adopt an icemaking energy use test, either mandatory or optional, in the recently concluded test procedure rulemaking cycle and has finalized the test procedure on that basis. 86 FR 56790 (October 12, 2021). Regarding the potential for circumvention by making the icemaker inoperative during the test, DOE notes that the wording of section 5.5.2(j) of HRF-1-2019, which is incorporated by reference by the DOE test procedure, has clear instructions that only the harvesting of ice shall be interrupted when an icemaker is made inoperative during an energy test and that the inoperative state should simulate the state when the icemaker senses that the bin is filled. Any tests that reduce the power of additional components when the icemaker is inoperative during an energy test would be invalid. DOE believes that these requirements are sufficiently clear and that it would not be justified to impose the additional burden of connecting a water supply to a test unit to allow the ice bin to be filled and the bin sensor to make the icemaker inoperative.

C. Technological Feasibility

1. General

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

After DOE has determined that particular technology options are technologically feasible, it further evaluates each technology option in light of the following additional screening criteria: (1) practicability to manufacture, install, and service; (2) adverse impacts on product utility or availability; (3) adverse impacts on health or safety, and (4) unique-pathway proprietary technologies. Sections 6(b)(3)(ii)-(v) and 7(b)(2)-(5) of the Process Rule. Section IV.B of this document discusses the results of the screening analysis for refrigerators, refrigerator-freezers, and freezers, particularly the designs DOE considered, those it screened out, and those that are the basis for the standards considered in this rulemaking. For further details on the screening analysis for this rulemaking, see chapter 4 of the NOPR TSD.

2. Maximum Technologically Feasible Levels

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

D. Energy Savings

1. Determination of Savings

For each trial standard level ("TSL"), DOE projected energy savings from application of the TSL to refrigerators, refrigerator-freezers, and freezers purchased in the 30-year period that begins in the year of compliance with the proposed standards (2027–

2056).[16] The savings are measured over the entire lifetime of refrigerators, refrigerator-freezers, and freezers purchased in the previous 30-year period. DOE quantified the energy savings attributable to each TSL as the difference in energy consumption between each standards case and the no-new-standards case. The no-new-standards case represents a projection of energy consumption that reflects how the market for a product would likely evolve in the absence of amended energy conservation standards.

DOE used its national impact analysis ("NIA") spreadsheet model to estimate national energy savings ("NES") from potential amended or new standards for refrigerators, refrigerator-freezers, and freezers. 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.[17] 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.

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[16] Each TSL is composed of specific efficiency levels for each product class. The TSLs considered for this NOPR are described in section V.A of this document. DOE conducted a sensitivity analysis that considers impacts for products shipped in a 9-year period.
[17] The FFC metric is discussed in DOE's statement of policy and notice of policy amendment. 76 FR 51282 (Aug. 18, 2011), as amended at 77 FR 49701 (Aug. 17, 2012).

2. Significance of Savings

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

The significance of energy savings offered by a new or amended energy conservation standard cannot be determined without knowledge of the specific circumstances surrounding a given rulemaking.[18] Certain covered products and equipment may have most of their energy consumption occur during periods of peak energy demand. The impacts of such products on the energy infrastructure can be more pronounced than products with relatively constant demand. However, residential refrigerators, freezers, and refrigerator-freezers have loads that are more consistent throughout the year. Accordingly, DOE evaluates the significance of energy savings on a case-by-case basis, taking into account the significance of cumulative FFC national energy savings, the cumulative FFC emissions reductions, and the need to confront the global climate crisis, among other factors. DOE has initially determined the energy savings from the proposed standard levels are "significant" within the meaning of 42 U.S.C. 6295(o)(3)(B).

[18] 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).

E. Economic Justification

1. Specific Criteria

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

a. Economic Impact on Manufacturers and Consumers

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

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

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

EPCA requires DOE to consider the savings in operating costs throughout the estimated average life of the covered product in the type (or class) compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered product that are likely to result from a standard. (42 U.S.C. 6295(o)(2)(B)(i)(II)) DOE conducts this comparison in its LCC and PBP analysis.

The LCC is the sum of the purchase price of a product (including its installation) and the operating expense (including energy, maintenance, and repair expenditures) discounted over the lifetime of the product. The LCC analysis requires a variety of inputs, such as product prices, product energy consumption, energy prices, maintenance and repair costs, product lifetime, and discount rates appropriate for consumers. To account for uncertainty and variability in specific inputs, such as product lifetime and discount rate, DOE uses a distribution of values, with probabilities attached to each value.

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

For its LCC and PBP analysis, DOE assumes that consumers who follow existing purchase patterns will purchase the covered products in the first year of compliance with new or amended standards. Consumer response to higher costs associated with the rule may reduce sales below the levels that otherwise would have been expected in the absence of a new standard. The LCC savings for the considered efficiency levels are calculated relative to the case that reflects projected market trends in the absence of new or amended standards. DOE's LCC and PBP analysis is discussed in further detail in section IV.F of this document.

c. Energy Savings

Although significant conservation of energy is a separate statutory requirement for adopting an energy conservation standard, EPCA requires DOE, in determining the economic justification of a standard, to consider the total projected energy savings that are expected to result directly from the standard. (42 U.S.C. 6295(o)(2)(B)(i)(III)) As discussed in section III.D of this document, DOE uses the NIA spreadsheet models to project national energy savings.

d. Lessening of Utility or Performance of Products

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

e. Impact of Any Lessening of Competition

EPCA directs DOE to consider the impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from a proposed standard. (42 U.S.C. 6295(o)(2)(B)(i)(V)) It also directs the Attorney General to determine the impact, if any, of any lessening of competition likely to result from a proposed standard and to transmit such determination to the Secretary within 60 days of the publication of a proposed rule, together with an analysis of the nature and extent of the impact. (42 U.S.C. 6295(o)(2)(B)(ii)) DOE will transmit a copy of this proposed rule to the Attorney General with a request that the Department of Justice ("DOJ") provide its determination on this issue. DOE will publish and respond to the Attorney General's determination in the final rule. DOE invites comment from the public regarding the competitive impacts that are likely to result from this proposed rule. In addition, stakeholders may also provide comments separately to DOJ regarding these potential impacts. *See* the **ADDRESSES** section for information to send comments to DOJ.

f. Need for National Energy Conservation

DOE also considers the need for national energy and water conservation in determining whether a new or amended standard is economically justified. (42 U.S.C.

6295(o)(2)(B)(i)(VI)) The energy savings from the proposed standards are likely to provide improvements to the security and reliability of the Nation's energy system. Reductions in the demand for electricity also may result in reduced costs for maintaining the reliability of the Nation's electricity system. DOE conducts a utility impact analysis to estimate how standards may affect the Nation's needed power generation capacity, as discussed in section IV.M of this document.

DOE maintains that environmental and public health benefits associated with the more efficient use of energy are important to take into account when considering the need for national energy conservation. The proposed standards are likely to result in environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases ("GHGs") associated with energy production and use. DOE conducts an emissions analysis to estimate how potential standards may affect these emissions, as discussed in section IV.K of this document; the estimated emissions impacts are reported in section V.B.6 of this document. DOE also estimates the economic value of emissions reductions resulting from the considered TSLs, as discussed in section IV.L of this document.

g. Other Factors

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

2. Rebuttable Presumption

As set forth in 42 U.S.C. 6295(o)(2)(B)(iii), EPCA creates a rebuttable presumption that an energy conservation standard is economically justified if the additional cost to the consumer of a product that meets the standard is less than three times the value of the first year's energy savings resulting from the standard, as calculated under the applicable DOE test procedure. DOE's LCC and PBP analyses generate values used to calculate the effects that proposed energy conservation standards would have on the payback period for consumers. These analyses include, but are not limited to, the 3-year payback period contemplated under the rebuttable-presumption test. In addition, DOE routinely conducts an economic analysis that considers the full range of impacts to consumers, manufacturers, the Nation, and the environment, as required under 42 U.S.C. 6295(o)(2)(B)(i). The results of this analysis serve as the basis for DOE's evaluation of the economic justification for a potential standard level (thereby supporting or rebutting the results of any preliminary determination of economic justification). The rebuttable presumption payback calculation is discussed in section IV.F.10 of this proposed rule.

IV. Methodology and Discussion of Related Comments

This section addresses the analyses DOE has performed for this proposed rulemaking with regard to refrigerators, refrigerator-freezers, and freezers. 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 proposed rulemaking: *www.regulations.gov/docket/EERE-2017-BT-STD-0003*. 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.

DOE received some comments that, rather than addressing specific aspects of the analysis, are general statements regarding the appropriateness of amending energy conservation standards and/or the efficiency levels that might be appropriate.

AHAM stated that the preliminary analysis relied heavily on the use of technologies that can affect reliability, longevity, and affordability of products. Accordingly, they claimed that DOE had placed too much emphasis on the implementation of variable-speed compressors later in the EL progression, and that DOE was overestimating the impact of vacuum insulated panels ("VIPs") in reducing energy consumption. (AHAM, No. 31, pp. 8-11)

Sub-Zero fully supported and affirmed the comments that were submitted by AHAM, which emphasized that there are significant limitations to further energy regulation if products are to remain reliable, long-lived and affordable. Sub-Zero also stated that further increases in efficiency for the built-in[19] products they manufacture are not justified and will save minimal energy worldwide and pose a significant and unnecessary burden on manufacturers and noted that built-ins comprise only 1.3 percent of total U.S. refrigerator and freezer shipments according to AHAM 2019 shipment data. (Sub-Zero, No. 34, p. 1; Sub-Zero, No. 34, p. 2)

AHAM and Sub-Zero comments suggesting that amending standards might reduce reliability and product life are addressed in section IV.F.6 of this document. AHAM's comments and those of other stakeholders regarding the impact of VIPs are discussed in section IV.A.2 of this document. In response to Sub-Zero regarding built-in products, DOE revised the analysis in the NOPR phase to more specifically address built-in classes—this is discussed in more detail in section IV.C.1.a of this document.

Samsung noted the freestanding top-mount product classes (3, 3A, and 3I) serves as a great example of increased energy savings given it has significant market share of 42 percent and it has the ability to adapt to a tightening of standards given the room for innovation with energy efficiency technologies compared to other freestanding products. They stated that improving on the EL for these classes can provide nearly double the energy savings. (Samsung, No. 32, p. 2)

When considering the information provided in the preliminary analysis TSD published in October 2021, DOE found that in 2020 top-mount refrigerator-freezers and classes for which they are a proxy (PC 1, 2, 3, 6) constituted 36.7% of the market, while

[19] DOE defines a built-in consumer refrigeration product as one that is no more than 24 inches in depth, excluding doors, handles, and custom front panels; that is designed, intended, and marketed exclusively to be (1) Installed totally encased by cabinetry or panels that are attached during installation; (2) Securely fastened to adjacent cabinetry, walls or floor; (3) Equipped with unfinished sides that are not visible after installation; and (4) Equipped with an integral factory-finished face or built to accept a custom front panel (see 10 CFR 430.2).

bottom-mounts alone constituted 40.2 percent (PC 5, 5A). These data indicate that, in contrast to the Samsung claim, focusing on the bottom-mount product classes could actually lead to greater energy savings due to its larger market share. In any case, DOE agrees that increasing stringency for classes that have large market shares could be very effective in achieving national energy savings.

The California IOUs stated they generally support DOE analyzing the updated energy conservation standards levels for this equipment and the finding that there are significantly higher efficiency levels with positive net present value (NPV) for consumers. (California IOUs, No. 33, p. 1)

The California IOUs included two tables, which identified the highest EL that DOE presented in the preliminary analysis for which DOE found a positive NPV for freestanding and built-in product classes. Barring updates to the preliminary analysis that incorporate other comments, they asked that DOE adopt the efficiency level for each product class with the highest savings while still having a positive NPV. (California IOUs, No. 33, p. 5-6) DOE notes that EPCA requires consideration of seven factors when setting standard levels including total projected energy savings, among others (see the discussion in section III.E.1 of this document).

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 proposed rule include (1) a determination of the scope of the rulemaking and product classes, (2) manufacturers and industry structure, (3) existing efficiency programs, (4) shipments information, (5) market and industry trends; and (6) technologies or design options that could improve the energy efficiency of consumer refrigerators, refrigerator-freezers, and freezers. 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 Product Classes

In the October 2021 Preliminary Analysis, DOE identified two potential product class modifications, products with icemakers, and products with multiple doors or specialty doors. The following two subsections address these topics.

Product Classes with Automatic Icemakers

As discussed later in this section, DOE has identified an opportunity to simplify and consolidate the presentation of maximum allowable energy use for products within product classes that may or may not have an automatic icemaker, and in doing so DOE expects the product class representations to be more streamlined and simplified.

To represent the annual energy consumed by automatic icemakers in refrigerators, refrigerator-freezers, and freezers, DOE's test procedures specify a constant energy-use adder of 84 kWh/year (by use of a 0.23 kWh/day adder; see section 5.3(a)(i) of 10 CFR part 430, subpart B, appendix A and section 5.3.(a) of appendix B). With this constant adder, the standard levels for product classes with an automatic icemaker are equal to the standards of their counterparts without an icemaker plus the 84 kWh/year. Consistent with prior discussions in the test procedure rulemaking, this NOPR proposes to amend this equation such that for representations made on or after the compliance date of any potential new energy conservation standards, the adder to be used shall change from 84 kWh/yr to 28 kWh/yr. DOE determined as part of the October 2021 TP Final Rule that the revised adder would more accurately reflect energy use during a representative average use cycle. 86 FR 56811. However, DOE indicated that it would not adopt this change in the test procedure until the date of potential future energy conservation standard amendments. *Id*. at 86 FR 56793. Thus, this change is being proposed in this document, with an implementation date to coincide with the compliance date of the standards proposed in this document.

AHAM reiterated their support for merging product classes for products with and without automatic icemakers due to use of the icemaker adder rather than a measured value but stated DOE must ensure that the icemaking classes do not end up with a more stringent standard as a result. (AHAM, No. 31, pp. 6-7; AHAM, Public Meeting Transcript, No. 30, pp. 13-14)

DOE has concluded that because the standards for the product classes with and without automatic icemakers are effectively the same, except for the constant adder, there is an opportunity to express the maximum allowable energy use for both icemaking and non-icemaking classes in the same equation, thus consolidating the presentation of classes and their energy conservation standards. The equation would, for those classes that may or may not have an icemaker, include a term equal to the icemaking energy use adder multiplied by a factor that is defined to equal 1 for products with icemakers and to equal zero for products without icemakers. This approach would consolidate the product class structure, and while products with and without ice makers would be represented by a single product class descriptor and maximum energy use equation, they would continue to have different maximum energy use values, due to the ice maker coefficient in the equations.

DOE requests comments on its proposal to consolidate the presentation of maximum allowable energy use for products of classes that may or may not have an automatic icemaker.

Special Door and Multi-Door Designs

In the October 2021 Preliminary Analysis, DOE considered certain refrigerators, refrigerator-freezers, and freezers available on the market that offer special door types that allow consumers to access or view the internal storage compartment without a typical door opening. Some products available on the market offer glass doors to allow a view inside the cabinet. Potential changes to product class structure to address changes to energy consumption as a result of these features were considered, and more information was requested from interested parties.

Door-in-door design is a relatively new setup offered in certain standard-size refrigerator-freezers. Typically, manufacturers add a second smaller door between the fresh food compartment's outer door and the inner cabinet. This design allows the consumer to access items loaded in the door shelves without opening an interior door that encloses the inner cabinet. Some door-in-door designs have an outer glass door, providing the user a transparent view of the inner cabinet. Some refrigerators, refrigerator-freezers, and freezers, available on the market also offer multi-door setups which deviate from the popular French-door design. Some designs include one or more “drawers” which can be pulled out of the main compartment and allow for more fresh food storage than more traditional designs. Other designs may include a “quadrant” design in which four doors are placed in a two-by-two configuration with two doors for the freezer compartment, and two for the fresh food.

AHAM commented that in its preliminary analysis DOE declined to adopt a separate product class or an energy use allowance for products with glass door or door-in-door type features. They stated that other jurisdictions have a constant multiplier used in the development of standards to account for the number of doors on a product, and there are separate product classes for glass door products in commercial refrigerators. (AHAM, No. 31, p. 7) GEA supported AHAM’s position on multidoor products and suggested using gasket area as a basis for a multidoor multiplier. (GEA, No. 38, p. 3) Whirlpool also noted that there is justification for applying a multiplier for multidoor products. (Whirlpool, No. 35, pp. 8-10) Sub-Zero asked DOE to consider adding a product class for built-ins with specialty doors and urged DOE to define additional product classes for analyses and set separate standards levels for built-ins with specialty doors. (Sub-Zero, No. 34, p. 2)

DOE reviewed the prevalence of products with multiple or specialty doors and conducted analysis to assess the energy use impact of such design features. More detail regarding this assessment is provided in Chapters 3 and 5 of the NOPR TSD. As a result, DOE concluded that some allowance for multiple doors and specialty doors would be appropriate for classes where such features are offered. Specifically, DOE is proposing the following allowances for classes for which the specific features are relevant.

- Two percent energy use allowance for each externally-opening door in excess of the typical minimum for the class (*i.e.*, more than 2 doors for refrigerator-freezer classes 5 and 7, and more than 3 doors for class 5A). This would be applicable for current product classes 5, 5A, and 7, with a limits of six percent for product classes 5 and 7, representing a product with five doors (three in excess of the typical minimum), and four percent for product class 5A, also representing a product with five doors (in this case two in excess of the typical minimum). For the purposes of this provision, a drawer with an externally-exposed face would be considered an externally-opening door.

- Six percent total energy use allowance for a product with a door-in-door feature implemented in one or more of its doors. This would apply instead of any multiple-door allowance for product classes 5, 5A, and 7.
- Ten percent total energy use allowances for a product with a transparent door or doors. This would apply instead of any multiple-door or door-in-door allowance for product classes 3A, 5, 5A, 7, and 13A.

With this proposed approach, the maximum energy use allowance would be ten percent, for a glass door. However, if the standard level for any of the eligible classes is set at a level for which this allowance would represent backsliding, *i.e.*, allow such a product to have more energy use than the current standard (adjusted for the change in icemaker energy use adder), the allowance would be reduced to eliminate such backsliding. The proposal uses the number of doors in excess of the typical minimum number of doors, rather than using an adjustment based on gasket size, as suggested by GEA, in an attempt to maintain better simplicity of the adjustment and determination of the maximum allowable energy use. In response to Sub-Zero, DOE notes that this provision would apply to built-in classes as well as freestanding classes.

DOE requests comment on its proposal for establishing energy use allowances for multiple doors and/or specialty doors. Should such an energy use allowance structure be established, and, if so, are the proposed energy use allowance levels appropriate? If they are not appropriate, DOE requests input on what the energy use allowance values should be, with supporting data to demonstrate that the alternative levels suggested are justified.

DOE also considered whether any definitions would be required to clarify what products the door allowances would apply to. As described previously, the allowances for multiple doors would apply for externally-opening doors or drawers. DOE believes that these descriptions provide sufficient clarity such that additional definitions regarding multiple doors would not be required.

For transparent doors, DOE proposes to add a definition that aligns with the definition of display doors for walk-in coolers and freezers, which defines a display door as a door that either is designed for product display or has 75 percent or more of its surface area composed of glass or another transparent material. (*See* 10 CFR 431.302). Specifically, DOE proposes to define transparent door as a door for which 75 percent or more of the surface area is glass or another transparent material.

For door-in-door features, DOE proposes to add a clarifying definition indicating that a door-in-door is a set of doors or an outer door and inner drawer for which (a) both doors (or both the door and the drawer) must be opened to provide access to the interior through a single opening, (b) gaskets for both doors (or both the door and the drawer) are exposed to external ambient conditions on the outside around the full perimeter of the respective openings, and (c) the space between the two doors (or between the door and the drawer) achieves temperature levels consistent with the temperature requirements of the interior compartment to which the door-in-door provides access.

DOE requests comments on the proposed definitions to clarify transparent door and door-in-door features. If the proposed definitions are not appropriate, DOE requests comment on what specific changes should be made to the definitions, or what other definitions are necessary, so that they would appropriately describe the intended specialized doors.

2. Technology Options

In the preliminary market analysis and technology assessment, DOE identified 37 technology options that would be expected to improve the efficiency of refrigerators, refrigerator-freezers, and freezers, as measured by the DOE test procedure:

Table IV.1 Technology Options Identified in the Preliminary Analysis

Insulation
1. Improved resistivity of insulation (insulation type)
2. Inert blowing fluid CO2
3. Increased insulation thickness
4. Gas-filled insulation panels
5. Vacuum-insulated panels ("VIP")
Gasket and Door Design
6. Improved gaskets
7. Double door gaskets
8. Improved door face frame
9. Reduced heat load for through-the-door ("TTD") feature
Anti-Sweat Heater
10. Condenser hot gas (Refrigerant anti-sweat heating)
11. Electric anti-sweat heater sizing
12. Electric heater controls
Compressor
13. Improved compressor efficiency
14. Variable-speed compressors
15. Linear compressors

Evaporator
16. Increased surface area
17. Improved heat exchange
Condenser
18. Increased surface area
19. Microchannel condenser
20. Improved heat exchange
21. Force convection condenser
Defrost System
22. Reduced energy for automatic defrost
23. Adaptive defrost
24. Condenser hot gas defrost
Control System
25. Electronic Temperature control
26. Anti-Distribution control
Other Technologies
27. Fan and fan motor improvements
28. Improved expansion valve
29. Fluid control or solenoid off-cycle valve
30. Alternative refrigerants
31. Component location
32. Phase change materials
Alternative Refrigeration Cycles
33. Ejector refrigerator
34. Dual evaporator systems
35. Two-stage system
36. Dual-loop system
37. Lorenz-Meutzner cycle

Several commenters provided feedback on some of these technology options. These comments are summarized, along with DOE's responses.

Samsung agreed with the DOE's various technology options, specifically DOE's identification of variable-speed compressors and R-600a as means to improve energy efficiency. (Samsung, No. 32, pp. 2-3)

AHAM clarified that when considering "alternate refrigerants" as a technology option, DOE recognize that the use of R-600a should not be considered an option to account for a decrease in energy consumption if DOE's analysis accounts for a full transition from HFCs by January 1, 2023. AHAM also stated DOE's analysis regarding refrigerant for product classes 5, 5I, and 5A are flawed as the alternative refrigerants considered may not be accurate of the current or transitioning market. AHAM further stated the R-600a compressors only at ELs 3 and 4 is not reflective of the market; AHAM shipment data indicate a significant number of units are already using Isobutane (R-600a) refrigerant and/or variable-speed compressors to meet the current DOE standard or ENERGY STAR® levels. AHAM stated DOE needs to redo its analysis of product classes 5, 5I and 5A to incorporate market representative models and adjust the projected technology paths to account for options already in use. (AHAM, No. 31, pp. 4, 8-9)

In response, DOE reassessed its treatment of R-600a as a design option in the October 2021 Preliminary Analysis. It is DOE's understanding, confirmed through discussions with manufacturers, that following the removal of HFC-134a as a viable refrigerant for consumer refrigeration product in the U.S., manufacturers are primarily using R-600a as a replacement.[20] Hence, DOE assumed for its NOPR analysis that all consumer refrigeration products, even those at baseline efficiency levels, now use R-600a. DOE is aware that other alternative refrigerant choices are allowed to be used and

[20] In a final rule published December 1, 2016, the Environmental Protection Agency ("EPA"), as part of its Significant New Alternatives Policy ("SNAP") program covering ozone-depleting refrigerants and related substances, changed the status of HFC-134a, the refrigerant to "unacceptable" for consumer refrigeration products starting January 1, 2021. 81 FR 86778, 86893.

further would not be banned by a recent EPA proposal restricting refrigerants.[21] However, based on all available information, DOE is not aware of any instances in which these alternatives are being considered by manufacturers as viable approaches for increases in efficiency in these products. 87 FR 76738, 76785 (December 15, 2022). Hence, refrigerant change has not been included as a technology option in this NOPR.

Darren Rains stated that the current design of many homes, commercial, and industrial refrigeration units allow cooling fans to pull air directly over a unit's condenser coils, resulting in dust and debris clogging the coils. As a result of this Rains states that accumulation of dust, hair, and lint on the condenser coils lowers the unit's ability to dissipate heat. Rains suggests that all incoming airflow openings must be covered by filtering materials sufficient to keep out the vast majority of debris, lint, and hair away from the condenser coils, and that filtering materials be easy to remove, replace, and are resistant to cleaning with a vacuum. Rains also suggests that gaps underneath refrigeration units have closed cell foam to address suction of debris into the unit. (Rains, No. 27, pp. 1-2)

DOE responds that consumer refrigeration products are tested before installation in homes and therefore before there is the potential to clog the condenser coil. Hence, even though air filters and/or other protection of the coils from dust or other debris may provide an efficiency benefit during home use, they would not be expected to affect the measurement of efficiency in the DOE test procedure. This is a factor that AHAM could

[21] On December 15, 2022, EPA published a proposed rule restricting the use of refrigerants with GWP of 150 or greater. 87 FR 76738. Refrigerants including R-290, R-441A, R-600a, and HFC-152a meet this GWP requirement and are listed as acceptable under EPA's SNAP rules (see *https://www.epa.gov/snap/substitutes-household-refrigerators-and-freezers*).

potentially consider in development of a future revision of the HRF-1 test standard, and is also a factor that DOE may consider in a future test procedure rulemaking.

The Joint Commenters stated they believe DOE may be underestimating VIP performance by relying on outdated information and/or otherwise inappropriate assumptions. The Joint Commenters noted DOE did not provide ample explanation for the 50 percent degradation factor/scaling factor and urged DOE to investigate an appropriate, updated scaling factor informed by recent interviews with manufacturers rather than relying on the previous rulemaking. They also stated the energy savings from VIPs presented in the preliminary analysis appear to be notably smaller than those found in a 2018 study and therefore urged DOE to reevaluate its modeling to ensure that the energy savings from VIPs are appropriately being captured. (Joint Commenters, No. 36, pp. 3-4)

DOE notes that, while the use of VIPs has become more common, it is not yet a technology that is used in a majority of products. DOE found few VIPs in the products that it purchased, and reverse engineered using destructive teardowns. The use of VIPs is not advertised in manufacturer product literature; thus, it is difficult to conduct statistical analysis to correlate efficiency levels with use of the technology. Manufacturers have reported varied levels of success using the technology. The information that DOE has been able to obtain on this topic through manufacturer interviews is by no means exhaustive, but it doesn't suggest that energy use reduction associated with use of VIPs is significantly different than would be estimated by the approach derivative of the previous rulemaking that was adopted in the preliminary analysis. DOE has used this approach also for the NOPR analysis. The details of the VIP analysis are described further in Chapter 5 of the NOPR TSD.

Based on the comments received, DOE has not identified any new technologies to add to the list provided as part of the preliminary analysis, and has removed alternative refrigerants as a technology option, since it would already be used in products at any efficiency level.

For Product Class 11A, ASAP recognized that many of the most efficient models are powered coolers that have small, adjusted volumes. However, they encouraged DOE to investigate the design features present in these very high-efficiency models to determine if such design features are more broadly applicable to the product class. (ASAP, Public Meeting Transcript, No. 30, p. 22)

In response, DOE notes that several of the most efficient products certified under product class 11A are DC-input models marketed for use in cars or boats. For example, the Alpicool TS50 is rated as a 1.8 cuft model with energy use 40% less than the maximum allowable annual energy use for products in its class. Product information shows that it is intended for car or boat service, and thus, it cannot be considered representative of the market. ("Alpicool TS Series", No. XXXX)

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:[22]

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

(4) *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.

[22] 10 CFR part 430, subpart C, appendix A, sections 6(b)(3) and 7(b)

(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.

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 October 2021 preliminary analysis, DOE screened out the technologies presented in Table IV.2 on the basis of technological feasibility, practicability to manufacture, install, and service, adverse impacts on utility or availability, adverse impacts on health and safety, and/or unique-pathway proprietary technologies.

AHAM stated DOE's analysis relies heavily on the use of variable-speed compressors ("VSCs") to achieve efficiency gains, indicating that (a) for some product classes, achieving even EL1 would require the use of VSCs, (b) there is additional design work and related costs required to implement VSCs, and (c) there are potential concerns about harmonic and interference issues. (AHAM, No. 31, p. 10) GEA stated DOE's analysis of the potential use of VSCs to reach certain energy levels fails to account for several costs associated with the use of VSCs. (GEA, No. 38 at p. 10)

DOE notes that it is clear from AHAM's statements, review of product literature, and discussions with manufacturers, that VSCs are a common design option used in a large percentage of currently-shipped consumer refrigeration products, with around one third of the US refrigerator market adapting to VSCs and increasing implementation. (Samsung, No. 32, pp. 2-3) Furthermore, while AHAM suggested that DOE consider harmonics and possible electric grid interference from VSCs, DOE is not aware of any issues related to VSCs and harmonics to date, nor any requirements in place at this time. DOE is aware that Natural Resources Canada (NRCan) has released a comprehensive energy efficiency guide regarding variable frequency drives for informative purposes, with discussion of harmonics.[23] DOE notes, however, that the stated primary focus of the NRCan publication is for 'off-the-shelf', low-voltage variable frequency drives typically used in conjunction with AC, polyphase, and induction motors, which does not include drives for consumer refrigeration VSCs. Hence, because VSCs are currently implemented in a substantive number of products and DOE is not aware of harmonic interference at this time, DOE believes it is inappropriate to screen out this technology.

Table IV.2 Technologies Screened-Out in the Preliminary Analysis

Improved Gaskets, Double Gaskets, and Improved Door Face Frame
Linear Compressors
Fluid Control or Solenoid Off-Cycle Valves
Improved Evaporator Heat Exchange
Improved Condenser Heat Exchange
Forced Convection Condenser

[23] The NRCan publication regarding variable frequency drives can be found at *https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/energystar/variable-frequency-drives-eng.pdf.*

Condenser Hot Gas Defrost
Compressor Location at Top
Evaporator Fan Motor Location Outside Cabinet
Air Distribution Control
Phase Change Materials
Lorenz-Meutzner Cycle
Dual-Loop Systems
Two-Stage System
Ejector Refrigerator
Improved VIPs
Inert Blowing Fluid CO_2

2. Remaining Technologies

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

Table IV.3 Technologies Remaining in the Preliminary Analysis

Insulation
1. Improved resistivity of insulation (insulation type)
2. Increased insulation thickness
3. Gas-filled insulation panels
4. Vacuum-insulated panels
Gasket and Door Design
5. Reduced heat load for TTD feature
Anti-Sweat Heater
6. Refrigerant anti-sweat heating
7. Electric anti-sweat heater sizing
8. Electric heater controls
Compressor
9. Improved compressor efficiency
10. Variable-speed compressors
Evaporator
11. Improved expansion valve
12. Increased surface area
13. Dual evaporator systems

Condenser
14. Increased surface area
15. Microchannel condenser
Defrost System
16. Reduced energy for automatic defrost
17. Adaptive defrost
Control System
18. Electronic Temperature control
Other Technologies
19. Fan and fan motor improvements
20. Alternative refrigerants

DOE has 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.

DOE did not receive any comments specifically about screening technologies that have not already been mentioned previously. DOE's assessment of screening technologies has not changed for the NOPR analysis, and thus DOE has screened out that same group of technologies in the NOPR phase. Hence, the technologies remaining, that are considered as design options for the engineering analysis, are the same as those in the preliminary analysis, except for alternative refrigerants, which DOE has removed from the technology option list for the reasons mentioned in section IV.A.2 of this document.

C. Engineering Analysis

The purpose of the engineering analysis is to establish the relationship between the efficiency and cost of consumer refrigerators, refrigerator-freezers, and freezers. There are two elements to consider in the engineering analysis; the selection of efficiency levels to analyze (*i.e.,* the "efficiency analysis") and the determination of product cost at each efficiency level (*i.e.,* the "cost analysis"). In determining the performance of higher-efficiency products, DOE considers technologies and design option combinations not eliminated by the screening analysis. For each product class, DOE estimates the baseline cost, as well as the incremental cost for the product at efficiency levels above the baseline. The output of the engineering analysis is a set of cost-efficiency "curves" that are used in downstream analyses (*i.e.,* the LCC and PBP analyses and the NIA).

1. Efficiency Analysis

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

For the preliminary analysis, DOE used a combined efficiency-level and design-option approach. First, an efficiency-level approach was used to establish an analysis tied to existing products on the market. A design option approach was used to extend the analysis through "built-down" efficiency levels and "built-up" efficiency levels where there were gaps in the range of efficiencies of products that were reverse engineered. Products from the product classes 3, 5, 5A, 7, 9, 10, 11A, & 18 were tested and torn down to provide information to lay the groundwork for the analysis. Design option analysis techniques were used to extend the analysis to higher efficiency levels and to fill any efficiency level gaps. Due to limitations in acquiring models from every product class for testing, DOE did not acquire for test and teardown, nor construct analysis for, all product classes. DOE focused the analysis on products with the highest market share. Regarding built-in product classes, certification data collected in DOE's Compliance Certification Database ("CCD") indicated that the potential for efficiency improvement was comparable for built-in classes and their corresponding freestanding classes. (See Section 5.2.1 of the Preliminary Analysis TSD) Thus, DOE concluded that the freestanding classes could act as proxies for the built-in classes. Section 10.4 of the preliminary analysis TSD discusses use of the engineering analysis for the analyzed classes to represent the cost-efficiency relationship for the classes for which engineering analysis was not conducted.

AHAM raised two general comments regarding representativeness of the classes and products analyzed for the preliminary analysis. First, AHAM claimed that DOE used product classes as proxy for other classes which were not sufficiently representative—this comment primarily addressed built-in classes. (AHAM, No. 31, pp. 5-6) Second, AHAM asserted that DOE selected models for teardown that were not representative of the specific classes analyzed—this comment primarily addressed the increase in multi-door product configurations, mainly for product classes 5, 5I, and 5A. (AHAM, No. 31, p. 2) These general comments are discussed in detail below.

a. Built-in Products

AHAM agreed that, given the significant number of product classes, it is appropriate for DOE to evaluate some classes in detail and use that analysis as a proxy for other similar product classes. However, AHAM stated DOE consolidated its analysis too much. (AHAM, Public Meeting Transcript, No. 30, p. 7-8[24]) Specifically, AHAM stated freestanding product classes are not a proxy for built-in product classes and DOE should evaluate them separately. (AHAM, No. 31, 5-6) In addition to AHAM, GEA also objected to the use of freestanding products as analogues for built-in products in DOE's

[24] A notation in the form "AHAM, Public Meeting Transcript, No. 30 at p. 3" identifies an oral comment that DOE received on December 1, 2021, during the public meeting, and was recorded in the public meeting transcript posted in the docket for this test procedure rulemaking (Docket No. EERE-2014-BT-STD-0003). This particular notation refers to a comment (1) made by the Association of Home Appliance Manufacturer during the public meeting; (2) recorded in document number 30, which is the public meeting transcript that is filed in the docket of this test procedure rulemaking; and (3) which appears on page 3 of document number 30.

analysis and requested a separate analysis for built-in product classes. GEA stated built-in products are fundamentally different than freestanding products in that built-in products have different physical constraints as to size and shape, different configurations for their mechanical systems, and different markets and customer segments. Sub-Zero also noted that built-ins now utilize combinations of every practical energy saving design option identified by DOE and therefore urged DOE to seriously address the reality that a more stringent standard is not justified for some product classes, such as built-ins. (GEA, No. 38, p. 2; Sub-Zero, No. 34, p. 2)

On the other hand, the Joint Commenters stated they support DOE's approach of analyzing the same potential efficiency increases for built-in product classes as those for corresponding freestanding product classes. (Joint Commenters, No. 36, p. 5)

In response to these comments, DOE revised its analysis to address built-in products more directly. Specifically, DOE conducted additional analysis for class 5-BI, based on information from the 5-BI analysis conducted to support the September 2011 Final Rule, CCD and product literature data, and information provided by built-in product manufacturers during interviews. DOE has used the differences in the analyses between class 5 and 5-BI to approximate the differences between freestanding and built-in class pairs for other relevant built-in classes (*e.g.,* classes 3A, 7, and 9).

b. Representativeness of Reverse-Engineered and Analyzed Products

AHAM expressed concern that in some cases the features present in the teardown products were not representative of the market. (AHAM, Public Meeting Transcript, No.

30, pp. 7, 14-17) According to AHAM, DOE's analysis of product classes 5 and 5A in the preliminary analysis did not appear to be representative of the market in terms of volume, features, and number of doors; specifically, DOE's analysis focused on bottom-mount refrigerator/freezers with only two doors—one for the refrigerator and one for the freezer. AHAM stated it is unclear whether the analysis accounts for the differences between classes 5 and 5A and urged DOE to conduct further consultation with manufacturers in order to better account for these distinctions. (AHAM, No. 31, p. 2-3) Whirlpool agreed with these AHAM comments. (No. 35, pp. 2-3)

The California IOUs expressed similar concerns about whether all of the models selected to represent specific classes and efficiency levels were fully representative. They specifically pointed to the high cost of dual-evaporator systems, used in the DOE analysis for product classes 5A and 7 to reach EL2, as being non-representative. (California IOUs, Public Meeting Transcript, No. 30, p. 30) ASAP also noted that, when going from efficiency level 1 to 2 in the preliminary analysis, there is an incremental cost increase of more than $300 for Product Class 5A and more than $250 for Product Class 7 and that the technology options added at EL-2 are a higher-efficiency compressor and a single VIP for Product Class 5A and then dual evaporators in a single VIP for Product Class 7. ASAP requested an explanation of what is driving that incremental cost in both cases of going from EL-1 to EL-2. (ASAP, Public Meeting Transcript, No. 30, p. 27-28)

In response to these comments regarding the representativeness of the models analyzed, DOE investigated and came to similar conclusions. Thus, DOE revised the analysis for this NOPR such that (a) analyses for both product classes 5 and 5A are based on three-door designs, (b) the capacities of the product class 5 representative units are larger, (c) the capacities of the product class 5A units are smaller, and (d) the analyses for product classes 5A and 7 do not consider use of dual evaporators as a design option, remaining more consistent with a more representative single-evaporator design. DOE believes the analyses conducted for this NOPR are representative of the product classes in the market.

c. Baseline Efficiency/Energy Use

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

For the preliminary analysis, DOE chose baseline efficiency levels represented by the current Federal energy conservation standards, expressed as maximum annual energy consumption as a function of the product's adjusted volume, with the exclusion of the automatic icemaker energy contribution for product classes that include this feature. The current standards incorporate allowance of a constant 84 kWh/yr icemaker adder for product classes with automatic icemakers, consistent with the current test procedure, which requires adding this amount of annual energy use to the product's tested performance if the product has an automatic icemaker.

For the analysis in this NOPR, DOE adjusted the baseline energy usage levels for each class to account for the planned revision in the test procedure of the icemaker energy use adder to 28 kWh/year. From this baseline DOE conducted direct analyses for 9 product classes, with some classes including two representative adjusted volumes. In conducting these analyses, 13 baseline units were used in construction of cost curves, and had their characteristics determined in large part by purchased, tested, and reverse engineered tear-down models. Further information on the design characteristics of specific analyzed baseline models is summarized in the NOPR TSD.

d. Higher Efficiency Levels

AHAM commented that DOE should examine a gap-fill EL between the current DOE standard and the previously analyzed EL 1 for freestanding bottom-mount refrigerator-freezers (product classes 5, 5I, and 5A). Whirlpool agreed, but expanded on this, indicating that DOE should examine a gap-fill EL between the current DOE standard and the analyzed EL 1 for freestanding top-mount and side-by-side refrigerator-freezers (product classes 3, 3I, 4, 6, and 7). (AHAM, No. 31, p. 4; Whirlpool, No. 35, p. 4-5)

Whirlpool also noted that in the last refrigerator, refrigerator-freezer, and freezer energy conservation standards rulemaking, DOE considered (in the corresponding TSD) gap-fill efficiency levels between baseline and ESTAR Version 4.0 levels, which at the time were 20% more efficient than the DOE federal minimum for most product classes. Whirlpool stated DOE should analyze gap fill levels like those considered in the last rulemaking due to their own precedent and to at least consider them at this state and due to distinct technology options, product cost, and customer impacts of refrigerators, refrigerator-freezers, and freezers produced at these levels compared to refrigerators, refrigerator-freezers, and freezers at baseline and EL1. Whirlpool further stated it is extremely important that DOE consider these gap fill levels for the non-built-in top mount and side-by-side product classes. They stated the product costs needed to improve even a 5% gap fill level for those PCs will be substantially lower than their estimated costs of meeting EL1 and that savings would still be delivered to consumers, but at a much lower product cost increase, which would minimize the impact from amended standards to low-income consumers often from disadvantaged communities. (Whirlpool, No. 35, p. 4-8)

In interviews, manufacturers reiterated that gap-fill ELs should be evaluated, particularly for top-mount and side-by-side refrigerator-freezers.

In response, in this NOPR analysis DOE analyzed a 5% EL for product classes 3 and 7 (the top-mount refrigerators-freezers, and side-by-side refrigerator-freezers, respectively).

For the NOPR analysis, DOE analyzed up to five incremental efficiency levels beyond the baseline for each of the analyzed product classes. For products classes 3 and 7, this included an efficiency level roughly 5% more efficient than the current energy conservation standard. For other classes, the efficiency levels start at EL2, near 10% more efficiency than the current energy conservation standard, equivalent to the current ENERGY STAR® level for refrigerators, refrigerator-freezers, and freezers. For the NOPR analysis, DOE extended the efficiency levels in steps of close to 5% of the current energy conservation standard up to EL 4. Finally, EL 5 represents "max-tech", using design option analysis to extend the analysis beyond EL 4 using all applicable design options, including max efficiency variable-speed compressors, and considerable use of VIPs.

For Product Classes 5A, 7, and 11A, ASAP, California IOUs, and Joint Commenters stated they found that there are models listed in DOE's Compliance Certification Database that are more efficient than DOE's max-tech levels. They further stated that DOE presented a figure in the PTSD that showed available models that are more efficient than the max-tech efficiency level for Product Class 7. They therefore encouraged DOE to reevaluate the max-tech efficiency levels for Product Classes 5A, 7, and 11A so that they represent true max-tech levels. (ASAP, Public Meeting Transcript, No. 30, p. 22; California IOUs, No. 30; pp. 24-26; Joint Commenters, No. 36, p. 1-2) As indicated in section IV.A.2, DOE notes that some of the most efficient products of product class 11A are DC-input products and thus not generally representative of the refrigerator market. As for product classes 5A and 7, the max-tech efficiency levels analyzed in this NOPR were 21.5% and 22%, respectively. These max-tech levels are consistent with the maximum available efficiency levels of representative products sold by major manufacturers with which DOE conducted interviews.

The Joint Commenters noted that the TSD states that the energy efficiency ratios ("EER") for VSCs are typically consistent with those of the highest available efficiency single-speed compressors ("SSC") at the same capacity but stated that low-capacity compressors (generally models less than ¼ hp or 500 BTU/hr) would typically be present in compact product classes. They included a figure which showed, for both R-134a and R-600a compressors, the EER of a VSC can be 1 to 2 points higher than that of the most efficient SSC at the same capacity (<500 BTU/hr) and, therefore, DOE may be underestimating the savings from VSC for compact products by failing to capture the improved full-load efficiency in addition to the part-load savings. (Joint Commenters, No. 36, p. 4-5)

While published EER levels for VSCs may be much higher than published EERs for single-speed compressors in the capacity range suitable for compact products, DOE has not found many such products that use such compressors, and thus has little evidence that the suggested efficiency improvements could be guaranteed. DOE believes that its engineering analysis for compact products is representative of likely performance using VSCs.

The efficiency levels analyzed beyond the baseline are shown in Table IV.4.

Table IV.4 Incremental Efficiency Levels for Analyzed Products (% Energy Use Less than Baseline)

	Standard-Size Refrigerator							Standard-Size Freezers		Compact Refrigerators and Freezers			
Product Class (AV, ft)	3 (11.9)	3 (20.6)	5** (23.0)	5** (30.0)	5A** (35.0)	5-BI** (26.0)	7 (31.5)	9 (29.3)	10 (26.0)	11A (1.7)	11A (4.4)	17 (9.0)	18 (8.9)
EL 1*	5%	5%	8%	7%	11%	8%	5%	10%	10%	10%	10%	10%	10%
EL 2*	10%	10%	13%	11%	16%	13%	9.5%	15%	15%	15%	15%	15%	15%
EL 3	15%	15%	18%	15%	21.5%	14%	14.5%	20%	20%	20%	20%	20%	20%
EL 4	20%	20%	20%	17%			19%	25%	23%	32%	30%		30%
EL 5	27%	28%					22%						

* ENERGY STAR® % level varies based on specific teardown units analyzed
** Percentages are based on a 3-door configuration.

e. VIP Analysis and Max-Tech Levels

ASAP noted that a 2018 study[25] found that the installation of vacuum insulated panels ("VIPs") in the rear cabinet wall reduced energy consumption by 5 percent and when VIPs were added to the doors, the total reduction was almost 12 percent. ASAP further noted that, with VIPs added to the side walls and top wall (where VIPs cover approximately half of the cabinet area), the total reduction energy consumption was about 20 percent. ASAP therefore stated DOE's conclusion of a 4 to 6 percent energy savings from the installation of VIPs covering half of the cabinet area seems lower than expected and questioned this discrepancy. California IOUs also reiterated energy savings from

[25] Thiessen, S., Knabben, F. T., Melo, C., & Gonçalves, J. M. (2018). A study on the effectiveness of applying vacuum insulation panels in domestic refrigerators. *International Journal of Refrigeration, 96*, p. 10–16. *https://doi.org/10.1016/j.ijrefrig.2018.09.006*

using VIPs was being undercounted. (ASAP, Public Meeting Transcript, No. 30, pp. 22-23; California IOUs, No. 33, pp. 2-3)

The California IOUs recommended that DOE increase the maximum ELs in the PTSD by reviewing design options for commercialized products that meet or exceed the max-tech levels. The California IOUs stated that it is likely that DOE is underestimating the energy savings that can be achieved at max-tech level because there is no indication that any of the products analyzed have VIPs, which is the additional design option for most product classes at max-tech. They therefore requested that DOE revise EL 3 and EL 4 to either incorporate additional design options or revise the energy savings attributed to the included design options if they are the only ones used in these commercialized products. (California IOUs, No. 33, p. 3-4)

ASAP requested specific information, particularly dimensions, of the single VIP referenced in table 5.5.1 of the preliminary analysis which shows the design options by efficiency level for each product class. ASAP also noted there is a reference to the VIPs covering half of the cabinet area and requested clarification on whether the full cabinet area is referring to all five sides being the top, bottom, two sides, and rear (excluding the doors) or if it was something else. (ASAP, Public Meeting Transcript, No. 30, pp. 15-17 & 21-22)

ASAP noted that DOE assumed a mid-panel thermal conductivity for the VIPs but then used a scaling factor of 50 percent to account for the actual versus expected performance of VIPs and requested clarification regarding what the 50 percent factor is capturing. (ASAP, Public Meeting Transcript, No. 30, p. 23)

On the other hand, AHAM stated DOE does not account for the limitations of VIPs and does not apply it as it would likely be used in actual products and, as a result, overestimates the use and impact of VIPs in its analysis. AHAM noted DOE's emphasis on VIPs appears to result from the teardown of a single unit, which is likely not representative of how VIPs are generally deployed on a larger scale. GEA stated DOE must also account for the technical limitations of VIPs including edge effects, which is particularly important when analyzing their use in smaller products. GEA also noted that DOE's analysis indicates manufactures will implement VIPs to achieve higher energy levels, but stated that many manufacturers, including GEA, already use VIPs to meet existing standards minimums and EL 1. (AHAM, No. 31, pp. 10-11; GEA, No. 38, p. 2)

In response to the ASAP and California IOUs comments regarding a study involving use of VIPs, DOE notes that the Department's analysis was generally consistent with the study in terms of how and where VIPs would be applied into the products. DOE further notes that its analysis also was consistent with information provided by manufacturers in interviews on VIP placement—specifically, that VIPs would primarily be used on the door(s), the walls, and the tops of cabinets, preferentially for the freezer compartments. In response to ASAP's question about the 50 percent factor, this was an adjustment that DOE used in the analysis leading up to the September 2011 Final Rule based on information regarding VIP experiences by manufacturers at that time. Based on discussions with manufacturers in the current rulemaking, it is not clear that success using VIPs in production settings has significantly increased. While the cited study provides some indication that VIPs can provide significant energy savings, DOE is now aware of evidence showing commercialized products are consistently achieving such levels of improvement.

Regarding table 5.5.1 of the preliminary analysis TSD and Product Classes 5A and 7, the California IOUs acknowledged that the breakdown for different ELs was determined by the units that were selected for a direct analysis that were purchased by DOE. The California IOUs requested clarification regarding whether there were other design options, like the dual evaporators, that were not necessarily used primarily to improve efficiency. They pointed to the transition to the R600A refrigerant in the new variable-speed compressor which has its own added costs at EL-3. (California IOUs, Public Meeting Transcript No. 30, p. 28-29)

The Joint Commenters stated DOE is significantly overestimating the incremental cost to meet intermediate efficiency levels for Product Classes 5A and 7 in the preliminary analysis. They stated that DOE included dual evaporators as a design option at EL2, but it is not reasonable to assume that dual evaporators would be employed to meet intermediate ELs (i.e., EL2 and EL3) given their high cost if they became the minimum standard. (Joint Commenters, No. 36, p. 2-3)

In response, DOE notes that while dual evaporators were considered for product classes 5A and 7 in the preliminary analysis, DOE did not include dual evaporators in its engineering analysis for the NOPR, due to its high cost compared to efficiency gains.

The Joint Commenters stated that, since recent state laws and the American Innovation and Manufacturing ("AIM") Act of 2020 have caused manufacturers to already transition to R-600a and since they expect a full transition to occur well before any amended DOE standards would take effect, DOE should not attribute conversion costs associated with the refrigerant transition to updated efficiency standards. (Joint Commenters, No. 36, p. 5-6) The California IOUs requested that Iso-Butane (R-600a) be included as a refrigerant design option for all products and be incorporated into efficiency levels with positive NPV for Product Classes 5A and 7, before other less cost-effective design options. (California IOUs, No. 33, p. 1-2)

DOE agrees that all manufacturers will have transitioned to R-600a by the time of the compliance date for any new energy conservation standards. Hence, the NOPR analysis assumes that all products will use R-600a at all efficiency levels.

2. Cost Analysis

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

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

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

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

In the present case, DOE conducted the analysis using a combination of physical teardowns, catalog teardowns, and price surveys. Where possible, physical teardowns were used to provide a baseline of technology options and pricing for a specific product class at a specific EL level. Then with technology option information, DOE estimated the cost of various design options including compressors, VIPs, and insulation, by extrapolating the costs from price surveys. With specific costs for technology options, DOE was then able to "build-up" or "build-down" from the various teardown models to finish the cost-efficiency curves. DOE used this approach primarily because it allowed the comparison of different technologies and design options.

3. Cost-Efficiency Results

The results of the engineering analysis are presented as cost-efficiency data for each of the efficiency levels for each of the product classes that were analyzed. DOE developed estimates of MPCs for each unit in the teardown sample, and also performed additional modeling based on representative teardown samples, to extend the analysis to cover the range of efficiency levels appropriate for a representative product. In this way, DOE estimated key design details for this range of efficiency levels. The manufacturer interviews provided input for these design details—DOE selected design options that were, to the extent possible, representative of manufacturer input regarding what design options would be required to attain specific efficiency levels for the analyzed product classes. DOE then calculated differential MPCs based on design option differences across the efficiency levels--using the calculated MPCs of the teardown units and the differential MPCs, DOE calculated MPCs for each considered efficiency level. The efficiency levels and design option progression for the analyzed standard-size refrigerator-freezers are presented in Table IV.5 and Table IV.6 of this document. The cells in the table list the design options that would be applied at each higher efficiency level as compared with the next-lower efficiency level. Similarly, the efficiency levels and design options for the other analyzed classes are presented in Table IV.7 of this document. The resulting MPCs for the analyzed classes across the considered efficiency levels are presented in Tables IV.8 and IV.9 of this document. See chapter 5 of the NOPR TSD for additional detail on the engineering analysis.

DOE seeks comment on the method for estimating manufacturing production costs and on the resulting cost-efficiency curves.

See section VII.E of this document for a list of issues on which DOE seeks comment.

Table IV.5 Efficiency Levels and Design Options for Analyzed Standard-Size Refrigerator-freezers

Product Class (AV[5])		**EL1**	**EL2**	**EL3**	**EL4**	**EL5**

3 (11.9)	EL Percent[1]	5%	10%	15%	20%	27%
	Design Options Added	Variable Defrost; Higher-EER Compressor	Higher-EER Compressor	Highest-EER Compressor	VIP side walls and doors	Variable-speed compressor system[3]
3 (21.0)	EL Percent[1]	5%	10%	15%	20%	28%
	Design Options Added	Higher-EER Compressor	Variable Defrost; Higher-EER Compressor	Variable-speed compressor system[3]	40% of Max-tech VIP[4]	VIP side walls and doors
5 (23.0)[2]	EL Percent[1]	8%	13%	18%	20%	
	Design Options Added	BLDC Evaporator Fan Motor; Variable-speed compressor system[3]	Highest-EER Variable-speed Compressor	71% of Max-tech VIP[4]	VIP side walls and doors	
5 (30.0)[2]	EL Percent[1]	7%	11%	15%	17%	
	Design Options Added	Efficiency levels were shifted such that the number of EL's matches that of the 23 AV analysis. MPCs were interpolated to these new EL numbers. See Table IV.6IV.6 for design options for the efficiency levels analyzed in the engineering analysis.				
5-BI[2] (26.0)	EL Percent[1]	8%	13%	14%		
	Design Options Added	Variable-speed compressor system[3];43% of Max-tech VIP	90% of Max-tech VIP[4]	VIP side walls and doors		
5A (35.0)[2]	EL Percent[1]	11%	16%	21.5%		
	Design Options Added	Variable-speed compressor system[3]	Highest-EER Variable-speed Compressor; 42% of Max-tech VIP[4]	VIP side walls and doors		
7 (31.5)	EL Percent[1]	5%	9.5%	14.5%	19%	22%
	Design Options Added	Highest-EER Compressor	BLDC Evaporator Fan Motor; Variable-speed compressor system[3]	38% of Max-tech VIP[4]	Highest-EER Variable-speed Compressor; 75% of Max-tech VIP[4]	VIP side walls and doors

Notes:

1. Percent energy use less than baseline.

2. For three-door configuration.

3. Includes two-speed fan control.

4. The percentage of surface area of VIP as compared with the VIP surface area used in the maximum-technology design, for which VIP would be installed for full coverage of the side walls and doors.

5. Adjusted Volume in cubic feet.

Table IV.6 Product Class 5, 30 AV, 3-Door Design Options and Manufacturing Production Cost

Percent Energy use below Baseline	0%	8%	13%	17%
Design Options Added		Highest-EER Compressor; BLDC Evaporator Fan Motor	Variable-speed compressor system[3]; 50% of Max-tech VIP	VIP side walls and doors
MPC	$748	$776	$809	$845
Incremental MPC		$28	$62	$97

Note: This information is the initial engineering analysis output. LCC, PBP, and other downstream analyses used the EL's and MPC's in Table IV.8.

Table IV.7 Efficiency Levels and Design Options for Analyzed Standard-Size Freezers and Compact Refrigerators, Refrigerator-Freezers, and Freezers

Product Class (AV[4])		EL1	EL2	EL3	EL4
9 (29.3)	EL Percent[1]	10%	15%	20%	25%
	Design Options Added	Highest-EER Compressor; Switch to forced-convection condenser; BLDC fans	Highest-EER Variable-speed compressor system[2]	38% of Max-tech VIP[3]	VIP side walls and door
10 (26.0)	EL Percent[1]	10%	15%	20%	23%
	Design Options Added	Variable-speed compressor system[2]	Wall thickness increase	Highest-EER Variable-speed Compressor	VIP door
	EL Percent[1]	10%	15%	20%	32%

11A (1.7)	Design Options Added	Wall thickness increase	Higher-EER Compressor	Higher-EER Compressor; VIP sides and door	Highest-EER Compressor
11A (4.4)	EL Percent[1]	10%	15%	20%	30%
	Design Options Added	Higher-EER Compressor	Wall thickness increase	Higher-EER Compressor	Variable Speed Compressor System[2]; VIP sides walls and door
17 (9.0)	EL Percent[1]	10%	15%	20%	
	Design Options Added	Highest-EER Variable Speed Compressor System[2]; Variable Defrost	50% of Max-tech VIP[3]	VIP side walls and door panels	
18 (8.9)	EL Percent[1]	10%	15%	20%	30%
	Design Options Added	Higher-EER Compressor; Variable Defrost	Wall thickness increase	Higher-EER Compressor, VIP door	Variable Speed Compressor System[2]

Notes:

1. Percent energy use less than baseline.
2. Includes two-speed fan control.
3. The percentage of surface area of VIP as compared with the VIP surface area used in the maximum-technology design, for which VIP would be installed for full coverage of the side walls and doors.
4. Adjusted Volume in cubic feet.

Table IV.8 Cost-Efficiency Curves for Standard-Size Refrigerator-freezers

Product Class (AV[3])		EL0	EL1	EL2	EL3	EL4	EL5
3 (11.9)	EL Percent[1]	0%	5%	10%	15%	20%	27%
	MPC	$419	$426	$427	$429	$478	$507
	Incremental MPC	$0	$7.14	$8.60	$10	$59	$88
3 (21.0)	EL Percent[1]	0%	5%	10%	15%	20%	28%
	MPC	$511	$513	$530	$554	$580	$618
	Incremental MPC	$0	$1.59	$19	$43	$69	$107
5 (23.0)[2]	EL Percent[1]	0%	8%	13%	18%	20%	[redacted]
	MPC	$666	$691	$693	$736	$753	
	Incremental MPC	$0	$25	$27	$70	$87	
5 (30.0)[2]	EL Percent[1]	0%	7%	11%	15%	17%	
	MPC	$748	$773	$796	$827	$845	

	Incremental MPC	$0	$26	$48	$79	$97	
5-BI[3] (26.0)	EL Percent[1]	0%	10%	15%	16%		
	MPC	$947	$983	$1,015	$1,020		
	Incremental MPC	$0	$35	$68	$72		
5A (35.0)[2]	EL Percent[1]	0%	11%	16%	21.5%		
	MPC	$818	$839	$872	$914		
	Incremental MPC	$0	$21	$55	$96		
7 (31.5)	EL Percent[1]	0%	5%	9.5%	14.5%	19%	22%
	MPC	$706	$708	$728	$748	$775	$791
	Incremental MPC	$0	$2.26	$22	$42	$69	$85

Notes:
1. Percent energy use less than baseline.
2. For three-door configuration.
3. Adjusted volume in cubic feet

Table IV.9: Cost-Efficiency Curves for Standard-Size Freezers and Compact Refrigerators, Refrigerator-freezers, and Freezers.

Product Class (AV[2])		**EL0**	**EL1**	**EL2**	**EL3**	**EL4**
9 (29.3)	EL Percent[1]	0%	10%	15%	20%	25%
	MPC[2]	$519	$536	$568	$592	$620
	Incremental MPC	$0	$17	$49	$73	$101
10 (26.0)	EL Percent[1]	0%	10%	15%	20%	23%
	MPC	$549	$580	$604	$606	$629
	Incremental MPC	$0	$31	$55	$57	$81
11A (1.7)	EL Percent[1]	0%	10%	15%	20%	32%
	MPC	$170	$175	$176	$197	$201

	Incremental MPC	$0	$5.00	$6.22	$26.78	$31
11A (4.4)	EL Percent[1]	0%	10%	15%	20%	30%
	MPC	$255	$257	$263	$274	$322
	Incremental MPC	$0	$2.19	$8.12	$19	$67
17 (9.0)	EL Percent[1]	0%	10%	15%	20%	
	MPC	$226	$252	$272	$293	
	Incremental MPC	$0	$26	$47	$67	
18 (8.9)	EL Percent[1]	0%	10%	15%	20%	30%
	MPC	$213	$215	$225	$238	$269
	Incremental MPC	$0	$2.54	$12	$25	$56

Notes:

1. Percent energy use less than baseline.
2. Adjusted volume in cubic feet

4. Manufacturer Selling Price

To account for manufacturers' non-production costs and revenue attributable to the product, DOE applies a multiplier (the manufacturer markup) to the MPC. The resulting manufacturer selling price ("MSP") is the price at which the manufacturer charges its direct customer (*e.g.*, a retailer). DOE developed an average manufacturer markup by examining the annual Securities and Exchange Commission ("SEC") 10-K reports[26] filed by publicly traded manufacturers primarily engaged in appliance manufacturing and whose combined product range includes refrigerators, refrigerator-

[26] U.S. Securities and Exchange Commission, *Electronic Data Gathering, Analysis, and Retrieval (EDGAR) system.* Available at *www.sec.gov/edgar/search/* (last accessed July 1, 2022).

freezers, and freezers. See chapter 12 of the NOPR TSD for additional detail on the manufacturer markup.

D. Markups Analysis

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

For refrigerators, refrigerator-freezers, and freezers, the main parties in the distribution chain are retailers, wholesalers and general contractors.

DOE developed baseline and incremental markups for each actor in the distribution chain. Baseline markups are applied to the price of products with baseline efficiency, while incremental markups are applied to the difference in price between baseline and higher-efficiency models (the incremental cost increase). The incremental markup is typically less than the baseline markup and is designed to maintain similar per-unit operating profit before and after new or amended standards.[27]

[27] Because the projected price of standards-compliant products is typically higher than the price of baseline products, using the same markup for the incremental cost and the baseline cost would result in higher per-unit operating profit. While such an outcome is possible, DOE maintains that in markets that are reasonably competitive it is unlikely that standards would lead to a sustainable increase in profitability in the long run.

Based on microeconomic theory, the degree to which firms can pass along a cost increase depends on the level of market competition, as well as sensitivity to price changes on both the supply and demand sides (*e.g.*, supply and demand elasticity). DOE examined industry data from IBISWorld and the results suggest that the competition level among each industry group and between industry groups involved in appliance retail is medium to high.[28] In addition, consumer demand for household appliances is relatively inelastic with respect to price (*i.e.,* demand is not expected to decrease substantially with an increase in the price of product). Given the medium to high level of competition, it may be tenable for retailers to maintain a fixed markup for a short period of time after an input price increase, but the market competition should eventually force them to readjust their markups to reach a medium-term equilibrium in which per-unit margin is relatively unchanged before and after standards are implemented. DOE developed the incremental markup approach based on the effect of energy efficiency standards under second-degree price discrimination.[29] Initially, firms supply products with a wide range of energy efficiencies with the "premium" models significantly more energy efficient than "basic" models. The firm earns low margins on the basic models, and high margins on the premium models, based on customer willingness to pay for relative energy efficiency. An energy efficiency standard temporarily narrows the quality gap between the basic and premium models. To prevent premium product customers shifting to basic products that

[28] IBISWorld. *US Industry Reports (NAICS): 45211 - Department Stores; 44311 - Consumer Electronics Stores; 44411 - Home Improvement Stores; 42362 TV & Appliance Retailers in the US*. 2022. IBISWorld. (Last accessed February 1, 2022.) *www.ibisworld.com*.
[29] Spurlock, C.A., and Fujita, K.S. (2022). Equity implications of market structure and appliance energy efficiency regulation. Energy Policy, vol. 165, 112943, 1-12.

have lower margins, firms maintain their margins on premium products by reducing their markups.

To estimate the markup under standards, DOE derived an incremental markup that is applied to the incremental product costs of higher efficiency products. The overall markup on the products meeting standards is an average of the markup on the component of the cost that is equal to the baseline product and the markup on the incremental cost accrued due to standards, weighted by the share of each in the total cost of the standards-compliant product.

DOE relied on economic data from the U.S. Census Bureau to estimate average baseline and incremental markups. Specifically, DOE used the 2017 Annual Retail Trade Survey for the "electronics and appliance stores" sector to develop retailer markups,[30] the 2017 Annual Wholesale Trade Survey for the "household appliances, and electrical and electronic goods merchant wholesalers" sector to estimate wholesaler markups,[31] and the industry series for the "residential building construction" sector published by the 2017 Economic Census to derive general contractor markups.[32]

Chapter 6 of the NOPR TSD provides details on DOE's development of markups for refrigerators, refrigerator-freezers, and freezers.

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30 U.S. Census Bureau, *Annual Retail Trade Survey*. 2017. *www.census.gov/programs-surveys/arts.html*

31 U.S. Census Bureau, *Annual Wholesale Trade Survey*. 2017. *www.census.gov/awts*

32 U.S. Census Bureau. 2017 Economic Census. *https://www.census.gov/newsroom/press-kits/2020/2017-economic-census.html.*

DOE requests comment on its markups analysis and the underlying assumptions, including price elasticities specific to the market for new refrigeration products and any potential effects from a market for second refrigerators or second-hand products.

E. Energy Use Analysis

The purpose of the energy use analysis is to determine the annual energy consumption of refrigerators, refrigerator-freezers, and freezers 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 product efficiency. The energy use analysis estimates the range of energy use of refrigerators, refrigerator-freezers, and freezers in the field (*i.e.*, as they are actually used by consumers). The energy use analysis provides the basis for other analyses DOE performed, particularly assessments of the energy savings and the savings in consumer operating costs that could result from adoption of amended or new standards.

The DOE test procedure produces standardized results that can be used to assess or compare the performance of products operating under specified conditions. Actual energy usage in the field often differs from that estimated by the test procedure because of variation in operating conditions, the behavior of users, and other factors. In the case of refrigerators, refrigerator-freezers, and freezers, DOE used usage adjustment factors (UAFs) in the October 2021 Preliminary Analysis to address the difference in field-metered energy consumption and the DOE test results due to household-specific characteristics. 80 FR 57378-57385.

Specifically, DOE combined field-metered energy use data for full-size refrigeration products from the September 2011 Final Rule, the Northwest Energy

Efficiency Alliance ("NEEA"), and the Florida Solar Energy Center ("FSEC") with estimates of the test energy use of each field-metered unit. Then, DOE calculated a unit's UAF by dividing the annual field-metered energy use by the annual energy consumption from the DOE test procedure. DOE then used maximum likelihood estimation to fit log-normal distributions to the empirical distributions of UAFs for primary refrigerators and refrigerator-freezers, secondary refrigerators and refrigerator-freezers, and freezers. DOE sampled UAFs from these fitted log-normal distributions to estimate the actual energy use of refrigeration products for the consumer sample. DOE did not have adequate field-metering data to derive UAFs for compact refrigeration products; therefore, DOE assumed the UAF of compact refrigeration products was 1.0.

In response to the October 2021 Preliminary Analysis energy use methodology, the CA IOUs noted that the UAFs are based on refrigeration products that were installed prior to the September 2011 Final Rule standard coming into effect and questioned whether the usage patterns of these older refrigeration products are reflective of current usage patterns. (CA IOUs, No. 16 at p.34) While DOE acknowledges that the available field-metering data for generating UAF distributions are from refrigeration products installed prior to the September 2011 Final Rule standard coming into effect, DOE is unaware of more recent data to inform the estimation of UAFs or to examine how usage patterns may have changed since the effective date. Moreover, because most field-metering studies are confined to a single geographic location, using all available field-metering data for the derivation of UAFs allows for a more representative analysis. DOE also believes it is unlikely that the UAFs derived from the field-metering data—which are used to account for differences in energy use due to things like the number of occupants and outdoor temperature—would differ substantially with data vintage. As a result, DOE has continued to use the same data and methodology for this NOPR analysis as was used in the October 2021 Preliminary Analysis. Chapter 7 of the NOPR TSD provides details on DOE's energy use analysis for refrigerators, refrigerator-freezers, and freezers.

DOE requests comment on its methodology to develop UAFs and also requests data on actual energy use for standard-size consumer refrigerators, refrigerator-freezers, and freezers in the field to further inform the UAF development for subsequent rounds of this rulemaking.

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 refrigerators, refrigerator-freezers, and freezers. 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 refrigerators, refrigerator-freezers, and freezers in the absence of new or amended energy conservation standards. In contrast, the PBP for a given efficiency level is measured relative to the baseline product.

For each considered efficiency level in each product class, DOE calculated the LCC and PBP for a nationally-representative set of housing units (all product classes) and commercial buildings (product class 11A only). DOE included commercial applications in the analysis of compact refrigerators and refrigerator-freezers (product class 11A) because they are used in both the residential and commercial sectors (*e.g.*, hotel rooms and higher-education dormitories). DOE developed household samples from the 2015 Residential Energy Consumption Survey ("RECS") and commercial building samples from the 2018 Commercial Buildings Energy Consumption Survey ("CBECS"). For each sample household or building, DOE determined the energy consumption for the refrigerator, refrigerator-freezer, or freezer and the appropriate electricity price and discount rate. By developing a representative sample of households and buildings, the analysis captured the variability in energy consumption, energy prices, and discount rates associated with the use of refrigerators, refrigerator-freezers, and freezers.

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

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

Table IV.10 summarizes the approach and data DOE used to derive inputs to the LCC and PBP calculations. The subsections that follow provide further discussion. Details of the spreadsheet model, and of all the inputs to the LCC and PBP analyses, are contained in chapter 8 of the NOPR TSD and its appendices.

Table IV.10 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. Applied price learning based on historical price index data to project product costs. Applied price trend to electronic controls used on products with VSDs.
Installation Costs	Assumed no change with efficiency level; therefore, not included.
Annual Energy Use	The total annual energy use multiplied by a usage adjustment factor, which is derived using field data. Variability: Based on product class and field data.
Energy Prices	Electricity: Based on Edison Electric Institute data for 2021. Variability: Regional energy prices determined for each Census Division.
Energy Price Trends	Based on *AEO2022* price projections.
Repair and Maintenance Costs	Assumed no change with efficiency level for maintenance costs. Repair costs estimated for each product class and efficiency level.
Product Lifetime	Weibull distributions based on historical shipments and age distribution of installed stock.
Discount Rates	Approach involves identifying all possible debt or asset classes that might be used to purchase the considered appliances, or might be affected indirectly. Primary data source was the Federal Reserve Board's Survey of Consumer Finances.
Compliance Date	2027

* 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.

DOE requests comment on the overall methodology and results of the LCC and PBP analyses.

AHAM stated that the method DOE used to report the fraction of consumers with a net cost in the preliminary analysis does not indicate the proportion of households that were forced to change their purchase decision (due to an assumed standard) and also had a negative impact. As a result, AHAM argues the analysis is incomplete and misleading. AHAM stated the correct interpretation of these results is that the market is working and the households who will benefit from a higher standard are already receiving that benefit. AHAM stated DOE needs to take this more nuanced interpretation into account when selecting a standard level. (AHAM, No. 31 at pp. 15) DOE maintains that showing the share of all consumers who would experience a net LCC cost is useful information, as EPCA requires DOE to consider the impact of standards on all "consumers," not only those who might make a different purchasing decision. Moreover, DOE takes into consideration the results of multiple analyses, not just the LCC savings, when considering if and at what level to set an efficiency standard.

AHAM and Shorey Consulting commented that DOE only provided a summary of results from the LCC model, rather than the full LCC model. (AHAM, Public Meeting Transcript, No. 30 at pp. 41-42; Shorey Consulting, Public Meeting Transcript, No. 30 at pp. 42-43) In comparison to the Crystal Ball-based LCC models that DOE has historically used, AHAM and Shorey Consulting commented that the preliminary analysis LCC spreadsheet is less transparent, making it difficult for stakeholders to make informed comments. (AHAM, No. 31 at p. 15; Shorey Consulting, Public Meeting Transcript, No. 30 at pp. 42-43) In response, DOE notes that the complexity of the LCC analysis is such that using Crystal Ball to perform the analysis is overly burdensome and time intensive. For this reason, DOE performed the analysis using the Python programming language instead. While the current LCC spreadsheet therefore does not rely on the Crystal Ball software that LCC spreadsheets in the past have used, DOE notes that the current LCC spreadsheet continues to provide full consumer samples and essential LCC calculations on a consumer-by-consumer basis. In this framework, stakeholders are able to adjust key input values to observe how such changes would affect LCC and LCC savings at the consumer level. Moreover, this functionality is available to stakeholders without requiring the purchase of software (*e.g.,* Crystal Ball) other than Microsoft Excel, which is widely available. DOE believes this approach allows for a rigorous LCC analysis while still providing an appropriate level of transparency to stakeholders.

1. Adjusted Volume Distribution

DOE developed adjusted volume distributions within each PC containing more than one representative unit to determine the likelihood that a given purchaser would select each of the representative units for a given PC from the engineering analysis. DOE estimated the distribution of adjusted volumes for PC 3 and PC 5 based on the capacity distribution reported in the TraQline® refrigerator data spanning from Q1 2018 to Q1 2019.[33] DOE estimated the distribution of adjusted volumes for PC 11A based on the distribution of models from DOE's Compliance Certification Management System Database. Table IV.11 presents the adjusted volume distribution of each of the PCs having more than one representative unit. DOE assumed that the adjusted volume distribution remains constant over the years considered in the analysis.

[33] TraQline® is a quarterly market share tracker of 150,000+ consumers.

Table IV.11 Adjusted Volume Probability for each Product Class having more than One Representative Unit

Adjusted Volume (cu. ft.)	Probability (%)
PC 3	
11.9	22.3
20.6	77.7
PC 5	
23	34.7
30	65.3
PC 11A	
1.7	77.8
4.4	22.2

DOE requests comment on its methodology to develop market share distributions by adjusted volume in the compliance year for each PC with two representative volumes, as well as data to further inform these distributions in subsequent rounds of this proposed rulemaking.

2. Product Cost

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

Economic literature and historical data suggest that the real costs of many products may trend downward over time according to “learning” or “experience” curves.

Experience curve analysis implicitly includes factors such as efficiencies in labor, capital investment, automation, materials prices, distribution, and economies of scale at an industry-wide level.[34] In the experience curve method, the real cost of production is related to the cumulative production or "experience" with a manufactured product. DOE used historical Producer Price Index ("PPI") data for "household refrigerator and home freezer manufacturing" from the Bureau of Labor Statistics' ("BLS") spanning the time period between 1981 and 2021 as a proxy of the production cost for refrigerators, refrigerator-freezers and freezers.[35] This is the most representative and current price index for refrigerators, refrigerator-freezers, and freezers. An inflation-adjusted price index was calculated by dividing the PPI series by the gross domestic product index from Bureau of Economic Analysis for the same years. The cumulative production of refrigerators, refrigerator-freezers, and freezers were assembled from the annual shipments from the Association of Household Appliance Manufacturers (AHAM) between 1951 and 2020, and shipment estimates prior to 1951 using a trend analysis. The estimated learning rate (defined as the fractional reduction in price expected from each doubling of cumulative production) is 40.0 ± 1.8 percent.

DOE included variable-speed compressors as a technology option for higher efficiency levels. To develop future prices specific for that technology, DOE applied a different price trend to the controls portion of the variable-speed compressor, which represents part of the price increment when moving from an efficiency level achieved

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[34] Taylor, M. and Fujita, K.S. Accounting for Technological Change in Regulatory Impact Analyses: *The Learning Curve Technique*. LBNL-6195E. Lawrence Berkeley National Laboratory, Berkeley, CA. April 2013. *http://escholarship.org/uc/item/3c8709p4#page-1*.
[35] Household refrigerator and home freezer manufacturing PPI series ID: PCU3352203352202; *www.bls.gov/ppi/*.

with the highest efficiency single-speed compressor to an efficiency level with variable-speed compressor. DOE used PPI data on "semiconductors and related device manufacturing" between 1967 and 2021 to estimate the historic price trend of electronic components in the control.[36] The regression, performed as an exponential trend line fit, results in an R-square of 0.99, with an annual price decline rate of 6.3 percent. See chapter 8 of the TSD for further details on this topic.

In response to the October 2021 Preliminary Analysis, AHAM stated the use of learning curves to forecast future refrigerator prices is a purely empirical relationship without theoretical justification for why experience should continue to affect total costs., Rather, AHAM comments that DOE should be driven by the actual data. AHAM noted the curve used by DOE is already below actual data for certain years, and the curve is likely to significantly overestimate the future reduction in costs. AHAM stated DOE should recalculate its learning curve values to determine an appropriate rate based on the actual current data. (AHAM, No. 31 at pp. 13-14)

DOE notes that there is considerable historical evidence of consistent price declines for appliances in the past few decades. This phenomenon is generally attributable to manufacturing efficiency gained with cumulative experience producing a certain good through learning by workers and management, and is modeled by an empirical experience curve (Desroches *et al.* 2013)[37]. Several studies examined

[36] Semiconductors and related device manufacturing PPI series ID: PCU33441333 4413; *www.bls.gov/ppi/*.
[37] Desroches, L.-B., K. Garbesi, C. Kantner, R. Van Buskirk, and H.-C. Yang. Incorporating Experience Curves in Appliance Standards Analysis. Energy Policy. 2013. 52 pp. 402–416.

refrigerator retail prices during different periods of time and showed that prices have been steadily falling while efficiency has been increasing, including for example Dale, et al. (2009)[38] and Taylor, et al. (2015)[39]. The development of experience curve analysis relies on extensive historical data on the manufacturing costs of a given product; however, such data are very difficult to obtain. Thus, DOE used the Producer Price Index (PPI) published by the BLS as a proxy for manufacturing costs. The PPI, which measures the average changes in prices received by domestic producers, is quality-adjusted and available for a wide variety of specific industries (*e.g.,* refrigerator manufacturing). Since what matters in the experience curve model is the changes in producer prices and not the absolute prices, the use of PPI is suitable for the analysis. To capture the overall price evolution in relation to cumulative production during the entire period where data are available, the full historical PPI series for "household refrigerator and home freezer manufacturing" should be used in the price learning estimation rather than only focusing on the more recent data. A least-square power-law fit performed on the deflated price index and cumulative shipments yields an R-square of 97%, which is considered a great fit to the data. Sensitivity analyses that are based on a particular segment of the PPI data for household refrigerator manufacturing were also conducted to investigate the impact of different product price projections in the NIA of this NOPR.

[38] Dale, L., C. Antinori, M. McNeil, James E. McMahon, and K. S. Fujita. Retrospective evaluation of appliance price trends. Energy Policy. 2009. 37 pp. 597–605.

[39] Taylor, M., C. A. Spurlock, and H.-C. Yang. Confronting Regulatory Cost and Quality Expectations. An Exploration of Technical Change in Minimum Efficiency Performance Standards. 2015. Lawrence Berkeley National Lab. (LBNL), Berkeley, CA (United States). Report No. LBNL-1000576. (Last accessed July 27, 2022.) *https://www.osti.gov/biblio/1235570/*.

The CA IOUs cited a 2014 study which found that energy efficient equipment has steeper price learning curves, indicating that efficiency standards can accelerate long-term price declines even further. They stated that the learning rate used in the preliminary analysis likely overstates the cost of increasingly efficient equipment, while understating the costs of freezers and the least efficient products (since they are undergoing less change). Therefore, the CA IOUs recommended DOE develop additional learning curves by efficiency level to better reflect the pricing dynamics consistent with established economic theory. (CA IOUs, No. 33 at pp. 4-5)

DOE acknowledges that products at different efficiency levels may experience different rates of price learning. For the most part, however, there are not sufficient data to derive experience curves at that level of detail. However, as noted above, in this NOPR, DOE included variable-speed compressors as a technology option for higher efficiency levels. To account for the faster learning associated with the electronics for variable-speed compressors, DOE applied a separate price trend to the controls portion of refrigerators, refrigerator-freezers, and freezers that utilize variable-speed compressors. DOE assumed these controls have an MPC of $20 (see chapter 5 of the NOPR TSD). This results in a greater price decline for refrigerators, refrigerator-freezers, and freezers at higher efficiency levels. If more data become available on this topic in the future, DOE will work toward further improving the price learning estimation.

3. Installation Cost

Installation cost includes labor, overhead, and any miscellaneous materials and parts needed to install the product. DOE found no evidence that installation costs for refrigerators, refrigerator-freezers, and freezers would be impacted with increased efficiency levels. As a result, DOE did not include installation costs in the LCC and PBP analysis.

DOE requests comment and data on its assumption that installation costs do not change as a function of EL for refrigeration products.

4. Annual Energy Consumption

For each sampled household or commercial building, DOE determined the energy consumption for refrigerators, refrigerator-freezers, and freezers at different efficiency levels using the approach described previously in section IV.E of this document.

5. 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).[40] For the commercial sector, DOE calculated electricity prices using the methodology described in Coughlin and Beraki (2019).[41]

To estimate energy prices in future years, DOE multiplied the 2021 energy prices by the projection of annual average price changes for each of the nine census divisions from the reference case in *AEO 2022*, which has an end year of 2050.[42] To estimate price trends after 2050, DOE used the 2050 electricity prices, held constant.[43]

6. Maintenance and Repair Costs

Repair costs are associated with repairing or replacing product components that have failed in an appliance; maintenance costs are associated with maintaining the operation of the product. DOE is not aware of any data that suggest the cost of maintenance changes as a function of efficiency for refrigerators, refrigerator-freezers, and freezers. DOE therefore assumed that maintenance costs are the same regardless of EL and do not impact the LCC or PBP.

For the preliminary analysis, DOE developed a repair cost estimation method based on the average total installed cost and average annual repair costs by PC and EL from the 2011 Final Rule. For each of three categories—standard-size refrigerator-

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[40] Coughlin, K. and B. Beraki. Residential Electricity Prices: A Review of Data Sources and Estimation Methods. 2018. Lawrence Berkeley National Lab. (LBNL), Berkeley, CA (United States). Report No. LBNL-2001169. (Last accessed September 3, 2021.) *https://ees.lbl.gov/publications/residential-electricity-prices-review*.

[41] Coughlin, K. and B. Beraki. Non-residential Electricity Prices: A Review of Data Sources and Estimation Methods. 2019. Lawrence Berkeley National Lab. (LBNL), Berkeley, CA (United States). Report No. LBNL-2001203. (Last accessed September 3, 2021.) *https://ees.lbl.gov/publications/non-residential-electricity-prices*.

[42] U.S. Energy Information Administration. Annual Energy Outlook 2022. 2022. Washington, D.C. (Last accessed June 1, 2022.) *https://www.eia.gov/outlooks/aeo/index.php*.

freezers, standard-size freezers, and compact refrigeration products—DOE averaged the annual repair cost as a fraction of the total installed cost at each EL. Based on this method, DOE estimated consumers with standard-size refrigerator-freezers have annual repair costs equal to 1.8 percent of their total installed cost, consumers with standard-size freezers have an annual repair cost of 0.8 percent of their total installed cost, and consumers with compact refrigeration products have an annual repair cost of 0.9percent of their total installed cost. Because high-efficiency products have a higher installed cost, their estimated average annual repair costs are also higher.

As mentioned in section IV of this document, Sub-Zero indicated in comments on the preliminary TSD that there are significant limitations to further energy regulation if products are to remain reliable, long-lived and affordable. (Sub-Zero, No. 34, p. 1) As noted here, the LCC model DOE used in the preliminary analysis assumes that repair costs scale with total installed cost. Therefore, the higher first cost associated with higher efficiency levels translates into more expensive repair costs in DOE's repair costs analysis. DOE has not received data to support a change to this methodology, and therefore has continued to use this same methodology in the NOPR analyses. For more detail, see chapter 8 of the NOPR TSD.

DOE requests comment on its assumption that maintenance costs do not change as a function of EL for refrigeration products. DOE also requests comment and data on its methodology for determining repair costs by PC and EL.

7. Product Lifetime

DOE performed separate modeling of lifetime for standard-size refrigerators and refrigerator-freezers, standard-size freezers, and compact refrigeration products. For standard-size refrigerators, refrigerator-freezers, and freezers, DOE estimated product lifetimes by fitting a survival probability function to data on historical shipments and the age distributions of installed stock from RECS 2005, RECS 2009, and RECS 2015. The survival function, which DOE assumed has the form of a cumulative Weibull distribution, provides an average and median lifetime. Moreover, the conversion from primary to secondary refrigerator or refrigerator-freezer was also modeled as part of the lifetime determination for standard-size refrigerators and refrigerator-freezers.

For compact refrigerators, DOE estimated an average lifetime of 7.7 years using data on shipments and the number of units in use (stock). For compact freezers, DOE did not have reliable stock data available to compare against historical shipments. Therefore, DOE estimated an average lifetime of 10.7 years by multiplying the average lifetime of compact refrigerators by the ratio of the average lifetime of standard-size freezers (20.6 years) to the average lifetime of standard-size refrigerators and refrigerator-freezers (14.8 years).

In response to the preliminary analysis lifetime analysis, AHAM encouraged DOE to further consider incorporating AHAM's consumer research. Specifically, AHAM recommended that DOE adopt the average lifetimes that AHAM provided in a confidential response to the RFI. (AHAM, No. 31 at pp. 11-12) DOE appreciates AHAM's comments and the average lifetimes provided in response to the RFI. DOE incorporated the latest available shipments and representative consumer survey data into its lifetime models for the NOPR analysis. When compared to the average lifetimes provided confidentially by AHAM in response to the RFI and the average lifetimes from the September 2011 Final Rule analysis, DOE notes that the lifetime models used in the October 2021 Preliminary Analysis generally fall between the two. Using updated shipments data from AHAM, DOE has further updated the lifetime distributions for compact refrigeration products for this NOPR. This update has increased the average lifetime of compact products relative to the preliminary analysis, which aligns even more closely with the confidential data AHAM provided. A comparison of the average lifetimes in each analysis is provided in Table IV.12.

Table IV.12 Comparison of Average Lifetimes by Product Category by Rulemaking Phase

Category	Average Lifetime (years)		
	2023 Notice of Proposed Rulemaking	2021 Preliminary Analysis	2011 Final Rule
Standard-size refrigerators and refrigerator-freezers	14.8	14.8	17.4
Standard-size freezers	20.6	20.6	22.3
Compact refrigerators and refrigerator-freezers	7.7	6.9	5.6
Compact freezers	10.7	9.7	7.5

Because DOE’s lifetime models are based on nationally representative data, and because DOE’s updated lifetime models are more aligned with the useful lifetimes provided by AHAM, DOE has continued to use the same lifetime model methodology that was used in the preliminary analysis, but with updated data.

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

DOE requests comment and data on the assumptions and methodology used to calculate refrigerator, refrigerator-freezer, and freezer survival probabilities. DOE requests comment and data on source of second refrigerators, whether from new purchase, conversion of surviving first refrigerators, or second-hand markets. DOE also welcomes any information indicating whether or not the service lifetime of refrigeration products differs by efficiency level.

8. Discount Rates

In the calculation of LCC, DOE applies discount rates appropriate to residential and commercial consumers to estimate the present value of future operating cost savings. DOE estimated distributions of residential and commercial discount rates for refrigerators, refrigerator-freezers, and freezers based on consumer financing costs and the opportunity cost of consumer funds (for the residential sector) and cost of capital of publicly traded firms (for the commercial sector).

DOE applies weighted average discount rates calculated from consumer debt and asset data, rather than marginal or implicit discount rates.[44] The LCC analysis estimates NPV over the lifetime of the product, so the appropriate discount rate will reflect the general opportunity cost of household funds, taking this time scale into account. Given the long time horizon modeled in the LCC analysis, the application of a marginal interest rate associated with an initial source of funds is inaccurate. Regardless of the method of purchase, consumers are expected to continue to rebalance their debt and asset holdings over the LCC analysis period, based on the restrictions consumers face in their debt payment requirements and the relative size of the interest rates available on debts and assets. DOE estimates the aggregate impact of this rebalancing using the historical distribution of debts and assets.

To establish residential discount rates for the LCC analysis, DOE identified all relevant household debt or asset classes in order to approximate a consumer's opportunity cost of funds related to appliance energy cost savings. It estimated the average percentage shares of the various types of debt and equity by household income group using data from the Federal Reserve Board's Survey of Consumer Finances ("SCF") for 1995, 1998, 2001, 2004, 2007, 2010, 2013, 2016, and 2019.[45] Using the SCF and other

[44] 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.

[45] 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 February 1, 2022.) *http://www.federalreserve.gov/econresdata/scf/scfindex.htm.*

sources, DOE developed a distribution of rates for each type of debt and asset by income group to represent the rates that may apply in the year in which amended standards would take effect.

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 discount rates. See chapter 8 in the NOPR TSD for details.

In response to the preliminary analysis, AHAM suggested DOE use the marginal cost of debt in the LCC, rather than weighted-average interest rates from a stable portfolio of debts and assets. AHAM noted that this is especially important for low-income households. (AHAM, No. 31 and pp. 17-19) AHAM also stated that the distribution of discount rates used in the LCC analysis do not correspond to reality, and strongly suggested that the assumptions that produced these distributions be reconsidered. (AHAM, No. 31 at pp. 19-20)

In response, DOE notes that the LCC analysis is not modeling a purchase decision. The LCC analysis estimates the NPV of financial trade-offs of increased upfront product costs weighed against reduced operating costs over the lifetime of the covered product, assuming the product has already been obtained and installed. The marginal rate is not the appropriate discount rate to use because fixing the discount rate at the marginal rate associated with a credit card assumes that consumers purchase the appliance with a credit card, and keep that purchase on the credit card throughout the entire time it takes to pay off that debt with only operating costs savings from the more efficient product. There is little evidence that consumers behave in this way. Consumers do not tend to shift all of their funds to assets with the highest interest rate, nor away from debt types with the highest interest rate. Examination of many years of data from the Federal Reserve's Survey of Consumer Finances suggests that, at the time of each survey, the vast majority of households held multiple types of debt and/or assets. This tendency is observed across numerous cross-sections of the population, such as income groups (low-income households included), geographic locations, and age of household head. Therefore, DOE believes that using an average discount rate in the LCC best approximates the actual opportunity cost of funds faced by consumers. This opportunity cost of funds is the time-value of money for consumers. For a more detailed discussion, please see the 2020 final energy conservation standards rulemaking for room air conditioners. 85 FR 1378-1447.

See chapter 8 of the NOPR TSD for further details on the development of consumer discount rates.

9. Energy Efficiency Distribution in the No-New-Standards Case

To accurately estimate the share of consumers that would be affected by a potential energy conservation standard at a particular efficiency level, DOE's LCC analysis considered the projected distribution (market shares) of product efficiencies under the no-new-standards case (*i.e.,* the case without amended or new energy conservation standards).

To estimate the expected energy efficiency distribution of refrigerators, refrigerator-freezers, and freezers for 2027, DOE utilized model counts from DOE's CCMS database.[46] Models in the database were categorized by capacity and assigned an efficiency level based on reported energy use. In the absence of data on trends in efficiency, DOE assumed the current efficiency distribution would be representative of the efficiency distribution in 2027 in the no-new-standards case. The estimated market shares for the no-new-standards case for refrigerators, refrigerator-freezers, and freezers are shown in Table IV.13 of this document. See chapter 8 of the NOPR TSD for further information on the derivation of the efficiency distributions.

DOE requests comment on its methodology to develop market share distributions by EL for each PC and representative unit for the no-new-standards case in the compliance year, as well as data to further inform these distributions in subsequent rounds of this proposed rulemaking. DOE also requests comment on the assumption that the current efficiency distribution would remain fixed over the analysis period, and data to inform an efficiency trend by PC.

[46] *https://www.regulations.doe.gov/certification-data/CCMS-4-Refrigerators_Refrigerator-Freezers_and_Freezers.html*, Last accessed on August 5, 2020.

Table IV.13 No-New-Standards Case Efficiency Distributions in 2027

Product Class	Total Adjusted Volume (cu. ft.)	2027 Market Share (%)						
		EL 0	EL 1	EL 2	EL 3	EL 4	EL 5	Total*
3	11.9	56.3	13.1	30.6	0.0	0.0	0.0	100.0
	20.6	66.2	1.3	32.3	0.0	0.2	0.0	100.0
5	23	47.6	49.9	1.1	0.8	0.6		100.0
	30	45.1	32.9	18.3	1.2	2.4		100.0
5A	35	96.0	2.1	2.0	0.9			100.0
5BI	26	30.3	48.5	0.0	21.2			100.0
7	31.5	83.3	10.6	4.1	1.6	0.2	0.2	100.0
9	29.3	75.9	22.5	0.8	0.8	0.0		100.0
10	26	94.1	5.9	0.0	0.0	0.0		100.0
11A	1.7	9.1	57.0	7.5	17.8	8.6		100.0
	4.4	22.9	70.3	0.0	5.1	1.7		100.0
17	9	35.4	41.5	16.9	6.2			100.0
18	8.9	92.8	6.2	0.0	1.0	0.0		100.0

* The total may not sum to 100% due to rounding.

In response to the October 2021 Preliminary Analysis, AHAM objected to DOE's use of random assignment of 2015 RECS households to base and standard cases, which assumes that consumers are agnostic to energy costs. AHAM stated that it is very unlikely that consumers with very high potential LCC savings would not have already decided to purchase a more efficient refrigerator (i.e., in the no-new-standards case), and DOE's assumption that these consumers are indifferent to operating costs appears contrary to common sense and experience in the retail field.

While DOE acknowledges that economic factors may play a role when consumers decide on what type of refrigeration product to install, assignment of refrigeration product efficiency for a given installation, based solely on economic measures such as life-cycle cost or simple payback period most likely would not fully and accurately reflect actual real-world installations. There are a number of market failures discussed in the economics literature that illustrate how purchasing decisions with respect to energy efficiency are unlikely to be perfectly correlated with energy use, as described below. DOE maintains that the method of assignment, which is in part random, is a reasonable approach, one that simulates behavior in the refrigeration product market, where market failures result in purchasing decisions not being perfectly aligned with economic interests, and is more realistic than relying only on apparent cost-effectiveness criteria derived from the information in RECS. DOE further emphasizes that its approach does not assume that all purchasers of refrigeration products make economically irrational decisions (*i.e.*, the lack of a correlation is not the same as a negative correlation). By using this approach, DOE acknowledges the uncertainty inherent in the data and minimizes any bias in the analysis by using random assignment, as opposed to assuming certain market conditions that are unsupported given the available evidence.

DOE notes that consumers are typically motivated by more than simple financial trade-offs. There are consumers who are willing to pay a premium for more energy-efficient products because they are environmentally conscious.[47] There are also several behavioral factors that can influence the purchasing decisions of complicated multi-attribute products, such as refrigeration products. For example, consumers (or decision makers in an organization) are highly influenced by choice architecture, defined as the framing of the decision, the surrounding circumstances of the purchase, the alternatives

[47] Ward, D. O., Clark, C. D., Jensen, K. L., Yen, S. T., & Russell, C. S. (2011): "Factors influencing willingness-to pay for the ENERGY STAR® label," Energy Policy, 39(3), 1450-1458. (Available at: *www.sciencedirect.com/science/article/abs/pii/S0301421510009171*) (Last accessed Feb. 15, 2022).

available, and how they're presented for any given choice scenario.[48] The same consumer or decision maker may make different choices depending on the characteristics of the decision context (*e.g.,* the timing of the purchase, competing demands for funds), which have nothing to do with the characteristics of the alternatives themselves or their prices. Consumers or decision makers also face a variety of other behavioral phenomena including loss aversion, sensitivity to information salience, and other forms of bounded rationality. Thaler and Sunstein point out that these behavioral factors are strongest when the decisions are complex and infrequent, when feedback on the decision is muted and slow, and when there is a high degree of information asymmetry.[49] These characteristics describe almost all purchasing situations of appliances and equipment, including refrigeration products. The installation of a new or replacement refrigeration product is done very infrequently, as evidenced by the mean lifetime of over 14 years for standard-size products. Further, if the purchaser of the refrigeration product is not the entity paying the energy costs (*e.g.,* a tenant), there may be little to no feedback regarding energy costs on the purchase.

Additionally, there are systematic market failures that are likely to contribute further complexity to how products are chosen by consumers. The first of these market failures is known as the split-incentive or principal-agent problem. The principal-agent problem is a market failure that results when the consumer that purchases the equipment does not internalize all of the costs associated with operating the equipment. Instead, the

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[48] Ward, D. O., Clark, C. D., Jensen, K. L., Yen, S. T., & Russell, C. S. (2011): "Factors influencing willingness-to pay for the ENERGY STAR® label," *Energy Policy, 39*(3), 1450-1458. (Available at: *www.sciencedirect.com/science/article/abs/pii/S0301421510009171*) (Last accessed Feb. 15, 2022).
[49] Thaler, R.H., and Sunstein, C.R. (2008). Nudge: Improving Decisions on Health, Wealth, and Happiness. New Haven, CT: Yale University Press.

user of the product, who has no control over the purchase decision, pays the operating costs. There is a high likelihood of split incentive problems for refrigeration products. For example, in the case of rental properties where the landlord makes the choice of what refrigerator to install, whereas the renter is responsible for paying energy bills.

In addition to the split-incentive problem, because of the way information is presented, and in part because of the way consumers process information, there is also a market failure consisting of a systematic bias in the perception of equipment energy usage. Attari, Krantz, and Weber[50] show that consumers tend to underestimate the energy use of large energy-intensive appliances, but overestimate the energy use of small appliances. This can affect consumer choices. AHAM stated that the most appropriate solution is to have a much more robust consumer choice theory. (AHAM, no. 36 at p. 12) Therefore, it is likely that consumers systematically underestimate the energy use associated with refrigerators, resulting in less cost-effective refrigerator purchases.

These market failures affect a sizeable share of the consumer population. A study by Houde[51] indicates that there is a significant subset of consumers that appear to purchase appliances without taking into account their energy efficiency and operating costs at all.

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[50] Attari, S. Z., D. H. Krantz, and E. Weber. Energy conservation goals: What people adopt, what they recommend, and why. 2016. 11 pp. 342–351.

[51] Houde, S. (2018): "How Consumers Respond to Environmental Certification and the Value of Energy Information," *The RAND Journal of Economics*, 49 (2), 453-477 (Available at: *onlinelibrary.wiley.com/doi/full/10.1111/1756-2171.12231*) (Last accessed Feb. 15, 2022).

The existence of market failures is well supported by the economics literature and by a number of case studies. If DOE developed an efficiency distribution that assigned refrigeration product efficiency in the no-new-standards case solely according to energy use or economic considerations such as life-cycle cost or payback period, the resulting distribution of efficiencies within the household sample would not reflect any of the market failures or behavioral factors above. DOE thus concludes such a distribution would not be representative of the refrigerators, refrigerator-freezers, or freezers markets. Further, even if a specific household is not subject to the market failures above, the purchasing decision of refrigeration product efficiency can be highly complex and influenced by a number of factors not captured by the information available in the RECS samples. These factors can lead to consumers choosing a refrigeration product efficiency that deviates from the efficiency predicted using only energy use or economic considerations such as life-cycle cost or payback period. However, DOE intends to continue to investigate this issue, and it welcomes additional comments as to how it might improve its assignment of appliance efficiency in its analyses.

10. Payback Period Analysis

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

The inputs to the PBP calculation for each efficiency level are the change in total installed cost of the product and the change in the first-year annual operating expenditures relative to the baseline. 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 EL, DOE determined the value of the first year's energy savings by calculating the energy savings in accordance with the applicable DOE test procedure, and multiplying those savings by the average energy price projection for the year in which compliance with the amended standards would be required.

G. Shipments Analysis

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

[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.

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

Total shipments for each product category (*i.e.*, standard-size refrigerators and refrigerator-freezers, standard-size freezers, compact refrigerators and refrigerator-freezers, and compact freezers) are developed by considering the demand from various market segments. For standard-size refrigerators and refrigerator-freezers, DOE considered demand from replacements for units in stock that fail, shipments to new construction, and the demand created by increased saturation into existing households corresponding to the conversion of a primary unit to secondary unit. For all other product categories, DOE considered demand from replacements for units in stock that fail, shipments to new construction, and shipments to first-time owners in existing households. DOE calculated shipments due to replacements using the retirement functions developed for the LCC analysis (see chapter 8 of the NOPR TSD for details). DOE projected shipments to new construction using estimates for new housing starts and the average saturation of each product category in new households. Shipments to first-time owners were estimated by analyzing the increasing penetration of products into existing households in each product category. For standard-size refrigerators and refrigerator-freezers, DOE estimated shipments from increased saturation corresponding to the conversion of a primary unit to a secondary unit utilizing the primary-to-secondary conversion function developed for the LCC analysis.

For the NOPR analysis, DOE incorporated data from stakeholders into the shipments model. Confidential aggregate historical shipments data from 2015-2019 provided by AHAM was used to calibrate the total shipments for standard-size refrigerator-freezers, compact refrigerators, upright freezers, chest freezers, and built-in refrigerator-freezers. Based on data provided by AHAM in response to the November 2019 RFI, DOE assumed that 1.4% of modelled shipments of standard-size refrigerator and refrigerator-freezers shipments were built-in units. DOE also used the market share data provided by NEEA in response to the November 2019 RFI to further disaggregate shipments of standard-size refrigerator-freezers into shipments for top-mount, side-by-side, and bottom-mount product classes.

Chapter 9 in the NOPR TSD provides further information on the shipments analysis.

DOE requests comment on the overall methodology and results of the shipments analysis.

H. National Impact Analysis

The NIA assesses the national energy savings ("NES") and the NPV from a national perspective of total consumer costs and savings that would be expected to result from new or amended standards at specific efficiency levels.[53] ("Consumer" in this context refers to consumers of the product being regulated.) DOE calculates the NES and NPV for the potential standard levels considered based on projections of annual product shipments, along with the annual energy consumption and total installed cost data from the energy use and LCC analyses. For the present analysis, DOE projected the energy

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

savings, operating cost savings, product costs, and NPV of consumer benefits over the lifetime of refrigerators, refrigerator-freezers, and freezers sold from 2027 through 2056.

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

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

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

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

Inputs	Method
Shipments	Annual shipments from shipments model.
Compliance Date of Standard	2027
Efficiency Trends	No trend assumed.
Annual Energy Consumption per Unit	Calculated for each efficiency level based on inputs from energy use analysis.
Total Installed Cost per Unit	Prices for the year of compliance are calculated in the LCC analysis. Prices in subsequent years are calculated incorporating price learning based on historical data.
Annual Energy Cost per Unit	Calculated for each efficiency level using the energy use per unit, and electricity prices and trends
Repair and Maintenance Cost per Unit	Annual repair costs from LCC
Energy Price Trends	*AEO2022* projections to 2050 and fixed at 2050 thereafter.
Energy Site-to-Primary and FFC Conversion	A time-series conversion factor based on *AEO2022*.
Discount Rate	3 percent and 7 percent
Present Year	2022

1. Product Efficiency Trends

A key component of the NIA is the trend in energy efficiency projected for the no-new-standards case and each of the standards cases. Section IV.F.9 of this document describes how DOE developed an energy efficiency distribution for the no-new-standards case (which yields a shipment-weighted average efficiency) for each of the considered product classes for the year of anticipated compliance with an amended or new standard.

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

In the absence of data on trends in efficiency, DOE assumed no efficiency trend over the analysis period for both the no-new-standards and standards cases. For a given case, market shares by efficiency level were held fixed to their 2027 distribution.

DOE requests comment on its assumption of no efficiency trend and seeks historical product efficiency data.

2. National Energy Savings

The NES 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 *AEO 2022*. Cumulative energy savings are the sum of the NES for each year over the timeframe of the analysis.

In this NOPR analysis, DOE analyzed the energy and economic impacts of a potential standard on all product classes in the scope of refrigerators, refrigerator-freezers, and freezers. Non-representative product classes (i.e., those not analyzed in the engineering, energy-use, and LCC analyses) are scaled using results for the analyzed product class that best represents each non-representative product class. For non-representative freestanding product classes, energy use values are scaled by applying the ratio of the current Federal standard baseline between the two product classes at a fixed volume. For non-representative built-in product classes, DOE developed energy scalars using the most similar freestanding representative product class and assumed a 5 percent reduction in the increase in efficiency at each EL relative to the corresponding EL for the freestanding product class. For example, a 10 percent reduction in energy use for PC 3 would correspond to a 5 percent reduction for PC3-BI). DOE assumes the incremental cost between efficiency levels is the same for representative and non-representative product classes. See chapter 10 of the NOPR TSD for more details.

AHAM stated DOE's use of compact product classes 11 and 11A as a proxy for product classes 13 and 13A is inappropriate; classes 11 and 11A are manual defrost products and 13 and 13A are automatic defrost products, meaning they are totally different products and must be treated as such. AHAM stated, therefore, DOE should analyze class 11/11A and 13/13A separately. (AHAM, No. 31, p. 4-5)

DOE agrees that product class 11/11A is not a representative proxy for product class 13/13A. As described in chapter 10 of the October 2021 Preliminary Analysis TSD, DOE used product class 18 as a proxy for product classes 13/13A in the preliminary analysis. In this NOPR, DOE conducted an engineering analysis for product class 17, compact upright freezers with automatic defrost, which shares a similar product architecture with other compact, automatic defrost product classes such as product class 13/13A. Given the similarities, DOE used product class 17 as a proxy for product class 13/13A in this NOPR. DOE also updated its approach to use product class 17 as a proxy for product classes 14 and 15, which, like 13/13A, also use automatic defrost. See chapter 10 of this NOPR TSD for details.

DOE requests comment on assumptions made in the energy use scaling for non-representative product classes in the National Impacts Analysis.

Use of higher-efficiency products 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 refrigerators that would indicate that consumers would alter their utilization of their product as a result of an increase in efficiency. DOE assumed a rebound rate of 0.

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[54] that EIA uses to prepare its AEO. The FFC factors incorporate losses in production and delivery in the case of natural gas (including fugitive emissions) and additional energy used to produce and deliver the various fuels used by power plants. The approach used for deriving FFC measures of energy use and emissions is described in appendix 10B of the NOPR TSD.

[54] For more information on NEMS, refer to *The National Energy Modeling System: An Overview 2018*, DOE/EIA-0581(2018), April 2019. Available at *www.eia.gov/outlooks/aeo/nems/documentation/* (last accessed July 26, 2022).

3. Net Present Value Analysis

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

As discussed in section IV.F.2 of this document, DOE developed refrigerators, refrigerator-freezers, and freezers price trends based on an experience curve calculated using historical PPI data. For efficiency levels with a single-speed compressor, DOE applied a price trend developed using the "household refrigerator and home freezer manufacturing" PPI to the entire cost of the unit. For efficiency levels with a variable-speed compressor, DOE applied a price trend developed from the "semiconductors and related device manufacturing" PPI to the cost associated with the electronics used to control the variable-speed compressor and the same price trend used for single-speed compressor units to the non-controls portion of the cost of the unit. By 2056, which is the end date of the projection period, the average (inflation-adjusted) price of single-speed compressor refrigerators, refrigerator-freezers, and freezers is projected to drop 34 percent and the average price of refrigerators, refrigerator-freezers, and freezers with a variable-speed compressor is projected to drop about 35 percent relative to 2027, the compliance year. DOE's projection of product prices is described in appendix 10C of the NOPR TSD.

To evaluate the effect of uncertainty regarding the price trend estimates, DOE investigated the impact of different product price projections on the consumer NPV for the considered TSLs for refrigerators, refrigerator-freezers, and freezers. In addition to the default price trend, DOE considered high and low-price-decline sensitivity cases. For the single-speed compressor refrigerators, refrigerator-freezers, and freezers and the non-variable-speed controls portion of refrigerators, refrigerator-freezers, and freezers, DOE estimated the high price decline and the low-price-decline scenarios based on household refrigerator and home freezer PPI data limited to the period between the period 1981–2008 and 2009-2021, respectively. For the variable-speed controls portion of refrigerators, refrigerator-freezers, and freezers, DOE estimated the high price decline and the low-price-decline scenarios based on an exponential trend line fit of the semiconductor PPI between the period 1994-2021 and 1967-1993, respectively. The derivation of these price trends and the results of these sensitivity cases are described in appendix 10C of the NOPR TSD.

The operating cost savings are energy cost savings, which are calculated using the estimated energy savings in each year and the projected price of the appropriate form of energy. To estimate energy prices in future years, DOE multiplied the average regional energy prices by the projection of annual national-average residential and commercial energy price changes in the reference case from *AEO 2022*, 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 *AEO 2022* reference case that have lower and higher economic growth. Those cases have lower and higher energy price trends compared to the reference case. NIA results based on these cases are presented in appendix 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.[55] 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.

[55] United States Office of Management and Budget. *Circular A-4: Regulatory Analysis*. September 17, 2003. Section E. Available at *https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/circulars/A4/a-4.pdf* (last accessed January 9, 2023).

For this NOPR, DOE analyzed the impacts of the considered standard levels on low-income households and, for product class 11A, on small businesses. For low-income households, the analysis used a subset of the RECS 2015 sample composed of low-income households. DOE separately analyzed different groups in the low-income household sample using data from RECS on home ownership status and on who pays the electricity bill. Low-income homeowners are analyzed equivalently to how they are analyzed in the standard LCC analysis. Low-income renters who do not pay their electricity bill are assumed to not be impacted by any new or amended standards. In this case, the landlord purchases the appliance and pays its operating costs, so is effectively the consumer and the renter is not impacted. Low-income renters who do pay their electricity bill are assumed to incur no first cost. DOE made this assumption to acknowledge that the vast majority of low-income renters will not pay to have their refrigerator replaced (that would be up to the landlord).

AHAM stated that DOE needs to look separately at the effects on renters, and especially low-income renters. (AHAM, No. 42 at p. 21) As stated previously, DOE has analyzed low-income renters separately from low-income homeowners to account for differences in the responsibility for refrigerator, refrigerator-freezer, and freezer purchase and operating costs for renters versus owners.

DOE notes that RECS 2015 indicates that less than 5 percent of low-income households only have a single compact refrigerator and/or freezer. Because this is the only refrigeration product in the household, DOE assumed that the landlord typically supplies the product. Additionally, RECS 2015 indicates that less than 5 percent of low-income households have a refrigeration product that would be categorized into PC 5, PC

5BI, or PC 5A. As a result, DOE did not do a low-income subgroup analysis on product classes 5, 5BI, 5A, 11A, 17, and 18.

For small businesses, DOE used the same sample from CBECS 2018 that was used in the standard LCC analysis, but used discount rates specific to small businesses. DOE used the LCC and PBP model to estimate the impacts of the considered efficiency levels on these subgroups.

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

DOE requests comment on the overall methodology and results of the consumer subgroup analysis.

In response to the preliminary analysis, AHAM stated that the increase in first cost will disproportionately disadvantage low-income households, and that increased prices due to new or amended standards that eliminate low-price top-mount refrigerators would fall most heavily on low-income households. (AHAM, No. 42 at p. 16) As described in section V.B.1.b of this document, DOE found that low-income households typically have higher LCC savings and lower payback periods when compared to the full consumer sample. This result is due to the fact that most low-income renters are not likely to incur the purchase cost of standards-compliant products, but they would still reap the benefits from savings in energy costs.

J. Manufacturer Impact Analysis

1. Overview

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

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

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

DOE conducted the MIA for this proposed rulemaking in three phases. In Phase 1 of the MIA, DOE prepared a profile of the refrigerator, refrigerator-freezer, and freezer manufacturing industry based on the market and technology assessment and publicly available information. This included a top-down analysis of refrigerator, refrigerator-freezer, and freezer 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 refrigerator, refrigerator-freezer, and freezer manufacturing industry, including company filings of form 10-K from the SEC,[56] corporate annual reports, the U.S. Census Bureau's *Annual Survey of Manufactures ("ASM")*,[57] and reports from Dun & Bradstreet.[58]

In Phase 2 of the MIA, DOE prepared a framework industry cash-flow analysis to quantify the potential impacts of amended energy conservation standards. The GRIM uses several factors to determine a series of annual cash flows starting with the announcement of the standard and extending over a 30-year period following the

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[56] U.S. Securities and Exchange Commission, *Electronic Data Gathering, Analysis, and Retrieval (EDGAR) system.* Available at *www.sec.gov/edgar/search/* (last accessed July 1, 2022).

[57] U.S. Census Bureau, *Annual Survey of Manufactures*. "Summary Statistics for Industry Groups and Industries in the U.S (2020)." Available at: *www.census.gov/data/tables/time-series/econ/asm/2018-2020-asm.html* (Last accessed July 15, 2022).

[58] The Dun & Bradstreet Hoovers login is available at: *app.dnbhoovers.com* (Last accessed July 15, 2022).

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 refrigerators, refrigerator-freezers, and freezers 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 manufacturer subgroups.

In Phase 3 of the MIA, DOE conducted structured, detailed interviews with representative manufacturers. During these interviews, DOE discussed engineering, manufacturing, procurement, and financial topics to validate assumptions used in the GRIM and to identify key issues or concerns. See section IV.J.3 of this document for a description of the key issues raised by manufacturers during the interviews. As part of Phase 3, DOE also evaluated subgroups of manufacturers that may be disproportionately impacted by amended standards or that may not be accurately represented by the average cost assumptions used to develop the industry cash flow analysis. Such manufacturer subgroups may include small business manufacturers, low-volume manufacturers ("LVMs"), niche players, and/or manufacturers exhibiting a cost structure that largely differs from the industry average. DOE identified two subgroups for a separate impact analysis: small business manufacturers and domestic LVMs. The small business subgroup is discussed in section VI.B, "Review under the Regulatory Flexibility Act" and in chapter 12 of the NOPR TSD. The domestic LVM subgroup is discussed in section V.B.2.d and in chapter 12 of the NOPR TSD.

2. Government Regulatory Impact Model and Key Inputs

DOE uses the GRIM to quantify the changes in cash flow due to amended standards that result in a higher or lower industry value. The GRIM uses a standard, annual discounted cash-flow analysis that incorporates manufacturer costs, manufacturer markups, shipments, and industry financial information as inputs. The GRIM models changes in costs, distribution of shipments, investments, and manufacturer margins that could result from an amended energy conservation standard. The GRIM spreadsheet uses the inputs to arrive at a series of annual cash flows, beginning in 2023 (the NOPR publication year) and continuing to 2056. DOE calculated INPVs by summing the stream of annual discounted cash flows during this period. For manufacturers of refrigerators, refrigerator-freezers, and freezers, DOE used a real discount rate of 9.1 percent, which was derived from industry financials and then modified according to feedback received during manufacturer interviews.

The GRIM calculates cash flows using standard accounting principles and compares changes in INPV between the no-new-standards case and each standards case. The difference in INPV between the no-new-standards case and a standards case represents the financial impact of the amended energy conservation standard on manufacturers. As discussed previously, DOE developed critical GRIM inputs using a number of sources, including publicly available data, results of the engineering analysis and shipments analysis, and information gathered from industry stakeholders during the course of manufacturer interviews. The GRIM results are presented in section V.B.2 of this document. Additional details about the GRIM, the discount rate, and other financial parameters can be found in chapter 12 of the NOPR TSD.

a. Manufacturer Production Costs

Manufacturing more efficient equipment is typically more expensive than manufacturing baseline equipment due to the use of more complex components, which are typically more costly than baseline components. The changes in the MPCs of covered products can affect the revenues, gross margins, and cash flow of the industry. For a complete description of the MPCs, see chapter 5 of the NOPR TSD or section IV.C of this document.

b. Shipments Projections

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

c. Product and Capital Conversion Costs

Amended energy conservation standards could cause manufacturers to incur conversion costs to bring their production facilities and equipment designs into compliance. DOE evaluated the level of conversion-related expenditures that would be needed to comply with each considered efficiency level in each product class. For the MIA, DOE classified these conversion costs into two major groups: (1) product conversion costs; and (2) capital conversion costs. Product conversion costs are investments in research, development, testing, marketing, and other non-capitalized costs necessary to make product designs comply with amended energy conservation standards. Capital conversion costs are investments in property, plant, and equipment necessary to adapt or change existing production facilities such that new compliant product designs can be fabricated and assembled.

Product Conversion Costs

DOE based its estimates of the product conversion costs necessary to meet the varying efficiency levels on information from manufacturer interviews, the design paths analyzed in the engineering analysis, and market share and model count information. Generally, manufacturers preferred to meet amended standards with design options that were direct and relatively straight-forward component swaps, such as incrementally more efficiency compressors. However, at higher efficiency levels, manufacturers anticipated the need for platform redesigns. Efficiency levels that significantly altered cabinet construction would require very large investments to update designs. Manufacturers noted that increasing foam thickness would require complete redesign of the cabinet, and potentially, the liner and shelving, should there be changes in interior volume. Additionally, extensive use of VIPs would require redesign of the cabinet to maximize the benefits of VIPs.

Based on manufacturer feedback, DOE also estimated "re-flooring" costs associated with replacing obsolete display models in big-box stores (*e.g.,* Lowe's, Home

Depot, Best Buy) due to more stringent standards. Some manufacturers stated that with a new product release, big-box retailers discount outdated display models, and manufacturers share any losses associated with discounting the retail price. The estimated re-flooring costs for each efficiency level were incorporated into the product conversion cost estimates, as DOE modeled the re-flooring costs as a marketing expense. Manufacturer data was aggregated to protect confidential information.

DOE interviewed manufacturers accounting for approximately 81 percent of domestic refrigerator, refrigerator-freezer, and freezer shipments. DOE scaled product conversion costs by model counts to account for the portion of companies that were not interviewed. In manufacturer interviews, DOE received feedback on the analyzed product classes. For non-represented product classes, for which there was less available data, DOE used model counts to scale the product conversion cost estimates for analyzed product classes. See chapter 10 of the NOPR TSD for details on the mapping of analyzed product classes to non-represented product classes. See chapter 12 of the NOPR TSD for details on product conversion costs.

Capital Conversion Costs

DOE relied on information derived from manufacturer interviews and the engineering analysis to evaluate the level of capital conversion costs manufacturers would likely incur at the considered standard levels. During the interviews, manufacturers provided estimates and descriptions of the required tooling and plant changes that would be necessary to upgrade product lines to meet potential efficiency levels. Based on these inputs, DOE modeled incremental capital conversion costs for efficiency levels that could be reached with individual components swaps. However, based on feedback, DOE modeled major capital conversion costs when manufacturers would have to redesign their existing product platforms. DOE used information from manufacturer interviews to determine the cost of the manufacturing equipment and tooling necessary to implement complete redesigns.

Increases in foam thickness require either reductions to interior volume or increases to exterior volume. Since most refrigerators, refrigerator-freezers, and freezers must fit standard widths, increases in foam thickness could result in the loss of interior volume. The reduction of interior volume has significant consequences for manufacturing. In addition to redesigning the cabinet to increase the effectiveness of insulation, manufacturers must update all designs and tooling associated with the interior of the product. This could include the liner, shelving, drawers, and doors. Manufacturers would need to invest in significant new tooling to accommodate the changes in dimensions.

To minimize reductions to interior volume, manufacturers may choose to adopt VIP technology. Extensive incorporation of VIPs into designs require significant upfront capital due to differences in the handling, storing, and manufacturing of VIPs as compared to typical polyurethane foams. VIPs are relatively fragile and must be protected from punctures and rough handling. If VIPs have leaks of any size, the panel will eventually lose much of its thermal insulative properties and structural strength. If already installed within a cabinet wall, a punctured VIP may significantly reduce the structural strength of the refrigerator, refrigerator-freezer, or freezer cabinet. As a result, VIPs require cautious handling during the manufacturing process. Manufacturers noted the need to allocate special warehouse space in order to ensure the VIPs are not jostled or roughly handled in the manufacturing environment. Furthermore, manufacturers anticipated the need for expansion of warehouse space to accommodate the storage of VIPs. VIP panels require significantly more warehouse space than the polyurethane foams currently used in most refrigerators, refrigerator-freezers, and freezers. The application of VIPs can be challenging and requires significant investment in hard-tooling or robotic systems to ensure the panels are positioned properly within the cabinet or door. Manufacturers noted that producing cabinets with VIPs are much more labor and time intensive than producing cabinets with typical polyurethane foams. Particularly in high volume factories, which can produce over a million refrigerator-freezers per year, the increase in production time associated in increased VIP usage would necessitate additional investment in manufacturing capacity to meet demand. The cost of extending production lines varies greatly by manufacturer, as it depends heavily on floor space availability in and around existing manufacturing plants.

Higher volume manufacturers would generally have higher investments as they have more production lines and greater production capacity. For manufacturers of both PC 5 (“refrigerator-freezer—automatic defrost with bottom-mounted freezer without an automatic ice maker”) and PC 5A (“refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service”), cabinet changes in one product class would likely necessitate improvements in the other product class as they often share the same architecture, tooling and production lines.

DOE estimated industry capital conversion costs by extrapolating the interviewed manufacturers' capital conversion costs for each product class to account for the market share of companies that were not interviewed. DOE used the shipments analysis to scale the capital conversion cost estimates of the analyzed product class to account for the non-represented product class. See chapter 12 of the NOPR TSD for additional details on capital conversion costs.

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

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

d. Manufacturer Markup Scenarios

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

Under the preservation of gross margin percentage scenario, DOE applied a single uniform "gross margin percentage" markup across all efficiency levels, which assumes that manufacturers would be able to maintain the same amount of profit as a percentage of revenues at all efficiency levels within a product class. As manufacturer production costs increase with efficiency, this scenario implies that the per-unit dollar profit will increase. DOE assumed a gross margin percentage of 21 percent for all freestanding product classes and 29 percent for all built-in product classes.[59] Manufacturers tend to believe it is optimistic to assume that they would be able to maintain the same gross

[59] The gross margin percentages of 21 percent and 29 percent are based on manufacturer markups of 1.26 and 1.40 percent, respectively.

margin percentage as their production costs increase, particularly for minimally efficient products. Therefore, this scenario represents a high bound of industry profitability under an amended energy conservation standard.

In the preservation of operating profit scenario, as the cost of production goes up under a standards case, manufacturers are generally required to reduce their manufacturer markups to a level that maintains base-case operating profit. DOE implemented this scenario in the GRIM by lowering the manufacturer markups at each TSL to yield approximately the same earnings before interest and taxes in the standards case as in the no-new-standards case in the year after the expected compliance date of the amended standards. The implicit assumption behind this scenario is that the industry can only maintain its operating profit in absolute dollars after the standard takes effect.

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

3. Manufacturer Interviews

DOE interviewed manufacturers representing approximately 81 percent of domestic refrigerator, refrigerator-freezer, and freezer shipments. Participants included domestic-based and foreign-based original equipment manufacturers ("OEMs") as well as importers. Participants included manufacturers with a wide range of market shares and a variety of product class offerings.

In interviews, DOE asked manufacturers to describe their major concerns regarding potential more stringent energy conservation standards for refrigerators, refrigerator-freezers, and freezers. The following section highlights manufacturer concerns that helped inform the projected potential impacts of an amended standard on the industry. Manufacturer interviews are conducted under nondisclosure agreements ("NDAs"), so DOE does not document these discussions in the same way that it does public comments in the comment summaries and DOE's responses throughout the rest of this document.

a. Specialty Doors and Multiple Door Designs

Some manufacturers recommended DOE consider specialty door and multi-door designs in the NOPR analysis by creating new product classes or allowances for the additional energy consumption associated with implementing these features. These manufacturers stated that their market research indicates that multi-door, door-in-door, and transparent door designs provide utility to the consumer. For instance, manufacturers stated that multi-door configurations allow for the added climate control options, which can aid better food preservation. For transparent doors, manufacturers noted that some consumers enjoy the aesthetics as well as the ability to view the contents of the refrigerator without opening the door. These manufacturers asserted that the increasing prevalence of alternative door designs further supports that these features provide added value to consumers. Some manufacturers expressed concern that more stringent standards would limit their ability to offer these consumer features. These manufacturers stated that they currently must pair alternative door designs with high-efficiency technology options, such as variable-speed compressors and VIPs, just to meet the current DOE baseline. Manufacturers noted that more stringent standards would be particularly problematic for freestanding and built-in versions of both bottom-mount (French door) and side-by-side configurations. Some manufacturers also noted that high-end compact refrigerators, which are typically fully integrated into kitchen cabinetry (sometimes referred to as "undercounter" refrigerators) have transparent door designs.

b. Viability of Low-Cost Standard-Size Refrigerator-Freezers

Several manufacturers stated that adopting more stringent standards for certain product classes would increase upfront costs and negatively impact low-income consumers. These manufacturers had concerns about more stringent standards for standard-size top-mount refrigerator-freezers (product class 3). Manufacturers stated that top-mounts are typically the most affordable standard-size refrigerator-freezer option, and as a result, are often purchased by cost-conscious consumers. Specifically, manufacturers noted that efficiency levels requiring the use of variable-speed compressors or VIPs would make maintaining a range of entry-level price points very challenging. These manufacturers suggested that the higher upfront cost could impact consumers' purchasing decisions. For example, in lieu of purchasing a new refrigerator-freezer, consumers may opt to repair their existing standard-size refrigerator-freezer, turn to the pre-owned market, participate in a rent-to-own program, or purchase multiple compact refrigerator-freezer models. Multiple manufacturers supported including a 5-percent "gap fill" efficiency level for standard-size top-mount products, which would require minimal redesign effort.

c. Built-in Product Classes

Some manufacturers urged DOE to conduct a separate analysis for built-in product classes. These manufacturers asserted that built-in products face design constraints related to standardized installation dimensions and restricted airflow. These manufacturers stated that because of these differences, freestanding products cannot be used as proxies for built-in products. Some manufacturers also noted that built-in products appeal to a niche consumer segment and have notably different price points compared to their freestanding counterparts.

d. Supply Chain Constraints

In interviews, some manufacturers expressed concerns about the ongoing supply chain constraints related to sourcing high-quality components (*e.g*., variable-speed compressors, VIPs), microprocessors and electronics, and hydrofluoro-olefin ("HFO") foam. More stringent standards, particularly at TSLs requiring a large-scale implementation of variable-speed compressors, would require that industry source more high-efficiency compressors and electronic components, which are already difficult to secure. As standards get more stringent, some manufacturers also indicated they would try to source higher-performance foam for insulation, which would increase demand for certain blowing agents. If these supply constraints continue through the end of the conversion period, industry could face production capacity constraints.

4. Discussion of MIA Comments

In response to the October 2021 Preliminary Analysis, Sub-Zero detailed some of the challenges they face as a smaller manufacturer of major appliances. Sub-Zero noted that they offer a wide range of products in order to compete and match product offerings of larger, global appliance companies. Sub-Zero further noted that the redesign effort required to meet more stringent standards does not scale with production volumes. As a result, smaller manufacturers with lower staffing levels must work almost exclusively on redesigning products to meet amended standards, which impedes their ability to design products to meet other consumer requirements. (Sub-Zero, No. 34 at p. 2)

DOE understands that the level of effort required to redesign a model is independent of production volume. DOE's product conversion cost estimates reflect this feedback, which are based on aggregated manufacturer feedback from confidential interviews and unique basic model listings. Furthermore, DOE explores impacts of potential amended standards on the domestic LVM subgroup in section V.B.2.d of this document.

Sub-Zero noted that regulations restricting the use of certain refrigerants and blowing agents necessitated significant capital investment to update manufacturing equipment and production facilities for refrigerators, freezers, and miscellaneous refrigeration products. The commenter stated the timing of different regulations increased the burden. (Sub-Zero, No. 34 at pp. 2-3)

In NOPR interviews, most manufacturers stated that they have transitioned their consumer refrigeration products to make use of alternative refrigerants (*e.g.*, R-600a) and low-global warming potential ("GWP") blowing agents (*e.g.,* HFO or cyclopentane), in accordance with regulations enacted by states.[60] However, some manufacturers of built-in products noted that they are still in the process of transitioning their products to make use of alternative refrigerants, namely R-600a. These manufacturers stated that they aim

[60] Shortly after the D.C. Circuit partially vacated the SNAP Rule 20 (see *Mexichem Fluor, Inc. v. EPA*, 866 F.3d 451, 464 (D.C. Cir. 2017)), the same court issued a similar partial vacatur for portions of the SNAP Rule 21. See *Mexichem Fluor, Inc. v. EPA*, 760 Fed. Appx. 6 (Mem) (per curiam) (D.C. Cir. 2019). In lieu of a national ban on HFC refrigerants, the California Air Resources Board (CARB) adopted an agency regulation for new refrigeration equipment that implemented the majority of the HFC prohibitions in SNAP Rules 20 and 21. Several states have since also adopted SNAP-like prohibitions for certain substances in refrigeration and foam end-uses.

to complete the transition by January 1, 2023, due to State regulations restricting the use of high-GWP refrigerants in built-in products.[61]

As described in section IV.J.2.c of this document, DOE expects that 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. DOE estimates issuance of a final rule by the end of 2023. Therefore, for purposes of its analysis, DOE used 2027 as the first year of compliance with any amended standards for refrigerators, refrigerator-freezers, and freezers. Therefore, DOE expects that industry would have fully transitioned the products covered by this proposed rulemaking to make use of R-600a prior to any publication of a final rule. See section IV.A.2 for additional details on how DOE considered the treatment of R-600a as a design option in the NOPR analysis.

Regarding the timing of this energy conservation rulemakings, DOE has statutory requirements under EPCA. For refrigerators, refrigerator-freezers, and freezers, EPCA requires that not later than 6 years after issuance of any final rule establishing or amending a standard, DOE must publish either a notice of determination that standards for the product do not need to be amended, or a notice of proposed rulemaking including new proposed energy conservation standards (proceeding to a final rule, as appropriate). (42 U.S.C. 6295(m))

[61] California adopted regulations prohibiting the use of certain substances in refrigeration and foam end-uses. Specifically, California, among other states, will prohibit the use of certain refrigerants in built-in residential consumer refrigeration products as of January 1, 2023. *See* California Code of Regulations, Title 17, Division 3, Chapter 1, Subchapter 10 Climate Change, Article 4, under Section 95374 Table 2. Available at: *ww2.arb.ca.gov/sites/default/files/barcu/regact/2020/hfc2020/frorevised.pdf*.

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).[62]

FFC upstream emissions, which include emissions from fuel combustion during extraction, processing, and transportation of fuels, and "fugitive" emissions (direct

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

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 NIA.

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.[63]

SO_2 emissions from affected electric generating units ("EGUs") are subject to nationwide and regional emissions cap-and-trade programs. Title IV of the Clean Air Act sets an annual emissions cap on SO_2 for affected EGUs in the 48 contiguous States and the District of Columbia (D.C.). (42 U.S.C. 7651 *et seq.*) SO_2 emissions from numerous states in the eastern half of the United States are also limited under the Cross-State Air Pollution Rule ("CSAPR"). 76 FR 48208 (Aug. 8, 2011). CSAPR requires these states

[63] 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 22, 2022).

to reduce certain emissions, including annual SO_2 emissions, and went into effect as of January 1, 2015.[64] *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

[64] 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).

emissions, also reduce SO_2 emissions. Because of the emissions reductions under the MATS, it is unlikely that excess SO_2 emissions allowances resulting from the lower electricity demand would be needed or used to permit offsetting increases in SO_2 emissions by another regulated EGU. Therefore, energy conservation standards that decrease electricity generation would generally reduce SO_2 emissions. DOE estimated SO_2 emissions reduction using emissions factors based on *AEO2022.*

CSAPR also established limits on NO_X emissions for numerous states in the eastern half of the United States. Energy conservation standards would have little effect on NO_X emissions in those states covered by CSAPR emissions limits if excess NO_X emissions allowances resulting from the lower electricity demand could be used to permit offsetting increases in NO_X emissions from other EGUs. In such case, NOx emissions would remain near the limit even if electricity generation goes down. A different case could possibly result, depending on the configuration of the power sector in the different regions and the need for allowances, such that NO_X emissions might not remain at the limit in the case of lower electricity demand. In this case, energy conservation standards might reduce NOx emissions in covered states. Despite this possibility, DOE has chosen to be conservative in its analysis and has maintained the assumption that standards will not reduce NO_X emissions in states covered by CSAPR. Energy conservation standards would be expected to reduce NO_X emissions in the states not covered by CSAPR. DOE used *AEO2022* data to derive NO_X emissions factors for the group of states not covered by CSAPR.

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

L. Monetizing Emissions Impacts

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

On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22-30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana v. Biden*, No. 21-cv-1074-JDC-KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from "adopting, employing, treating as binding, or relying upon" the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. As reflected in this proposed rule, DOE has reverted to its approach prior to the injunction and presents monetized greenhouse gas abatement 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 exercises its own judgment in presenting monetized climate benefits as recommended by applicable executive orders and DOE would reach the same conclusion presented in this proposed rulemaking in the absence of the social cost of greenhouse gases, including the February 2021 Interim Estimates presented by the Interagency Working Group on the Social Cost of Greenhouse Gases. DOE estimated the global social benefits of CO_2, CH_4, and N_2O reductions (i.e., SC-GHGs) using the estimates presented in the Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990, published in February 2021 by the IWG. The SC-GHGs is the monetary value of the net harm to society associated with a marginal increase in emissions in a given year, or the benefit of avoiding that increase. In principle, SC-GHGs includes the value of all climate change impacts, including (but not limited to) changes in net agricultural productivity, human health effects, property damage from increased flood risk and natural disasters, disruption of energy systems, risk of conflict, environmental migration, and the value of ecosystem services. The SC-GHGs therefore, reflects the societal value of reducing emissions of the gas in question by one metric ton. The SC-GHGs is the theoretically appropriate value to use in conducting benefit-cost analyses of policies that affect CO_2, N_2O, and CH_4 emissions. As a member of the IWG involved in the development of the February 2021 SC-GHG TSD, DOE agrees that the interim SC-GHG estimates represent the most appropriate estimate of the SC-GHG until revised estimates have been developed reflecting the latest, peer reviewed science.

The SC-GHGs estimates presented here were developed over many years, using transparent process, peer reviewed methodologies, the best science available at the time of that process, and with input from the public. Specifically, in 2009, the IWG, that included the DOE and other executive branch agencies and offices was established to ensure that agencies were using the best available science and to promote consistency in the social cost of carbon (SC-CO_2) values used across agencies. The IWG published SC-CO_2 estimates in 2010 that were developed from an ensemble of three widely cited integrated assessment models (IAMs) that estimate global climate damages using highly aggregated representations of climate processes and the global economy combined into a single modeling framework. The three IAMs were run using a common set of input assumptions in each model for future population, economic, and CO_2 emissions growth, as well as equilibrium climate sensitivity – a measure of the globally averaged temperature response to increased atmospheric CO_2 concentrations. These estimates were updated in 2013 based on new versions of each IAM. In August 2016 the IWG published estimates of the social cost of methane (SC-CH_4) and nitrous oxide (SC-N_2O) using methodologies that are consistent with the methodology underlying the SC-CO_2 estimates. The modeling approach that extends the IWG SC-CO_2 methodology to non-CO_2 GHGs has undergone multiple stages of peer review. The SC-CH_4 and SC-N_2O estimates were developed by Marten *et al.*[65] 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

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

to various components of the estimation process (National Academies, 2017).[66] Shortly thereafter, in March 2017, President Trump issued Executive Order 13783, which disbanded the IWG, withdrew the previous TSDs, and directed agencies to ensure SC-CO_2 estimates used in regulatory analyses are consistent with the guidance contained in OMB's Circular A-4, "including with respect to the consideration of domestic versus international impacts and the consideration of appropriate discount rates" (Executive Order ("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

[66] 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.

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,[67] 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

[67] 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.*

Response to Comments on the Social Cost of Carbon for Regulatory Impact Analysis, OMB, DOE, and the other IWG members recognized that "Circular A-4 is a living document" and "the use of 7 percent is not considered appropriate for intergenerational discounting. There is wide support for this view in the academic literature, and it is recognized in Circular A-4 itself." Thus, DOE concludes that a 7 percent discount rate is not appropriate to apply to value the social cost of greenhouse gases in the analysis presented in this analysis. 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.[68] 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 IAMs, 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.

[68] 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/*.

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.[69]

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
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

[69] 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.

For 2051 to 2070, DOE used SC-CO2 estimates published by EPA, adjusted to 2020$. 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 refrigerators, refrigerator-freezers, and freezers after 2070, but a lack of available SC-CO_2 estimates for emissions years beyond 2070 prevents DOE from monetizing these potential benefits in this analysis.

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

b. Social Cost of Methane and Nitrous Oxide

The SC-CH_4 and SC- N_2O values used for this NOPR were based on the values developed for the February 2021 TSD. Table IV.16IV. 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. DOE adjusted the values to 2021$ using the implicit price deflator for gross domestic product ("GDP") from the Bureau of Economic Analysis. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the cases using the specific discount rate that had been used to obtain the SC-CH_4 and SC-N_2O estimates in each case.

2. Monetization of Other Emissions Impacts

For the NOPR, DOE estimated the monetized value of NO_X and SO_2 emissions reductions from electricity generation using the latest benefit-per-ton estimates for that sector from the EPA's Benefits Mapping and Analysis Program.[70] DOE used EPA's values for PM2.5-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

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

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

The output of this analysis is a set of time-dependent coefficients that capture the change in electricity generation, primary fuel consumption, installed capacity and power sector emissions due to a unit reduction in demand for a given end use. These coefficients are multiplied by the stream of electricity savings calculated in the NIA to 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.[71] 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").[72] 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.

[71] *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 July 26, 2022).
[72] Livingston, O. V., S. R. Bender, M. J. Scott, and R. W. Schultz. *ImSET 4.0: Impact of Sector Energy Technologies Model Description and User Guide*. 2015. Pacific Northwest National Laboratory: Richland, WA. PNNL-24563.

DOE notes that ImSET is not a general equilibrium forecasting model, and that the uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Because ImSET does not incorporate price changes, the employment effects predicted by ImSET may overestimate actual job impacts over the long run for this rule. Therefore, DOE used ImSET only to generate results for near-term timeframes (2027-2031), where these uncertainties are reduced. For more details on the employment impact analysis, see chapter 16 of the NOPR TSD.

V. Analytical Results and Conclusions

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

A. Trial Standard Levels

In general, DOE typically evaluates potential amended standards for products and equipment by grouping individual efficiency levels for each class into TSLs. Use of TSLs allows DOE to identify and consider manufacturer cost interactions between the product classes, to the extent that there are such interactions, and market cross elasticity from consumer purchasing decisions that may change when different standard levels are set.

In the analysis conducted for this NOPR, DOE analyzed the benefits and burdens of six TSLs for refrigerators, refrigerator-freezers, and freezers. DOE developed TSLs that combine efficiency levels for each analyzed product class. These TSLs were developed by combining specific efficiency levels for each of the refrigerator, refrigerator-freezer, and freezer product classes analyzed by DOE. TSL 1 represents a modest increase in efficiency, corresponding to the lowest analyzed efficiency level above the baseline for each analyzed product class. TSL 2 represents an increase in efficiency of 10% across the product classes analyzed, consistent with ENERGY STAR® requirements, except for product class 10, for which a majority of consumers would experience a net cost at all considered ELs. Efficiency improvements for product class 10 were considered only for TSL 1 and max-tech TSL 6. TSL 3 increases the stringency for product classes 5, 5A, 7, 11A, and 18 and increases NES while keeping economic impacts on consumers relatively modest. TSL 4 increases the proposed standard level for product classes 3 and 5A, as well as the expected NES, while average LCC savings are positive for every product class. TSL 5 increases the proposed standard level for product class 7, as well as the expected NES, while average LCC savings remain positive for every product class. TSL 6 represents max-tech. DOE presents the results for the TSLs in this document, while the results for all efficiency levels that DOE analyzed are in the NOPR TSD.

Table V.1 presents the TSLs and the corresponding efficiency levels that DOE has identified for potential amended energy conservation standards for refrigerators, refrigerator-freezers, and freezers.

Table V.1 Trial Standard Levels for Refrigerators, Refrigerator-Freezers, and Freezers

	PC 3	PC 5	PC 5 -BI	PC 5A	PC 7	PC 9	PC 10	PC 11A	PC 17	PC 18
TSL 1	EL 1	EL 1	EL 1	EL 1	EL 1	EL 1	EL 1	EL 1	EL 1	EL 1
TSL 2	EL 2	EL 1	EL 1	EL 1	EL 2	EL 1	EL 0*	EL 1	EL 1	EL 1
TSL 3	EL 2	EL 2	EL 1	EL 2	EL 3	EL 1	EL 0*	EL 2	EL 1	EL 2
TSL 4	EL 3	EL 2	EL 1	EL 3	EL 3	EL 1	EL 0*	EL 2	EL 1	EL 2
TSL 5	EL 3	EL 2	EL 1	EL 3	EL 4	EL 1	EL 0*	EL 2	EL 1	EL 2
TSL 6	EL 5	EL 4	EL 3	EL 3	EL 5	EL 4	EL 4	EL 4	EL 3	EL 4

* DOE did not consider efficiency levels above baseline for PC 10 for TSLs 2-5.

Table V.2 shows the design options determined to be required for representative products of each analyzed class as a function of the TSLs.

Table V.2 Design Options Added as Compared to Baseline by Trial Standard Levels

Product Class	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
PC 3	Higher-EER Compressor	Variable Defrost; Higher-EER Compressor		Variable-speed compressor system		VIP side walls and doors
PC 5	BLDC Evaporator Fan Motor; Variable-speed compressor system or higher-efficiency compressor		Highest-EER Variable-speed Compressor; some use of VIPs			VIP side walls and doors
PC 5-BI	Variable-speed compressor system; 43% of Max-tech VIP					VIP side walls and doors
PC 5A	Variable-speed compressor system		Highest-EER Variable-speed Compressor; 42% of Max-tech VIP	VIP side walls and doors		
PC 7	Highest-EER Compressor	BLDC Evaporator Fan Motor; Variable-speed compressor system	38% of Max-tech VIP		Highest-EER Variable-speed Compressor; 75% of Max-tech VIP	VIP side walls and doors
PC 9	Highest-EER Compressor; Switch to forced-convection condenser; BLDC fans					VIP side walls and door; Highest-EER Variable-speed compressor system
PC 10	Variable-speed compressor system	N/A				Wall thickness increase; VIP door; Variable-speed compressor system
PC 11A	Higher-EER Compressor		Wall thickness increase			Variable Speed Compressor System; VIP side walls and door
PC 17	Highest-EER Variable Speed Compressor System; Variable Defrost					VIP side walls and door panels
PC 18	Higher-EER Compressor; Variable Defrost		Wall thickness increase			Variable Speed Compressor System; VIP door

Note: Design options are cumulative (*i.e.* added as TSL's increase), except for PC 10, for which the efficiency level is baseline for TSL's 2 through 5.

B. Economic Justification and Energy Savings

1. Economic Impacts on Individual Consumers

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

a. Life-Cycle Cost and Payback Period

In general, higher-efficiency products affect consumers in two ways: (1) purchase price increases and (2) annual operating costs decrease. Inputs used for calculating the LCC and PBP include total installed costs and operating costs (*i.e.*, annual energy use, energy prices, energy price trends, and repair 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.3 through Table V.22 show the LCC and PBP results for the TSLs considered for each product class. In the first of each pair of tables, the simple payback is measured relative to the baseline product. In the second table, impacts are measured relative to the efficiency distribution in the no-new-standards case in the compliance year (see section IV.F.9 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.3 Average LCC and PBP Results for Product Class 3

TSL	Efficiency Level	Average Costs *2021$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	919.87	66.62	934.76	1,854.63	--	14.8
1	1	924.28	63.47	899.27	1,823.55	1.4	14.8
2-3	2	945.28	60.33	866.82	1,812.10	4.0	14.8
4-5	3	969.73	57.18	835.00	1,804.74	5.3	14.8
--	4	1,017.85	54.04	807.53	1,825.38	7.8	14.8
6	5	1,071.89	49.13	760.78	1,832.67	8.7	14.8

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

Table V.4 Average LCC Savings Relative to the No-New-Standards Case for Product Class 3

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2021$*	Percent of Consumers that Experience Net Cost
1	1	32.16	2.2
2-3	2	42.18	10.8
4-5	3	36.04	36.2
--	4	15.40	59.7
6	5	8.09	63.6

* The savings represent the average LCC for affected consumers.

Table V.5 Average LCC and PBP Results for Product Class 5

TSL	Efficiency Level	Average Costs *2021$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	1,347.67	103.18	1,449.02	2,796.70	--	14.8
1-2	1	1,379.42	95.90	1,370.03	2,749.46	4.4	14.8
3-5	2	1,403.48	91.60	1,324.36	2,727.83	4.8	14.8
--	3	1,458.23	87.29	1,284.39	2,742.62	7.0	14.8
6	4	1,485.38	85.31	1,266.25	2,751.63	7.7	14.8

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

Table V.6 Average LCC Savings Relative to the No-New-Standards Case for Product Class 5

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2021$*	Percent of Consumers that Experience Net Cost
1-2	1	47.15	8.9
3-5	2	49.73	23.4
--	3	28.47	52.2
6	4	19.14	58.3

* The savings represent the average LCC for affected consumers.

Table V.7 Average LCC and PBP Results for Product Class 5BI

TSL	Efficiency Level	Average Costs *2021$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	1,775.38	106.96	1,572.50	3,347.88	--	14.8
1-5	1	1,822.41	98.71	1,485.14	3,307.54	5.7	14.8
--	2	1,873.04	93.56	1,434.47	3,307.52	7.3	14.8
6	3	1,880.13	92.53	1,423.78	3,303.91	7.3	14.8

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

Table V.8 Average LCC Savings Relative to the No-New-Standards Case for Product Class 5BI

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2021$*	Percent of Consumers that Experience Net Cost
1-5	1	39.94	10.1
--	2	15.40	45.4
6	3	18.97	43.9

* The savings represent the average LCC for affected consumers.

Table V.9 Average LCC and PBP Results for Product Class 5A

TSL	Efficiency Level	Average Costs *2021$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	1,533.04	122.16	1,704.73	3,237.77	--	14.8
1-2	1	1,557.91	109.72	1,564.48	3,122.39	2.0	14.8
3	2	1,610.23	103.62	1,503.13	3,113.37	4.2	14.8
4-6	3	1,675.39	97.40	1,442.83	3,118.22	5.7	14.8

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

Table V.10 Average LCC Savings Relative to the No-New-Standards Case for Product Class 5A

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2021$*	Percent of Consumers that Experience Net Cost
1-2	1	115.32	1.0
3	2	121.98	16.6
4-6	3	115.76	33.2

* The savings represent the average LCC for affected consumers.

Table V.11 Average LCC and PBP Results for Product Class 7

TSL	Efficiency Level	Average Costs <u>*2021$*</u>				Simple Payback <u>*years*</u>	Average Lifetime <u>*years*</u>
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	1,324.08	106.37	1,464.94	2,789.02	--	14.8
1	1	1,327.60	101.34	1,407.81	2,735.42	0.7	14.8
2	2	1,350.17	96.31	1,354.21	2,704.37	2.6	14.8
3-4	3	1,382.07	91.28	1,302.32	2,684.40	3.8	14.8
5	4	1,424.36	86.25	1,252.36	2,676.72	5.0	14.8
6	5	1,449.23	84.24	1,233.84	2,683.07	5.7	14.8

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

Table V.12 Average LCC Savings Relative to the No-New-Standards Case for Product Class 7

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2021$*	Percent of Consumers that Experience Net Cost
1	1	53.56	0.0
2	2	78.56	5.1
3-4	3	95.26	15.8
5	4	101.33	28.5
6	5	94.68	35.7

* The savings represent the average LCC for affected consumers.

Table V.13 Average LCC and PBP Results for Product Class 9

TSL	Efficiency Level	Average Costs *2021$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	976.09	70.94	1,148.82	2,124.90	--	20.6
1-5	1	1,002.24	64.25	1,052.68	2,054.91	3.9	20.6
--	2	1,044.75	60.90	1,007.73	2,052.48	6.8	20.6
--	3	1,081.93	57.56	962.22	2,044.15	7.9	20.6
6	4	1,126.10	54.21	917.45	2,043.56	9.0	20.6

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.14 Average LCC Savings Relative to the No-New-Standards Case for Product Class 9

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2021$*	Percent of Consumers that Experience Net Cost
1-5	1	69.26	10.5
--	2	55.78	40.7
--	3	63.68	45.6
6	4	63.71	51.1

* The savings represent the average LCC for affected consumers.

Table V.15 Average LCC and PBP Results for Product Class 10

TSL	Efficiency Level	Average Costs *2021$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	1,030.90	41.71	714.28	1,745.18	--	20.6
1	1	1,071.75	37.89	663.11	1,734.85	10.7	20.6
--	2	1,109.39	35.98	639.34	1,748.73	13.7	20.6
--	3	1,112.40	34.07	611.91	1,724.32	10.7	20.6
6	4	1,148.80	29.86	554.72	1,703.51	10.0	20.6

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.16 Average LCC Savings Relative to the No-New-Standards Case for Product Class 10

TSL	Efficiency Level	Life-Cycle Cost Savings: Average LCC Savings* 2021$	Life-Cycle Cost Savings: Percent of Consumers that Experience Net Cost
1	1	10.20	52.7
--	2	-4.30	68.5
--	3	20.11	55.8
6	4	40.91	52.1

* The savings represent the average LCC for affected consumers.

Table V.17 Average LCC and PBP Results for Product Class 11A

TSL	Efficiency Level	Average Costs 2021$: Installed Cost	Average Costs 2021$: First Year's Operating Cost	Average Costs 2021$: Lifetime Operating Cost	Average Costs 2021$: LCC	Simple Payback *years*	Average Lifetime *years*
Residential							
--	Baseline	354.75	35.30	255.84	610.59	--	7.7
1-2	1	361.59	31.95	233.59	595.18	2.0	7.7
3-5	2	365.13	30.27	222.50	587.62	2.1	7.7
--	3	394.05	28.59	212.60	606.65	5.9	7.7
6	4	413.92	24.74	187.62	601.54	5.6	7.7
Commercial							
--	Baseline	354.64	25.05	165.33	519.97	--	7.7
1-2	1	361.48	22.90	152.77	514.25	3.2	7.7
3-5	2	365.01	21.82	146.51	511.53	3.2	7.7
--	3	393.93	20.74	141.33	535.26	9.1	7.7
6	4	413.79	18.26	127.42	541.21	8.7	7.7

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

Table V.18 Average LCC Savings Relative to the No-New-Standards Case for Product Class 11A

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2021$*	Percent of Consumers that Experience Net Cost
Residential			
1-2	1	16.78	0.7
3-5	2	9.97	8.3
--	3	-9.08	60.9
6	4	-3.35	50.9
Commercial			
1-2	1	6.97	1.6
3-5	2	3.42	17.2
--	3	-19.90	75.0
6	4	-23.47	73.2

* The savings represent the average LCC for affected consumers.

Table V.19 Average LCC and PBP Results for Product Class 17

TSL	Efficiency Level	Average Costs <u>2021$</u>				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	424.76	65.71	646.11	1,070.86	--	10.7
1-5	1	457.41	59.21	592.27	1,049.68	5.0	10.7
--	2	489.85	55.95	567.53	1,057.38	6.7	10.7
6	3	522.28	52.69	542.79	1,065.08	7.5	10.7

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

Table V.20 Average LCC Savings Relative to the No-New-Standards Case for Product Class 17

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2021$*	Percent of Consumers that Experience Net Cost
1-5	1	21.90	12.3
--	2	2.41	50.9
6	3	-5.74	66.3

* The savings represent the average LCC for affected consumers.

Table V.21 Average LCC and PBP Results for Product Class 18

TSL	Efficiency Level	Average Costs *2021$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	399.82	31.49	303.92	703.74	--	10.7
1-2	1	403.79	28.55	278.34	682.13	1.3	10.7
3-5	2	418.21	27.08	266.48	684.69	4.2	10.7
--	3	438.60	25.61	254.91	693.51	6.6	10.7
6	4	479.02	22.71	232.22	711.24	9.0	10.7

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

Table V.22 Average LCC Savings Relative to the No-New-Standards Case for Product Class 18

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2021$*	Percent of Consumers that Experience Net Cost
1-2	1	21.57	0.6
3-5	2	17.59	21.8
--	3	8.76	48.2
6	4	-9.06	69.9

* The savings represent the average LCC for affected consumers.

b. Consumer Subgroup Analysis

In the consumer subgroup analysis, DOE estimated the impact of the considered TSLs on low-income households. Table V.23 compares the average LCC savings and PBP at each trial standard level for the low-income consumer subgroup with similar metrics for the entire consumer sample for product classes 3, 7, 9, and 10 (see section IV.I of this document for an explanation of why other product classes are excluded). Table V.24 provides a similar comparison for product class 11A for the small business subgroup. In most cases, the average LCC savings and PBP for low-income households at the considered efficiency levels are improved (i.e., higher LCC savings and lower payback period) from the average for all households. The LCC savings and payback period results for the small business subgroup for product class 11A are similar to those for all businesses. Chapter 11 of the NOPR TSD presents the complete LCC and PBP results for the subgroups.

Table V.23 Comparison of LCC Savings and PBP for Low-Income Consumer Subgroup and All Consumers

TSL	Average LCC Savings* 2021$		Simple Payback years	
	Low-Income Households	All Households	Low-Income Households	All Households
Product Class 3				
1	34.97	32.16	0.6	1.4
2-3	61.49	42.18	1.6	4.0
4-5	69.19	36.04	2.1	5.3
6	125.31	8.09	3.4	8.7
Product Class 7				
1	55.46	53.56	0.5	0.7
2	88.12	78.56	1.9	2.6
3-4	115.06	95.26	2.8	3.8
5	134.54	101.33	3.7	5.0
6	135.73	94.68	4.2	5.7
Product Class 9				
1-5	79.17	69.26	2.7	3.9
6	116.06	63.71	6.2	9.0
Product Class 10				
1	27.22	10.20	6.9	10.7
2-5	N/A	N/A	N/A	N/A
6	88.95	40.91	6.4	10.0

* The savings represent the average LCC for affected consumers.

Table V.24 Comparison of LCC Savings and PBP for Small Business Consumer Subgroup and All Consumers

TSL	Average LCC Savings* *2021$*		Simple Payback *years*	
	Small Businesses	All Businesses	Small Businesses	All Businesses
Product Class 11A				
1-2	6.13	6.97	3.1	3.2
3-5	2.86	3.42	3.2	3.2
6	-25.12	-23.47	8.6	8.7

c. Rebuttable Presumption Payback

As discussed in section IV.F.10 of this document, EPCA establishes a rebuttable presumption that an energy conservation standard is economically justified if the increased purchase cost for a product that meets the standard is less than three times the value of the first-year energy savings resulting from the standard. In calculating a rebuttable presumption payback period for each of the considered TSLs, DOE used discrete values, and, as required by EPCA, based the energy use calculation on the DOE test procedure for refrigerators, refrigerator-freezers, and freezers. In contrast, the PBPs presented in section V.B.1.a of this document were calculated using distributions that reflect the range of energy use in the field.

Table V.25 presents the rebuttable-presumption payback periods for the considered TSLs for refrigerators, refrigerator-freezers, and freezers. 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.25 Rebuttable-Presumption Payback Periods

Efficiency Level	Rebuttable Payback Period *years*										
	PC 3	**PC 5**	**PC 5BI**	**PC 5A**	**PC 7**	**PC 9**	**PC 10**	**PC 11A (res)**	**PC 11A (com)**	**PC 17**	**PC 18**
1	1.6	5.0	6.5	2.3	0.8	3.9	10.6	2.0	3.0	4.8	1.3
2	4.6	5.5	8.3	4.7	3.0	6.7	13.5	2.0	3.0	6.4	4.1
3	6.0	7.9	8.3	6.5	4.5	7.8	10.6	5.7	8.5	7.2	6.4
4	8.8	8.8			5.8	8.8	9.9	5.5	8.2		8.8
5	9.8				6.3						

2. Economic Impacts on Manufacturers

DOE performed an MIA to estimate the impact of amended energy conservation standards on manufacturers of refrigerators, refrigerator-freezers, and freezers. The following section describes the expected impacts on manufacturers at each considered TSL. Chapter 12 of the NOPR TSD explains the analysis in further detail.

a. Industry Cash Flow Analysis Results

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

The impact of potential amended energy conservation standards was analyzed under two scenarios: (1) the preservation of gross margin percentage; and (2) the preservation of operating profit, as discussed in section IV.J.2.d of this document. The preservation of gross margin percentages applies a "gross margin percentage" of 21 percent for all freestanding product classes and 29 percent for all built-in product classes, across all efficiency levels.[73] This scenario assumes that a manufacturer's per-unit dollar profit would increase as MPCs increase in the standards cases and represents the upper-bound to industry profitability under potential new and amended energy conservation standards.

The preservation of operating profit scenario reflects manufacturers' concerns about their inability to maintain margins as MPCs increase to reach more stringent efficiency levels. In this scenario, while manufacturers make the necessary investments required to convert their facilities to produce compliant products, operating profit does not change in absolute dollars and decreases as a percentage of revenue. The preservation of operating profit scenario results in the lower (or more severe) bound to impacts of potential amended standards on industry.

Each of the modeled scenarios results in a unique set of cash flows and corresponding INPV for each TSL. INPV is the sum of the discounted cash flows to the industry from the base year through the end of the analysis period (2023–2056). The "change in INPV" results refer to the difference in industry value between the no-new-

[73] The gross margin percentages of 21 percent and 29 percent are based on manufacturer markups of 1.26 and 1.40 percent, respectively.

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

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

Table V.26 Manufacturer Impact Analysis Results for Refrigerators, Refrigerator-Freezers, and Freezers

	Unit	No-New-Standards Case	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
INPV	*2021$ Million*	4,966.4	4,908.2 to 4,944.5	4,867.7 to 4,920.2	4,475.6 to 4,619.8	4,366.5 to 4,554.0	3,965.2 to 4,173.5	3,255.9 to 3,688.2
Change in INPV	%	-	(1.2) to (0.4)	(2.0) to (0.9)	(9.9) to (7.0)	(12.1) to (8.3)	(20.2) to (16.0)	(34.4) to (25.7)
Free Cash Flow (2026)	*2021$ Million*	428.7	401.2	380.4	167.9	110.1	(118.7)	(509.7)
Change in Free Cash Flow (2026)	%	-	(6.4)	(11.3)	(60.8)	(74.3)	(127.7)	(218.9)
Conversion Costs	*2021$ Million*	-	77.8	135.7	653.1	793.0	1,323.6	2,251.7

*Parentheses denote negative (-) values.

The following cash flow discussion refers to product classes as defined in Table I.1 in section I of this document and the efficiency levels and design options as detailed in Table IV.5 through Table IV.7 in section IV.C.3 of this document.

At TSL 1, the standard represents a modest increase in efficiency, corresponding to the lowest analyzed efficiency level above the baseline for each analyzed product class. The change in INPV is expected to range from -1.2 to -0.4 percent. At this level, free cash flow is estimated to decrease by 6.4 percent compared to the no-new-standards case value of $428.7 million in the year 2026, the year before the standards year.[74]

[74] DOE estimates issuance of a final rule by the end of 2023. Therefore, for purposes of its analysis, DOE used 2027 as the first year of compliance with any amended standards for refrigerators, refrigerator-freezers, and freezers.

Currently, approximately 36 percent of domestic refrigerator, refrigerator-freezer, and freezer shipments meet the efficiencies required at TSL 1.

The design options DOE analyzed included implementing more efficient single-speed compressors, among other design options, for most of the directly analyzed product classes. For product classes 5A, 5-BI, 10, and 17, the design options analyzed included implementing variable-speed compressors. Additionally, for product class 5-BI, DOE expects manufacturers would implement some VIPs (though DOE notes that 70 percent of PC 5-BI shipments already meet TSL 1). At this level, capital conversion costs are minimal since most manufacturers can achieve TSL 1 efficiencies with relatively minor component changes. Product conversion costs may be necessary for developing, qualifying, sourcing, and testing new components. DOE expects industry to incur some re-flooring costs as manufacturers redesign baseline products to meet the efficiency levels required by TSL 1. DOE estimates capital conversion costs of $10.2 million and product conversion costs of $67.6 million. Conversion costs total $77.8 million.

At TSL 1, the shipment-weighted average MPC for all refrigerators, refrigerator-freezers, and freezers is expected to increase by 1.2 percent relative to the no-new-standards case shipment-weighted average MPC for all refrigerators, refrigerator-freezers, and freezers in 2027. In the preservation of gross margin percentage scenario, the minor increase in cashflow from the higher MSP is slightly outweighed by the $77.8 million in conversion costs, causing a negligible change in INPV at TSL 1 under this scenario. Under the preservation of operating profit scenario, manufacturers earn the same per-unit operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments. In this scenario, the manufacturer markup decreases in 2028, the year after the analyzed compliance year. This reduction in the manufacturer markup and the $77.8 million in conversion costs incurred by manufacturers cause a slightly negative change in INPV at TSL 1 under the preservation of operating profit scenario.

At TSL 2, the standard represents an increase in efficiency of 10 percent across all analyzed product classes, consistent with ENERGY STAR® requirements, except for product class 10. The change in INPV is expected to range from -2.0 to -0.9 percent. At this level, free cash flow is estimated to decrease by 11.3 percent compared to the no-new-standards case value of $428.7 million in the year 2026, the year before the standards year. Currently, approximately 38 percent of domestic refrigerator, refrigerator-freezer, and freezer shipments meet the efficiencies required at TSL 2.

The design options DOE analyzed include implementing similar design options as TSL 1, such as more efficient compressors, brushless-DC ("BLDC") fans, and variable defrost. For product classes 7, the design options analyzed included implementing variable-speed compressors. For product classes 3 and 7, TSL 2 corresponds to EL 2. For product class 10, TSL 2 corresponds to baseline efficiency. For the remaining product classes, the efficiencies required at TSL 2 are the same as TSL 1. The increase in conversion costs from the prior TSL is entirely due to the increased efficiencies required for product classes 3 and 7. Capital conversion costs may be necessary for updated tooling and additional stations to test more variable-speed compressors. Product conversion costs may be necessary for developing, qualifying, sourcing, and testing variable-speed compressors and associated electronics. DOE expects industry to incur slightly more re-flooring costs compared to TSL 1. DOE estimates capital conversion costs of $21.0 million and product conversion costs of $114.7 million. Conversion costs total $135.7 million.

At TSL 2, the shipment-weighted average MPC for all refrigerators, refrigerator-freezers, and freezers is expected to increase by 1.7 percent relative to the no-new-standards case shipment-weighted average MPC for all refrigerators, refrigerator-freezers, and freezers in 2027. In the preservation of gross margin percentage scenario, the slight increase in cashflow from the higher MSP is outweighed by the $135.7 million in conversion costs, causing a negative change in INPV at TSL 2 under this scenario. Under the preservation of operating profit scenario, the manufacturer markup decreases in 2028, the year after the analyzed compliance year. This reduction in the manufacturer markup and the $135.7 million in conversion costs incurred by manufacturers cause a negative change in INPV at TSL 2 under the preservation of operating profit scenario.

At TSL 3, the standard represents an increased stringency for product classes 5, 5A, 7, 11A, and 18 and increased NES while keeping economic impacts on consumers modest. The change in INPV is expected to range from -9.9 to -7.0 percent. At this level, free cash flow is estimated to decrease by 60.8 percent compared to the no-new-standards case value of $428.7 million in the year 2026, the year before the standards year. Currently, approximately 26 percent of domestic refrigerator, refrigerator-freezer, and freezer shipments meet the efficiencies required at TSL 1.

In addition to the design options DOE analyzed at TSL 2, the design options analyzed for product class 5 include implementing variable-speed compressors. Furthermore, for product classes 5A and 7, DOE expects manufacturers would also incorporate some VIPs. Additionally, for the compact-size product classes 11A and 18, DOE expects manufacturers may need to increase cabinet wall thickness. For product classes 5, 5A, 11A, and 18, TSL 3 corresponds to EL 2. For product class 7, TSL 3 corresponds to EL 3. For the remaining product classes, the efficiencies required at TSL 3 are the same as TSL 2. The increase in conversion costs from the prior TSL are driven by the efficiencies required for product classes 5A and 7, due to their large market share (together, these product classes account for approximately 21 percent of total shipments) and the design options required to meet this level. Capital conversion costs may be necessary for new tooling for VIP placement as well as new testing stations for high-efficiency components. Product conversion costs may be necessary for developing, qualifying, sourcing, and testing new components. For products implementing VIPs, product conversion costs may be necessary for prototyping and testing for VIP placement, design, and sizing. DOE expects industry to incur re-flooring costs as manufacturers redesign their products to meet the efficiency levels required by TSL 3. DOE estimates capital conversion costs of $356.5 million and product conversion costs of $296.7 million. Conversion costs total $653.1 million.

At TSL 3, the shipment-weighted average MPC for all refrigerators, refrigerator-freezers, and freezers is expected to increase by 4.5 percent relative to the no-new-standards case shipment-weighted average MPC for all refrigerators, refrigerator-freezers, and freezers in 2027. In the preservation of gross margin percentage scenario, the slight increase in cashflow from the higher MSP is outweighed by the $653.1 million in conversion costs, causing a negative change in INPV at TSL 3 under this scenario. Under the preservation of operating profit scenario, the manufacturer markup decreases in 2028, the year after the analyzed compliance year. This reduction in the manufacturer markup and the $653.1 million in conversion costs incurred by manufacturers cause a negative change in INPV at TSL 3 under the preservation of operating profit scenario.

At TSL 4, the standard represents an increased stringency for product classes 3 and 5A, as well as the expected NES, while maintaining positive average LCC savings for every analyzed product class. The change in INPV is expected to range from -12.1 to -8.3 percent. At this level, free cash flow is estimated to decrease by 74.3 percent compared to the no-new-standards case value of $428.7 million in the year 2026, the year before the standards year. Currently, approximately 18 percent of domestic refrigerator, refrigerator-freezer, and freezer shipments meet the efficiencies required at TSL 4.

In addition to the design options DOE analyzed at TSL 3, the design options analyzed for product class 3 include implementing variable-speed compressors. Furthermore, for product class 5A, DOE also expects manufacturers would incorporate VIPs on roughly half the cabinet surface (side walls and doors). For product classes 3 and 5A, TSL 4 corresponds to EL 3. For the remaining product classes, the efficiencies required at TSL 4 are the same as TSL 3. At this level, the increase in conversion costs is entirely driven by the higher efficiency levels required for product classes 3 and 5A, which together account for approximately 35 percent of current industry shipments. Many manufacturers of these product classes would need to redesign their platforms to integrate variable-speed compressors and extensive VIPs. Some manufacturers noted the potential need to adopt thicker sidewalls in conjunction or as an alternative to VIP. DOE expects industry to incur more re-flooring costs compared to TSL 3. DOE estimates capital conversion costs of $450.5 million and product conversion costs of $342.5 million. Conversion costs total $793.0 million.

At TSL 4, the shipment-weighted average MPC for all refrigerator, refrigerator-freezers, and freezers is expected to increase by 5.9 percent relative to the no-new-standards case shipment-weighted average MPC for all refrigerators, refrigerator-freezers, and freezers in 2027. In the preservation of gross margin percentage scenario, the increase in cashflow from the higher MSP is outweighed by the $793.0 million in conversion costs, causing a negative change in INPV at TSL 4 under this scenario. Under the preservation of operating profit scenario, the manufacturer markup decreases in 2028, the year after the analyzed compliance year. This reduction in the manufacturer markup and the $793.0 million in conversion costs incurred by manufacturers cause a negative change in INPV at TSL 4 under the preservation of operating profit scenario.

At TSL 5, the standard represents the maximum NPV. The change in INPV is expected to range from -20.2 to -16.0 percent. At this level, free cash flow is estimated to decrease by 127.7 percent compared to the no-new-standards case value of $428.7 million in the year 2026, the year before the standards year. Currently, approximately 18 percent of domestic refrigerator, refrigerator-freezer, and freezer shipments meet the efficiencies required at TSL 5.

In addition to the design options DOE analyzed at TSL 4, the design options analyzed for product class 7 include implementing VIPs on roughly half the cabinet surface (side walls and doors). For product class 7, TSL 5 corresponds to EL 4. For the remaining product classes, the efficiencies required at TSL 5 are the same as TSL 4. The increase in conversion costs compared to the prior TSL is entirely driven by the higher efficiency level required for product class 7, which likely necessitates incorporating VIPs on roughly half the cabinet surface (side walls and doors). In interviews, some manufacturers stated that their existing product class 7 platforms cannot reach this efficiency level and would require a platform redesign, which would likely mean new cases, liners, and fixtures. DOE expects slightly more re-flooring costs compared to the prior TSL as manufacturers redesign products to meet the required efficiencies. DOE estimates capital conversion costs of $891.2 million and product conversion costs of $432.4 million. Conversion costs total $1.32 billion.

At TSL 5, the large conversion costs result in a free cash flow dropping below zero in the years before the standards year. The increase in conversion costs at TSL 5 compared to TSL 4 is associated with implementing more VIPs into product class 7 designs. The negative free cash flow calculation indicates manufacturers may need to access cash reserves or outside capital to finance conversion efforts.

At TSL 5, the shipment-weighted average MPC for all refrigerators, refrigerator-freezers, and freezers is expected to increase by 6.5 percent relative to the no-new-standards case shipment-weighted average MPC for all refrigerators, refrigerator-freezers, and freezers in 2027. In the preservation of gross margin percentage scenario, the increase in cashflow from the higher MSP is outweighed by the $1.32 billion in conversion costs, causing a negative change in INPV at TSL 5 under this scenario. Under the preservation of operating profit scenario, the manufacturer markup decreases in 2028, the year after the analyzed compliance year. This reduction in the manufacturer markup and the $1.32 billion in conversion costs incurred by manufacturers cause a notable decrease in INPV at TSL 5 under the preservation of operating profit scenario.

At TSL 6, the standard reflects max-tech for all product classes. The change in INPV is expected to range from -34.4 to -25.7 percent. At this level, free cash flow is estimated to decrease by 218.9 percent compared to the no-new-standards case value of $428.7 million in the year 2026, the year before the standards year. Currently, approximately 1 percent of domestic refrigerator, refrigerator-freezer, and freezer shipments meet the efficiencies required at TSL 6.

At max-tech levels, manufacturers would likely need to implement VIPs for roughly half the cabinet surface (typically side walls and doors for an upright cabinet), the best-available-efficiency variable-speed compressor, forced-convection heat exchangers with multi-speed BLDC fans, variable defrost, and increase in cabinet wall thickness for some classes (*e.g.,* compact refrigerators and both standard-size and compact chest freezers). At TSL 6, only a few manufacturers offer any products that meet the efficiencies required. For PC 3, which accounts for approximately 25 percent of annual shipments, no OEMs currently offer products that meet the efficiency level required. For PC 5, which accounts for approximately 21 percent of annual shipments, DOE estimates that only one out of 23 OEMs currently offers products that meet the efficiency level required. For PC 7, which accounts for approximately 11 percent of annual shipments, only one out of the 11 OEMs currently offers products that meet the efficiency level required.

The efficiencies required by TSL 6 could require a major renovation of existing facilities and completely new refrigerator, refrigerator-freezer, and freezer platforms for many OEMs. In interviews, some manufacturers stated that they are physically constrained at their current production location and would therefore need to expand their existing production facility or move to an entirely new facility. These manufacturers stated that their current manufacturing locations are at capacity and cannot accommodate the additional labor required to implement VIPs. DOE expects industry to incur more re-flooring costs compared to TSL 5 as all display models below max-tech efficiency would need to be replaced due the more stringent standard. DOE estimates capital conversion costs of $1.58 billion and product conversion costs of $670.6 million. Conversion costs total $2.25 billion.

At TSL 6, the large conversion costs result in a free cash flow dropping below zero in the years before the standards year. The negative free cash flow calculation indicates manufacturers may need to access cash reserves or outside capital to finance conversion efforts.

At TSL 6, the shipment-weighted average MPC for all refrigerators, refrigerator-freezers, and freezers is expected to increase by 13.7 percent relative to the no-new-standards case shipment-weighted average MPC for all refrigerators, refrigerator-freezers, and freezers in 2027. In the preservation of gross margin percentage scenario, the increase in cashflow from the higher MSP is outweighed by the $2.25 billion in conversion costs, causing a large negative change in INPV at TSL 6 under this scenario. Under the preservation of operating profit scenario, the manufacturer markup decreases in 2028, the year after the analyzed compliance year. This reduction in the manufacturer markup and the $2.25 billion in conversion costs incurred by manufacturers cause a significant decrease in INPV at TSL 6 under the preservation of operating profit scenario.

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

b. Direct Impacts on Employment

To quantitatively assess the potential impacts of amended energy conservation standards on direct employment in the refrigerator, refrigerator-freezer, and freezer industry, DOE used the GRIM to estimate the domestic labor expenditures and number of direct employees in the no-new-standards case and in each of the standards cases during the analysis period. DOE calculated these values using statistical data from the 2020 *ASM*,[75] BLS employee compensation data,[76] results of the engineering analysis, and manufacturer interviews.

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

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

The number of production employees is then multiplied by the U.S. labor percentage to convert total production employment to total domestic production employment. The U.S. labor percentage represents the industry fraction of domestic manufacturing production capacity for the covered product. This value is derived from manufacturer interviews, product database analysis, and publicly available information. DOE estimates that 28 percent of refrigerators, refrigerator-freezers, and freezers are produced domestically.

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

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

Using the GRIM, DOE estimates in the absence of new energy conservation standards there would be 6,515 domestic workers for refrigerators, refrigerator-freezers, and freezers in 2027. Table V.27 shows the range of the impacts of energy conservation standards on U.S. manufacturing employment in the refrigerator, refrigerator-freezer, and freezer industry. The following discussion provides a qualitative evaluation of the range of potential impacts presented in Table V.27.

Table V.27 Domestic Direct Employment Impacts for Refrigerator, Refrigerator-Freezer, and Freezer Manufacturers in 2027

	No-New-Standards Case	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Direct Employment in 2027 (Production	6,515	6,528	6,530	6,695	6,786	6,897	7,637

Workers + Non-Production Workers)							
Potential Changes in Direct Employment Workers in 2027*	-	(5,737) to 12	(5,737) to 13	(5,737) to 159	(5,737) to 239	(5,737) to 337	(5,737) to 988

*DOE presents a range of potential employment impacts. Numbers in parentheses denote negative values.

The direct employment impacts shown in Table V.27 represent the potential domestic employment changes that could result following the compliance date for the refrigerator, refrigerator-freezer, and freezer product classes in this proposal. The upper bound estimate corresponds to an increase in the number of domestic workers that would result from amended energy conservation standards if manufacturers continue to produce the same scope of covered products within the United States after compliance takes effect. The lower bound estimate represents the maximum decrease in production workers if manufacturing moved to lower labor-cost countries. Most manufacturers currently produce at least a portion of their refrigerators, refrigerator-freezers, and freezers in countries with lower labor costs. Adopting an amended standard that necessitates large increases in labor content or large expenditures to re-tool facilities could cause manufacturers to reevaluate domestic production siting options. DOE seeks comments on domestic labor expenditures and decisions related to expanding domestic production in light of the proposed standard levels.

Additional detail on the analysis of direct employment can be found in chapter 12 of the NOPR TSD. Additionally, the employment impacts discussed in this section are independent of the employment impacts from the broader U.S. economy, which are documented in chapter 16 of the NOPR TSD.

c. Impacts on Manufacturing Capacity

In interviews, some manufacturers noted potential capacity concerns related to implementing VIPs, particularly for high-volume product lines (i.e., product classes 3, 5, 5A, and 7). These manufacturers noted that incorporating VIPs (or additional VIPs) is labor intensive. Implementing VIPs requires additional labor associated with initial quality control inspections, placement, and post-foam inspections. These manufacturers noted they are physically constrained at some factories and do not have the ability to extend production lines to accommodate additional labor content. As discussed in section V.B.2.a of this document, some manufacturers noted that the only way to maintain current production levels would be to expand the existing footprint, build a mezzanine, or move to a new production facility. In interviews, some manufacturers expressed concerns at the max-tech efficiencies for top-mount (TSL 6), bottom-mount (TSL 4), and side-by-side (TSL 6) standard-size refrigerator-freezers, and stated that the 3-year period between the announcement of the final rule and the compliance date of the amended energy conservation standard might be insufficient to update existing plants or build new facilities to accommodate the additional labor required to manufacture the necessary number of products to meet demand.

DOE seeks comment on whether manufacturers expect manufacturing capacity constraints would limit product availability to consumers in the timeframe of the amended standard compliance date (2027). In particular, DOE requests information on the product classes and associated efficiency levels that would delay manufacturer's ability to comply with a standard due to the extent of factory investments associated with VIP.

In both manufacturer interviews and written comments, manufacturer made statements about the impacts of VSC availability. GEA noted "if DOE were to increase energy efficiency requirements to a level that VSCs would be required for nearly all products, a significant supply shortage of VSCs would be created in an already supply constrained market" (GEA, No. 38, p.3) AHAM strongly opposed any standard that requires VSCs to comply with the standard (AHAM, No. 31, p.10). In contrast, Samsung stated its understanding that more than one third of the US refrigerator market incorporates VSC compressors. Additionally, Samsung noted that the increased adoption of VSC technology has led to improved accessibility and lowered costs. (Samsung, No.32, p.2).

DOE requests data on the availability of VSCs in the timeframe of the standard (2027). Additionally, DOE requests comment on the impact of international regulations on availability of VSCs for the domestic refrigerator, refrigerator-freezer, and freezer market.

d. Impacts on Subgroups of Manufacturers

Using average cost assumptions to develop industry cash-flow estimates may not capture the differential impacts among subgroups of manufacturers. Small manufacturers, niche players, or manufacturers exhibiting a cost structure that differs substantially from the industry average could be affected disproportionately. DOE investigated small businesses as a manufacturer subgroup that could be disproportionally impacted by energy conservation standards and could merit additional analysis. DOE also identified the domestic LVM subgroup as a potential manufacturer subgroup that could be adversely impacted by energy conservation standards based on the results of the industry characterization.

Small Businesses

DOE analyzes the impacts on small businesses in a separate analysis in section VI.B of this document as part of the Regulatory Flexibility Analysis. In summary, the SBA defines a "small business" as having 1,500 employees or less for NAICS 335220, "Major Household Appliance Manufacturing." Based on this classification, DOE identified one domestic OEM that qualifies as a small business. For a discussion of the impacts on the small business manufacturer subgroup, see the Regulatory Flexibility Analysis in section VI.B of this document and chapter 12 of the NOPR TSD.

Domestic, Low-Volume Manufacturers

In addition to the small business subgroup, DOE identified domestic LVMs as a manufacturer subgroup that may experience differential impacts due to potential amended standards. DOE identified three domestic LVMs of refrigerators, refrigerator-freezers, and freezers that would potentially face more challenges with meeting amended standards than other larger OEMs of the covered products.

Although these LVMs do not qualify as small businesses according to the SBA criteria previously discussed (*i.e.,* employee count exceeds 1,500), these manufacturers are significantly smaller in terms of annual revenues than the larger, diversified manufacturers selling refrigerators, refrigerator-freezers, and freezers in the United States. The domestic LVM subgroup consists of refrigerator, refrigerator-freezer, and freezer manufacturers that primarily sell high-end, built-in or fully integrated consumer refrigeration products ("undercounter" and standard-size) as well as commercial refrigeration equipment and cooking products. Specifically, manufacturers indicated during confidential interviews that the fully integrated compact ("undercounter") products produced by the domestic LVMs are niche products and are more expensive to produce (and, therefore, have higher selling prices) than the majority of the compact products sold in the United States.

Table V.28 lists the range of product offerings and total company annual revenue for the three domestic LVMs identified. These three manufacturers account for approximately 1 percent of the overall domestic refrigerator, refrigerator-freezer, and freezer shipments. This table also contains the range of total company annual revenue for the five largest appliance manufacturers selling refrigerators, refrigerator-freezers, and freezers in the U.S. market. These five appliance manufacturers account for approximately 95 percent of the overall domestic refrigerator, refrigerator-freezer, and freezer shipments.

Table V.28 Revenues and Product Offerings of Low-Volume Manufacturers and Large Manufacturers of Refrigerators, Refrigerator-Freezers, and Freezers.

Manufacturer Type	Estimated Range of Annual Company Revenue* *(2021$ Millions)*	Refrigerator, Refrigerator-Freezer, and Freezer Product Offerings
Domestic LVMs	$186 to $2,510	High-end, built-in or fully integrated "undercounter" or standard-size refrigeration products (*e.g.,* product classes 5-BI, 13A, 14)
Large Appliance Manufacturers	$14,650 to $174,550	Wide range of freestanding, standard-size refrigerator-freezers and freezers. (*e.g.,* product classes 3, 5, 5A, 7, 10) Most also offer premium brands for standard-size built-in products

*Revenue estimates refer to the total annual company revenue of the parent company and any associated subsidiaries.

LVMs may be disproportionately affected by conversion costs. Product redesign, testing, and certification costs tend to be fixed per basic model and do not scale with sales volume. Both large manufacturers and LVMs must make investments in R&D to redesign their products, but LVMs lack the sales volumes to sufficiently recoup these upfront investments without substantially marking up their products' selling prices. LVMs may also face challenges related to purchasing power and a less robust supply chain for key technologies or components, as compared to larger manufacturers. DOE notes that domestic LVMs have access to the same technology options as larger appliance manufacturers, the challenge with redesigning products to meet amended standards relates to scale and their ability to recover investments necessitated by more stringent standards.

Although domestic, low-volume manufacturers would likely face additional challenges meeting potential standards for the built-in and compact ("undercounter") refrigerator, refrigerator-freezer, and freezer product classes compared to other refrigerator, refrigerator-freezer, and freezer manufacturers, some of the proposed amendments may be beneficial for domestic LVMs. As discussed in IV.A.1 of this document, DOE is proposing to incorporate certain energy use allowances for products with specialty doors and multi-door designs. A review of the three domestic LVM's product offerings and information gathered in confidential interviews indicates transparent door designs are particularly prevalent in their products.

See section IV.A.1 for additional details on energy use allowances for products with specialty doors and multi-door designs.

DOE requests comment on the potential impacts on domestic, low-volume manufacturers at the TSLs presented in 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.

Table V.29 Compliance Dates and Expected Conversion Expenses of Federal Energy Conservation Standards Affecting Refrigerator, Refrigerator-Freezer, and Freezer Original Equipment Manufacturers

Federal Energy Conservation Standard	Number of OEMs*	Number of OEMs Affected from Today's Rule**	Approx. Standards Year	Industry Conversion Costs *(Millions $)*	Industry Conversion Costs / Product Revenue***
Portable Air Conditioners 85 FR 1378 (January 10, 2020)	11	2	2025	$320.9 (2015$)	6.7%
Room Air Conditioners† 87 FR 20608 (April 7, 2022)	8	4	2026	$22.8 (2020$)	0.5%
Commercial Water Heating Equipment† 87 FR 30610 (May 19, 2022)	14	1	2026	$34.6 (2020$)	4.7%
Consumer Furnaces† 87 FR 40590 (July 7, 2022)	15	1	2029	$150.6 (2020$)	1.4%
Consumer Clothes Dryers† 87 FR 51734 (August 23, 2022)	15	11	2027	$149.7 (2020$)	1.8%
Microwave Ovens† 87 FR 52282 (August 24, 2022)	18	11	2026	$46.1 (2021$)	0.7%
Consumer Conventional Cooking Products†88 FR 6818 (February 1, 2023)	34	12	2027	$183.4 (2021$)	1.2%
Residential Clothes Washers†‡	19	12	2027	$690.8 (2021$)	5.2%

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

** This column presents the number of OEMs producing refrigerators, refrigerator-freezers, and freezers that are also listed as OEMs in the identified energy conservation standard contributing to cumulative regulatory burden.

*** This column presents industry conversion costs as a percentage of product revenue during the conversion period. Industry conversion costs are the upfront investments manufacturers must make to sell compliant products/equipment. The revenue used for this calculation is the revenue from just the covered product/equipment associated with each row. The conversion period is the time frame over which conversion costs are made and lasts from the publication year of the final rule to the compliance year of the final rule. The conversion period typically ranges from 3 to 5 years, depending on the energy conservation standard.

† These rulemakings are in the NOPR stage and all values are subject to change until finalized.

‡ At the time of issuance of this refrigerator, refrigerator-freezer, and freezer proposed rule, the residential clothes washer proposed rule has been issued and is pending publication in the *Federal Register*. Once published, the proposed

rule pertaining to residential clothes washers will be available at: *www.regulations.gov/docket/EERE-2017-BT-STD-0014*.

In addition to the rulemakings listed in Table V.29, DOE has ongoing rulemakings for other products or equipment that refrigerator, refrigerator-freezer, and freezer manufacturers produce, including but not limited to miscellaneous refrigeration products;[77] dehumidifiers;[78] and dishwashers.[79] If DOE proposes or finalizes any energy conservation standards for these products or equipment prior to finalizing energy conservation standards for refrigerators, refrigerator-freezers, and freezers, DOE will include the energy conservation standards for these other products or equipment as part of the cumulative regulatory burden for the refrigerators, refrigerator-freezers, and freezers final rule.

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

3. National Impact Analysis

This section presents DOE's estimates of the NES and the NPV of consumer benefits that would result from each of the TSLs considered as potential amended standards.

[77] *www.regulations.gov/docket/EERE-2020-BT-STD-0039.*
[78] *www.regulations.gov/docket/EERE-2019-BT-STD-0043.*
[79] *www.regulations.gov/docket/EERE-2019-BT-STD-0039.*

a. Significance of Energy Savings

To estimate the energy savings attributable to potential amended standards for refrigerators, refrigerator-freezers, and freezers, 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 (2027–2056). Table V.30 Cumulative National Energy Savings for Freestanding Refrigerators, Refrigerator-Freezers, and Freezers; 30 Years of Shipments (2027–2056) presents DOE's projections of the NES for each TSL considered for freestanding consumer refrigerators, refrigerator-freezers, and freezers. Table V.30 presents DOE's projections of the NES for each TSL considered for built-in consumer refrigerators, refrigerator-freezers, and freezers. The savings were calculated using the approach described in section IV.H.2 of this document.

Table V.30 Cumulative National Energy Savings for Freestanding Refrigerators, Refrigerator-Freezers, and Freezers; 30 Years of Shipments (2027–2056)

	TSL	Standard Size Refrigerator-Freezers				Standard Size Freezers		Compact		Total
		Top Mount	Bottom Mount	Bottom Mount With TTD	Side-by-Side	Upright	Chest	Refrigerators	Freezers	
		PC 1, 1A, 2, 3, 3A, 3I, and 6	PC 5 and 5I	PC 5A	PC 4, 4I, and 7	PC 8 and 9	PC 10 and 10A	PC 11, 11A, 12, 13, 13A, 14, and 15	PC 16, 17, and 18	
		quads								
Primary Energy	1	0.292	0.355	0.696	0.316	0.312	0.161	0.047	0.056	2.237
	2	0.600	0.355	0.696	0.672	0.293	0.000	0.047	0.056	2.721
	3	0.600	0.744	1.046	1.044	0.293	0.000	0.072	0.082	3.881
	4	1.054	0.744	1.405	1.044	0.293	0.000	0.072	0.082	4.694
	5	1.054	0.744	1.405	1.421	0.293	0.000	0.072	0.082	5.072
	6	2.204	1.391	1.405	1.573	0.925	0.521	0.262	0.175	8.455
FFC	1	0.303	0.369	0.724	0.328	0.325	0.167	0.049	0.058	2.324
	2	0.624	0.369	0.724	0.698	0.305	0.000	0.049	0.058	2.827
	3	0.624	0.774	1.086	1.084	0.305	0.000	0.075	0.085	4.032
	4	1.095	0.774	1.460	1.084	0.305	0.000	0.075	0.085	4.877
	5	1.095	0.774	1.460	1.477	0.305	0.000	0.075	0.085	5.269
	6	2.290	1.445	1.460	1.634	0.961	0.541	0.273	0.182	8.784

Table V.31 Cumulative National Energy Savings for Built-in Refrigerators, Refrigerator-Freezers, and Freezers; 30 Years of Shipments (2027–2056)

	TSL	Built-In				Total
		All Refrigerator	Bottom-Mount Refrigerator	Side-by-Side Refrigerator-Freezers	Upright Freezers	
		PC 3A-BI	PC 5-BI, 5I-BI	PC 4-BI, 4I-BI, and 7-BI	PC 9-BI	
		quads				
Primary Energy	**1**	0.000	0.006	0.000	0.000	0.006
	2	0.004	0.006	0.005	0.000	0.015
	3	0.004	0.006	0.011	0.000	0.021
	4	0.009	0.006	0.011	0.000	0.025
	5	0.009	0.006	0.017	0.000	0.031
	6	0.025	0.016	0.019	0.001	0.062
FFC	**1**	0.000	0.006	0.000	0.000	0.006
	2	0.004	0.006	0.005	0.000	0.016
	3	0.004	0.006	0.011	0.000	0.022
	4	0.009	0.006	0.011	0.000	0.026
	5	0.009	0.006	0.017	0.000	0.032
	6	0.026	0.017	0.020	0.002	0.065

OMB Circular A-4[80] 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

[80] U.S. Office of Management and Budget. Circular A-4: Regulatory Analysis. September 17, 2003. *www.whitehouse.gov/omb/circulars_a004_a-4/* (last accessed July 26, 2022).

revised standards.[81] The review timeframe established in EPCA is generally not synchronized with the product lifetime, product manufacturing cycles, or other factors specific to consumer refrigerators, refrigerator-freezers, and freezers. 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.32 and Table V.33 of this document. The impacts are counted over the lifetime of consumer refrigerators, refrigerator-freezers, and freezers purchased in 2027–2035.

[81] 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.

Table V.32 Cumulative National Energy Savings for Freestanding Refrigerators, Refrigerator-Freezers, and Freezers; 9 Years of Shipments (2027–2035)

	TSL	Standard Size Refrigerator-Freezers				Standard Size Freezers		Compact		Total
		Top Mount	Bottom Mount	Bottom Mount With TTD	Side-by-Side	Upright	Chest	Refrigerators	Freezers	
		PC 1, 1A, 2, 3, 3A, 3I, and 6	PC 5 and 5I	PC 5A	PC 4, 4I, and 7	PC 8 and 9	PC 10 and 10A	PC 11, 11A, 12, 13, 13A, 14, and 15	PC 16, 17, and 18	
		quads								
Primary Energy	1	0.080	0.097	0.190	0.086	0.087	0.045	0.012	0.015	0.612
	2	0.164	0.097	0.190	0.183	0.082	0.000	0.012	0.015	0.743
	3	0.164	0.203	0.285	0.285	0.082	0.000	0.018	0.022	1.059
	4	0.288	0.203	0.384	0.285	0.082	0.000	0.018	0.022	1.281
	5	0.288	0.203	0.384	0.388	0.082	0.000	0.018	0.022	1.384
	6	0.599	0.379	0.384	0.429	0.257	0.145	0.065	0.046	2.304
FFC	1	0.083	0.101	0.198	0.090	0.091	0.047	0.012	0.015	0.636
	2	0.170	0.101	0.198	0.191	0.085	0.000	0.012	0.015	0.772
	3	0.170	0.211	0.297	0.296	0.085	0.000	0.018	0.023	1.100
	4	0.299	0.211	0.399	0.296	0.085	0.000	0.018	0.023	1.331
	5	0.299	0.211	0.399	0.403	0.085	0.000	0.018	0.023	1.438
	6	0.623	0.394	0.399	0.446	0.267	0.151	0.067	0.048	2.395

Table V.33 Cumulative National Energy Savings for Built-in Refrigerators, Refrigerator-Freezers, and Freezers; 9 Years of Shipments (2027–2035)

	TSL	Built-In				Total
		All Refrigerator	**Bottom-Mount Refrigerator**	**Side-by-Side Refrigerator-Freezers**	**Upright Freezers**	
		PC 3A-BI	PC 5-BI, 5I-BI	PC 4-BI, 4I-BI, and 7-BI	PC 9-BI	
		quads				
Primary Energy	**1**	0.000	0.002	0.000	0.000	0.002
	2	0.001	0.002	0.001	0.000	0.004
	3	0.001	0.002	0.003	0.000	0.006
	4	0.002	0.002	0.003	0.000	0.007
	5	0.002	0.002	0.005	0.000	0.008
	6	0.007	0.004	0.005	0.000	0.017
FFC	**1**	0.000	0.002	0.000	0.000	0.002
	2	0.001	0.002	0.001	0.000	0.004
	3	0.001	0.002	0.003	0.000	0.006
	4	0.002	0.002	0.003	0.000	0.007
	5	0.002	0.002	0.005	0.000	0.009
	6	0.007	0.005	0.005	0.000	0.018

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 refrigerators, refrigerator-freezers, and freezers. In accordance with OMB's guidelines on regulatory analysis,[82] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. Table V.34 and Table V.35 show the consumer NPV results with impacts counted over the lifetime of products purchased in 2027–2056.

[82] U.S. Office of Management and Budget. Circular A-4: Regulatory Analysis. September 17, 2003. *www.whitehouse.gov/omb/circulars_a004_a-4/* (last accessed July 26, 2022).

Table V.34 Cumulative Net Present Value of Consumer Benefits for Freestanding Refrigerators, Refrigerator-Freezers, and Freezers; 30 Years of Shipments (2027-2056)

Discount Rate	TSL	Standard Size Refrigerator-Freezers				Standard Size Freezers		Compact		Total
		Top Mount	Bottom Mount	Bottom Mount With TTD	Side-by-Side	Upright	Chest	Refrigerators	Freezers	
		PC 1, 1A, 2, 3, 3A, 3I, and 6	PC 5 and 5I	PC 5A	PC 4, 4I, and 7	PC 8 and 9	PC 10 and 10A	PC 11, 11A, 12, 13, 13A, 14, and 15	PC 16, 17, and 18	
		Billion $2021								
3 percent	1	1.85	1.97	4.12	2.01	1.46	0.41	0.10	0.34	12.26
	2	2.79	1.97	4.12	3.77	1.40	0.00	0.10	0.34	14.49
	3	2.79	3.64	4.70	4.84	1.40	0.00	0.21	0.35	17.93
	4	4.34	3.64	4.90	4.84	1.40	0.00	0.21	0.35	19.68
	5	4.34	3.64	4.90	5.45	1.40	0.00	0.21	0.35	20.29
	6	3.55	2.95	4.90	5.33	2.53	1.19	-0.53	0.27	20.20
7 percent	1	0.74	0.71	1.63	0.82	0.48	0.07	0.02	0.14	4.61
	2	0.99	0.71	1.63	1.45	0.47	0.00	0.02	0.14	5.41
	3	0.99	1.25	1.68	1.74	0.47	0.00	0.07	0.13	6.31
	4	1.41	1.25	1.51	1.74	0.47	0.00	0.07	0.13	6.57
	5	1.41	1.25	1.51	1.78	0.47	0.00	0.07	0.13	6.61
	6	0.09	0.34	1.51	1.60	0.46	0.18	-0.42	0.01	3.77

Table V.35 Cumulative Net Present Value of Consumer Benefits for Built-in Refrigerators, Refrigerator-Freezers, and Freezers; 30 Years of Shipments (2027–2056)

Discount Rate	TSL	Built-In				Total
		All Refrigerator	Bottom-Mount Refrigerator	Side-by-Side Refrigerator-Freezers	Upright Freezers	
		PC 3A-BI	PC 5-BI, 5I-BI	PC 4-BI, 4I-BI, and 7-BI	PC 9-BI	
		Billion $2021				
3 percent	1	0.00	0.03	0.00	0.00	0.03
	2	0.01	0.03	0.02	0.00	0.06
	3	0.01	0.03	0.04	0.00	0.08
	4	0.02	0.03	0.04	0.00	0.09
	5	0.02	0.03	0.06	0.00	0.11
	6	0.02	0.04	0.06	0.00	0.12
7 percent	1	0.00	0.01	0.00	0.00	0.01
	2	0.00	0.01	0.01	0.00	0.02
	3	0.00	0.01	0.01	0.00	0.02
	4	0.01	0.01	0.01	0.00	0.03
	5	0.01	0.01	0.02	0.00	0.03
	6	-0.01	0.01	0.01	0.00	0.01

The NPV results based on the aforementioned 9-year analytical period are presented in Table V.36 and Table V.37. The impacts are counted over the lifetime of products purchased in 2027–2035. As mentioned previously, such results are presented for informational purposes only and are not indicative of any change in DOE’s analytical methodology or decision criteria.

Table V.36 Cumulative Net Present Value of Consumer Benefits for Consumer Benefits for Freestanding Refrigerators, Refrigerator-Freezers, and Freezers; 9 Years of Shipments (2027–2035)

Discount Rate	TSL	Standard Size Refrigerator-Freezers				Standard Size Freezers		Compact		Total
		Top Mount	Bottom Mount	Bottom Mount With TTD	Side-by-Side	Upright	Chest	Refrigerators	Freezers	
		PC 1, 1A, 2, 3, 3A, 3I, and 6	PC 5 and 5I	PC 5A	PC 4, 4I, and 7	PC 8 and 9	PC 10 and 10A	PC 11, 11A, 12, 13, 13A, 14, and 15	PC 16, 17, and 18	
		Billion $2021								
3 percent	1	0.67	0.63	1.42	0.73	0.52	0.10	0.01	0.12	4.19
	2	0.95	0.63	1.42	1.27	0.50	0.00	0.01	0.12	4.90
	3	0.95	1.17	1.57	1.60	0.50	0.00	0.04	0.11	5.96
	4	1.33	1.17	1.55	1.60	0.50	0.00	0.04	0.11	6.32
	5	1.33	1.17	1.55	1.75	0.50	0.00	0.04	0.11	6.46
	6	0.65	0.69	1.55	1.66	0.75	0.34	-0.29	0.03	5.38
7 percent	1	0.36	0.30	0.76	0.40	0.23	0.01	0.00	0.07	2.11
	2	0.45	0.30	0.76	0.66	0.22	0.00	0.00	0.07	2.45
	3	0.45	0.53	0.74	0.77	0.22	0.00	0.02	0.06	2.79
	4	0.56	0.53	0.61	0.77	0.22	0.00	0.02	0.06	2.76
	5	0.56	0.53	0.61	0.75	0.22	0.00	0.02	0.06	2.74
	6	-0.31	-0.05	0.61	0.63	0.13	0.04	-0.26	-0.03	0.77

Table V.37 Cumulative Net Present Value of Consumer Benefits for Consumer Benefits for Built-in Refrigerators, Refrigerator-Freezers, and Freezers; 9 Years of Shipments (2027–2035)

	TSL	Built-In				Total
		All Refrigerator	Bottom-Mount Refrigerator	Side-by-Side Refrigerator-Freezers	Upright Freezers	
		PC 3A-BI	PC 5-BI, 5I-BI	PC 4-BI, 4I-BI, and 7-BI	PC 9-BI	
		billion $2021				
3 percent	**1**	0.00	0.01	0.00	0.00	0.01
	2	0.00	0.01	0.01	0.00	0.02
	3	0.00	0.01	0.01	0.00	0.02
	4	0.01	0.01	0.01	0.00	0.03
	5	0.01	0.01	0.02	0.00	0.03
	6	0.00	0.01	0.02	0.00	0.03
7 percent	**1**	0.00	0.00	0.00	0.00	0.00
	2	0.00	0.00	0.00	0.00	0.01
	3	0.00	0.00	0.01	0.00	0.01
	4	0.00	0.00	0.01	0.00	0.01
	5	0.00	0.00	0.01	0.00	0.01
	6	-0.01	0.00	0.01	0.00	0.00

The previous results reflect the use of a default trend to estimate the change in price for consumer refrigerators, refrigerator-freezers, and freezers over the analysis period (see section IV.H.3 of this document). DOE also conducted a sensitivity analysis that considered one scenario with a lower rate of price decline than the reference case and one scenario with a higher rate of price decline than the reference case. The results of these alternative cases are presented in appendix 10C of the NOPR TSD. In the high-price-decline case, the NPV of consumer benefits is higher than in the default case. In the low-price-decline case, the NPV of consumer benefits is lower than in the default case.

c. Indirect Impacts on Employment

It is estimated that that amended energy conservation standards for refrigerators, refrigerator-freezers, and freezers 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 (2027–2031), where these uncertainties are reduced.

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

4. Impact on Utility or Performance of Products

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

DOE's analysis for this proposed rule includes wall thickness increases over baseline only for product classes 10, 11A, and 18. Thickness increases were assumed to impact the external dimensions of the aforementioned product classes rather than internal volume. Thus, the expected useable, refrigerated volume would not be impacted and would remain similar to commercially available models today. DOE only considered an incremental increase in external dimensions for those three product classes that are consistent with commercially available product dimensions currently on the market. DOE does not believe such incremental increases that are consistent with currently available product dimensions will have an adverse impact on consumer utility because these products will not likely be installed within cabinetry.

DOE seeks comment on its analysis of wall thickness increases for product classes 10, 11A, and 18 along with its preliminary conclusions that consumer utility will not be impacted.

5. Impact of Any Lessening of Competition

DOE considered any lessening of competition that would be likely to result from new or amended standards. As discussed in section III.E.1.e of this document, the Attorney General determines the impact, if any, of any lessening of competition likely to result from a proposed standard, and transmits such determination in writing to the Secretary, together with an analysis of the nature and extent of such impact. To assist the Attorney General in making this determination, DOE has provided DOJ with copies of this NOPR and the accompanying TSD for review. DOE will consider DOJ's comments on the proposed rule in determining whether to proceed to a final rule. DOE will publish and respond to DOJ's comments in that document. DOE invites comment from the public regarding the competitive impacts that are likely to result from this proposed rule. In addition, stakeholders may also provide comments separately to DOJ regarding these potential impacts. *See* the **ADDRESSES** section for information to send comments to DOJ.

6. Need of the Nation to Conserve Energy

Enhanced energy efficiency, where economically justified, improves the Nation's energy security, strengthens the economy, and reduces the environmental impacts (costs) of energy production. Reduced electricity demand due to energy conservation standards is also likely to reduce the cost of maintaining the reliability of the electricity system, particularly during peak-load periods. Chapter 15 in the NOPR TSD presents the estimated impacts on electricity generating capacity, relative to the no-new-standards case, for the TSLs that DOE considered in this proposed rule.

Energy conservation resulting from potential energy conservation standards for refrigerators, refrigerator-freezers, and freezers is expected to yield environmental benefits in the form of reduced emissions of certain air pollutants and greenhouse gases. Table V.38 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 of this document. DOE reports annual emissions reductions for each TSL in chapter 13 of the NOPR TSD.

Table V.38 Cumulative Emissions Reduction for Refrigerators, Refrigerator-Freezers, and Freezers Shipped in 2027–2056

	Trial Standard Level					
	1	**2**	**3**	**4**	**5**	**6**
Power Sector Emissions						
CO_2 (*million metric tons*)	73.10	89.28	127.39	154.09	166.62	277.77
CH_4 (*thousand tons*)	5.76	7.04	10.05	12.16	13.15	21.90
N_2O (*thousand tons*)	0.81	0.99	1.41	1.70	1.84	3.07
NO_X (*thousand tons*)	36.66	44.81	63.96	77.37	83.66	139.34
SO_2 (*thousand tons*)	36.07	44.06	62.87	76.05	82.24	137.05
Hg (*tons*)	0.24	0.29	0.41	0.50	0.54	0.90
Upstream Emissions						
CO_2 (*million metric tons*)	5.53	6.75	9.62	11.64	12.59	21.00
CH_4 (*thousand tons*)	523.58	638.80	911.11	1,101.96	1,191.52	1,988.67
N_2O (*thousand tons*)	0.03	0.03	0.05	0.06	0.06	0.10
NO_X (*thousand tons*)	83.81	102.25	145.84	176.40	190.73	318.32
SO_2 (*thousand tons*)	0.38	0.46	0.66	0.80	0.86	1.44
Hg (*tons*)	0.00	0.00	0.00	0.00	0.00	0.00
Total FFC Emissions						
CO_2 (*million metric tons*)	78.63	96.03	137.01	165.73	179.20	298.78
CH_4 (*thousand tons*)	529.34	645.84	921.16	1,114.12	1,204.67	2,010.57
N_2O (*thousand tons*)	0.83	1.02	1.46	1.76	1.90	3.17
NO_X (*thousand tons*)	120.46	147.06	209.80	253.77	274.39	457.66
SO_2 (*thousand tons*)	36.45	44.53	63.53	76.85	83.10	138.49
Hg (*tons*)	0.24	0.29	0.41	0.50	0.54	0.90

Negative values refer to an increase in emissions.

As part of the analysis for this proposed rule, DOE estimated monetary benefits likely to result from the reduced emissions of CO_2 that DOE estimated for each of the considered TSLs for refrigerators, refrigerator-freezers, and freezers. Section IV.L of this document discusses the SC-CO_2 values that DOE used. Table V.39 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.39 Present Monetized Value of CO_2 Emissions Reduction for Refrigerators, Refrigerator-Freezers, and Freezers Shipped in 2027-2056

TSL	SC-CO_2 Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	Billion 2021$			
1	0.66	2.89	4.56	8.77
2	0.81	3.57	5.62	10.82
3	1.16	5.10	8.04	15.49
4	1.40	6.18	9.73	18.75
5	1.52	6.68	10.53	20.28
6	2.50	11.04	17.39	33.48

As discussed in section IV.L.1 of this document, DOE estimated the climate benefits likely to result from the reduced emissions of methane and N_2O that DOE estimated for each of the considered TSLs for refrigerators, refrigerator-freezers, and freezers. Table V.40 presents the value of the CH_4 emissions reduction at each TSL, and Table V.41 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.40 Present Monetized Value of Methane Emissions Reduction for Refrigerators, Refrigerator-Freezers, and Freezers Shipped in 2027-2056

TSL	SC-CH_4 Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	Billion 2021$			
1	0.20	0.62	0.88	1.65
2	0.25	0.77	1.08	2.03
3	0.36	1.10	1.55	2.91
4	0.43	1.33	1.87	3.52
5	0.47	1.44	2.02	3.81
6	0.77	2.38	3.35	6.30

Table V.41 Present Monetized Value of Nitrous Oxide Emissions Reduction for Refrigerators, Refrigerator-Freezers, and Freezers Shipped in 2027-2056

TSL	SC-N_2O Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	Billion 2021$			
1	0.00	0.01	0.02	0.03
2	0.00	0.01	0.02	0.04
3	0.00	0.02	0.03	0.05
4	0.01	0.02	0.04	0.06
5	0.01	0.03	0.04	0.07
6	0.01	0.04	0.07	0.11

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. As reflected in this rule, DOE has reverted to its approach prior to the injunction and presents monetized greenhouse gas abatement benefits where appropriate and permissible under law

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 refrigerators, refrigerator-freezers, and freezers. The dollar-per-ton values that DOE used are discussed in section IV.L of this document. Table V.42 presents the present value for NO_X emissions reduction for each TSL calculated using 7-percent and 3-percent discount rates, and Table V.43 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.42 Present Monetized Value of NO_X Emissions Reduction for Refrigerators, Refrigerator-Freezers, and Freezers Shipped in 2027-2056

TSL	3% Discount Rate	7% Discount Rate
	million 2021$	
1	4,368.08	1,612.82
2	5,376.87	1,999.06
3	7,692.46	2,866.91
4	9,310.10	3,471.24
5	10,069.16	3,754.82
6	16,660.11	6,171.74

Table V.43 Present Monetized Value of SO_2 Emissions Reduction for Refrigerators, Refrigerator-Freezers, and Freezers Shipped in 2027-2056

TSL	3% Discount Rate	7% Discount Rate
	million 2021$	
1	1,789.12	677.21
2	2,203.60	839.89
3	3,153.20	1,204.76
4	3,816.49	1,458.78
5	4,127.73	1,577.98
6	6,824.58	2,591.74

DOE has not considered the monetary benefits of the reduction of Hg for this proposed rule. Not all the public health and environmental benefits from the reduction of greenhouse gases, NOx, and SO_2 are captured in the values above, and additional unquantified benefits from the reductions of those pollutants as well as from the reduction of Hg, direct PM, and other co-pollutants may be significant.

7. Other Factors

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

8. Summary of Economic Impacts

Table V.44 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 proposed rule. The consumer benefits are domestic U.S. monetary savings that occur as a result of purchasing the covered refrigerators, refrigerator-freezers, and freezers, and are measured for the lifetime of products shipped in 2027–2056. The climate benefits associated with reduced GHG emissions resulting from the adopted standards are global benefits, and are also calculated based on the lifetime of refrigerators, refrigerator-freezers, and freezers shipped in 2027-2056.

Table V.44 Consumer NPV Combined with Present Value of Monetized Climate Benefits and Health Benefits

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
3% discount rate for Consumer NPV and Health Benefits (billion 2021$)						
5% Average SC-GHG case	19.3	23.2	30.4	34.7	36.6	47.1
3% Average SC-GHG case	22.0	26.5	35.1	40.4	42.7	57.3
2.5% Average SC-GHG case	23.9	28.8	38.5	44.5	47.2	64.6
3% 95th percentile SC-GHG case	28.9	35.0	47.3	55.2	58.7	83.7
7% discount rate for Consumer NPV and Health Benefits (billion 2021$)						
5% Average SC-GHG case	7.8	9.3	11.9	13.4	14.0	15.8
3% Average SC-GHG case	10.4	12.6	16.6	19.1	20.1	26.0
2.5% Average SC-GHG case	12.4	15.0	20.0	23.2	24.6	33.3
3% 95th percentile SC-GHG case	17.4	21.2	28.9	33.9	36.1	52.4

C. Conclusion

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

For this NOPR, DOE considered the impacts of amended standards for refrigerators, refrigerator-freezers, and freezers at each TSL, beginning with the maximum technologically feasible level, to determine whether that level was economically justified. Where the max-tech level was not justified, DOE then considered the next most efficient level and undertook the same evaluation until it reached the highest efficiency level that is both technologically feasible and economically justified and saves a significant amount of energy.

To aid the reader as DOE discusses the benefits and/or burdens of each TSL, tables in this section present a summary of the results of DOE's quantitative analysis for each TSL. In addition to the quantitative results presented in the tables, DOE also considers other burdens and benefits that affect economic justification. These include the impacts on identifiable subgroups of consumers who may be disproportionately affected by a national standard and impacts on employment.

DOE also notes that the economics literature provides a wide-ranging discussion of how consumers trade off upfront costs and energy savings in the absence of government intervention. Much of this literature attempts to explain why consumers appear to undervalue energy efficiency improvements.[83] There is evidence that consumers undervalue future energy savings as a result of (1) a lack of information or informational asymmetries, (2) a lack of sufficient salience of the long-term or aggregate benefits, (3) a lack of sufficient personal financial savings to warrant delaying or altering

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

purchases, (4) excessive focus on the short term, in the form of inconsistent weighting of future energy cost savings relative to available returns on other investments, due to loss aversion, myopia, inattention, or other factors, (5) computational or other difficulties associated with the evaluation of relevant tradeoffs, and (6) a divergence in incentives (for example, between renters and owners, or builders and purchasers, or between current and subsequent owners). Having less than perfect foresight and a high degree of uncertainty about the future, consumers may trade off these types of investments at a higher-than- expected rate between current consumption and uncertain future energy cost savings.

In addition to the demand-side market failures, an expanding set of studies highlight the need to recognize the importance of market failure on the supply side.[84] These market failures are associated primarily with innovation and imperfect competition. Underinvestment in innovation as a source of market failure emerges if there is underinvestment in R&D relative to the social optimum due to the positive externalities associated with increased knowledge.[85,86] Findings suggest that if appliance manufacturers were induced to innovate in the direction of increased energy efficiency by standards, the stock of knowledge in that direction would increase, thereby facilitating even more innovation in that direction in the future. [87,88] Imperfect competition in the

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[84] Houde, S., and Spurlock, C. A. (2016). "Minimum Energy Efficiency Standards for Appliances: Old and New Economic Rationales," Economics of Energy & Environmental Policy, 5(2).
[85] Jaffe, A. B., R. G. Newell, and R. N. Stavins (2003). "Technological change and the environment," Handbook of Environmental Economics, 1, 461–516.
[86] Spence, M. (1984). "Cost reduction, competition, and industry performance," Econometrica: Journal of the Econometric Society, 101–121.
[87] Newell, R. G., A. B. Jaffe, and R. N. Stavins (1999). "The Induced Innovation Hypothesis and Energy Saving Technological Change," Quarterly Journal of Economics, 114(458), 907–940.
[88] Popp, D. (2002). "Induced Innovation and energy prices," American Economic Review, 92(1), 160–180.

appliance market in the U.S. is another source of market failure that standards can address. Ronnen,[89] one of the first papers investigating minimum quality standards (MQS) in an imperfect competition setting, provides most of the intuition for this result. He showed that a MQS can be welfare improving because they effectively limit firms' ability to differentiate their products. This, in turn, limits the ability of the firm to screen customers with heterogeneous preferences over the regulated quality dimension (such as energy efficiency). As a result, firms can no longer charge an exaggerated premium for quality to customers with a high willingness to pay by suppressing quality targeted to customers with a low willingness to pay. A more recent study that looked at the U.S. clothes washer market and focused on how price changed following the revision of minimum standards found a similar pattern.[90] The findings show that mid-low efficiency products had a large decrease in price level together with a downward break in price trend exactly at the time more stringent standards became effective. This is the effect predicted when the market is made up of price-discriminating firms who want to continue to serve customers previously targeted with the products that were eliminated by the standard.

In DOE's current regulatory analysis, potential changes in the benefits and costs of a regulation due to changes in consumer purchase decisions are included in two ways. First, if consumers forgo the purchase of a product in the standards case, this decreases sales for product manufacturers, and the impact on manufacturers attributed to lost

[89] Ronnen, U. (1991). "Minimum quality standards, fixed costs, and competition," The RAND Journal of Economics, 490–504.
[90] Spurlock, C. A. (2013). "Appliance Efficiency Standards and Price Discrimination," Lawrence Berkeley National Laboratory Report, LBNL-6283E. *http://escholarship.org/uc/item/6wh9838j*

revenue is included in the MIA. Second, DOE accounts for energy savings attributable only to products actually used by consumers in the standards case; if a standard decreases the number of products purchased by consumers, this decreases the potential energy savings from an energy conservation standard. DOE provides estimates of shipments and changes in the volume of product purchases in chapter 9 of the NOPR TSD. However, DOE's current analysis does not explicitly control for heterogeneity in consumer preferences, preferences across subcategories of products or specific features, or consumer price sensitivity variation according to household income.[91]

While DOE is not prepared at present to provide a fuller quantifiable framework for estimating the benefits and costs of changes in consumer purchase decisions due to an energy conservation standard, DOE is committed to developing a framework that can support empirical quantitative tools for improved assessment of the consumer welfare impacts of appliance standards. DOE has posted a paper that discusses the issue of consumer welfare impacts of appliance energy conservation standards, and potential enhancements to the methodology by which these impacts are defined and estimated in the regulatory process.[92] DOE welcomes comments on how to more fully assess the potential impact of energy conservation standards on consumer choice and how to quantify this impact in its regulatory analysis in future rulemakings.

[91] P.C. Reiss and M.W. White. Household Electricity Demand, Revisited. *Review of Economic Studies*. 2005. 72(3): pp. 853–883. doi: *10.1111/0034-6527.00354*.

[92] Sanstad, A.H. *Notes on the Economics of Household Energy Consumption and Technology Choice*. 2010. Lawrence Berkeley National Laboratory. *www1.eere.energy.gov/buildings/appliance_standards/pdfs/consumer_ee_theory.pdf* (last accessed July 26, 2022).

1. Benefits and Burdens of TSLs Considered for Refrigerator, Refrigerator-Freezer, and Freezer Standards

Table V.45 and Table V.46 summarize the quantitative impacts estimated for each TSL for refrigerators, refrigerator-freezers, and freezers. There are also other important unquantified effects not presented in these tables, including certain unquantified climate benefits, unquantified public health benefits from the reduction of toxic air pollutants and other emissions, unquantified energy security benefits, and distributional effects, among others. The national impacts are measured over the lifetime of refrigerators, refrigerator-freezers, and freezers purchased in the 30-year period that begins in the anticipated year of compliance with amended standards (2027–2056). The energy savings, emissions reductions, and value of emissions reductions refer to full-fuel-cycle results. The efficiency levels contained in each TSL are described in section V.A of this document.

Table V.45 Summary of Analytical Results for Consumer Refrigerators, Refrigerator-Freezers, and Freezers TSLs: National Impacts

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Cumulative FFC National Energy Savings						
Quads	2.330	2.842	4.054	4.903	5.302	8.849
Cumulative FFC Emissions Reduction						
CO_2 (*million metric tons*)	78.63	96.03	137.01	165.73	179.20	298.78
CH_4 (*thousand tons*)	529.34	645.84	921.16	1,114.12	1,204.67	2,010.57
N_2O (*thousand tons*)	0.83	1.02	1.46	1.76	1.90	3.17
NO_X (*thousand tons*)	120.46	147.06	209.80	253.77	274.39	457.66
SO_2 (*thousand tons*)	36.45	44.53	63.53	76.85	83.10	138.49
Hg (*tons*)	0.24	0.29	0.41	0.50	0.54	0.90

Present Monetized Value of Benefits and Costs (*3% discount rate, billion 2021$*)						
Consumer Operating Cost Savings	14.79	18.11	25.57	30.47	32.71	52.41
Climate Benefits*	3.53	4.35	6.22	7.53	8.15	13.46
Health Benefits**	6.16	7.58	10.85	13.13	14.20	23.48
Total Benefits†	24.47	30.04	42.63	51.13	55.06	89.35
Consumer Incremental Product Costs	2.50	3.56	7.55	10.70	12.32	32.09
Consumer Net Benefits	12.29	14.55	18.01	19.77	20.40	20.31
Total Net Monetized Benefits	21.97	26.48	35.08	40.43	42.74	57.26
Present Monetized Value of Benefits and Costs (*7% discount rate, billion 2021$*)						
Consumer Operating Cost Savings	6.06	7.47	10.58	12.62	13.55	21.59
Climate Benefits*	3.53	4.35	6.22	7.53	8.15	13.46
Health Benefits**	2.29	2.84	4.07	4.93	5.33	8.76
Total Benefits†	11.88	14.66	20.87	25.08	27.03	43.81
Consumer Incremental Product Costs	1.44	2.05	4.24	6.02	6.91	17.81
Consumer Net Benefits	4.62	5.43	6.34	6.60	6.64	3.78
Total Net Monetized Benefits	10.44	12.61	16.63	19.06	20.12	26.00

Note: This table presents the costs and benefits associated with consumer refrigerators, refrigerator-freezers, and freezers shipped in 2027–2056. These results include benefits to consumers which accrue after 2056 from the products shipped in 2027–2056.

* Climate benefits are calculated using four different estimates of the SC-CO_2, SC-CH_4 and SC-N_2O. Together, these represent the global SC-GHG. For presentational purposes of this table, the climate benefits associated with the average SC-GHG at a 3 percent discount rate are shown, but the Department does not have a single central SC-GHG point estimate. On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22-30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana v. Biden*, No. 21-cv-1074-JDC-KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from "adopting, employing, treating as binding, or relying upon" the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. As reflected in this rule, DOE has reverted to its approach prior to the injunction and presents monetized greenhouse gas abatement 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. 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.

Table V.46 Summary of Analytical Results for Refrigerator, Refrigerator-Freezer, and Freezer TSLs: Manufacturer and Consumer Impacts

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Manufacturer Impacts						
Industry NPV (*million 2021$*) (No-new-standards case INPV = $4,966.4)	4,908.2 to 4,944.5	4,867.7 to 4,920.2	4,475.6 to 4,619.8	4,366.5 to 4,554.0	3,965.2 to 4,173.5	3,255.9 to 3,688.2
Industry NPV (*% change*)	(1.2) to (0.4)	(2.0) to (0.9)	(9.9) to (7.0)	(12.1) to (8.3)	(20.2) to (16.0)	(34.4) to (25.7)
Consumer Average LCC Savings (2021$)						
PC 3	32.16	42.18	42.18	36.04	36.04	8.09
PC 5	47.15	47.15	49.73	49.73	49.73	19.14
PC 5BI	39.94	39.94	39.94	39.94	39.94	18.97
PC 5A	115.32	115.32	121.98	115.76	115.76	115.76
PC 7	53.56	78.56	95.26	95.26	101.33	94.68
PC 9	69.26	69.26	69.26	69.26	69.26	63.71
PC 10	10.20	N/A	N/A	N/A	N/A	40.91
PC 11A (residential)	16.78	16.78	9.97	9.97	9.97	(3.35)
PC 11A (commercial)	6.97	6.97	3.42	3.42	3.42	(23.47)
PC 17	21.90	21.90	21.90	21.90	21.90	(5.74)
PC 18	21.57	21.57	17.59	17.59	17.59	(9.06)
Shipment-Weighted Average*	48.75	57.83	61.26	58.58	59.43	39.97
Consumer Simple PBP (years)						
PC 3	1.4	4.0	4.0	5.3	5.3	8.7
PC 5	4.4	4.4	4.8	4.8	4.8	7.7
PC 5BI	5.7	5.7	5.7	5.7	5.7	7.3
PC 5A	2.0	2.0	4.2	5.7	5.7	5.7
PC 7	0.7	2.6	3.8	3.8	5.0	5.7
PC 9	3.9	3.9	3.9	3.9	3.9	9.0
PC 10	10.7	N/A	N/A	N/A	N/A	10.0
PC 11A (residential)	2.0	2.0	2.1	2.1	2.1	5.6
PC 11A (commercial)	3.2	3.2	3.2	3.2	3.2	8.7
PC 17	5.0	5.0	5.0	5.0	5.0	7.5
PC 18	1.3	1.3	4.2	4.2	4.2	9.0
Shipment-Weighted Average*	2.9	3.5	4.2	4.7	4.9	7.7

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Percent of Consumers that Experience a Net Cost						
PC 3	2.2	10.8	10.8	36.2	36.2	63.6
PC 5	8.9	8.9	23.4	23.4	23.4	58.3
PC 5BI	10.1	10.1	10.1	10.1	10.1	43.9
PC 5A	1.0	1.0	16.6	33.2	33.2	33.2
PC 7	0.0	5.1	15.8	15.8	28.5	35.7
PC 9	10.5	10.5	10.5	10.5	10.5	51.1
PC 10	52.7	N/A	N/A	N/A	N/A	52.1
PC 11A (residential)	0.7	0.7	8.3	8.3	8.3	50.9
PC 11A (commercial)	1.6	1.6	17.2	17.2	17.2	73.2
PC 17	12.3	12.3	12.3	12.3	12.3	66.3
PC 18	0.6	0.6	21.8	21.8	21.8	69.9
Shipment-Weighted Average*	7.2	7.6	15.7	25.7	27.5	53.3

Parentheses indicate negative (-) values. The entry "N/A" means not applicable because there is no change in the standard at certain TSLs.
* Weighted by shares of each product class in total projected shipments in 2027.

DOE first considered TSL 6, which represents the max-tech efficiency levels. At this level, DOE expects that all product classes would require VIPs and most would require VSCs. For most product classes, this represents the use of VIPs for roughly half the cabinet surface (typically side walls and doors for an upright cabinet), the best-available-efficiency variable-speed compressor, forced-convection heat exchangers with multi-speed BLDC fans, variable defrost, and increase in cabinet wall thickness for some classes (*e.g.,* compact refrigerators and both standard-size and compact chest freezers). DOE estimates that approximately 1 percent of annual shipments across all refrigerator, refrigerator-freezer, and freezer product classes currently meet the max-tech efficiencies required. TSL 6 would save an estimated 8.85 quads of energy, an amount DOE considers significant. Under TSL 6, the NPV of consumer benefit would be $3.78 billion using a discount rate of 7 percent, and $20.31 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 6 are 299 Mt of CO_2, 138 thousand tons of SO_2, 458 thousand tons of NO_X, 0.90 tons of Hg, 2,011 thousand tons of CH_4, and 3.17 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 6 is $13.46 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 6 is $8.76 billion using a 7-percent discount rate and $23.48 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, health benefits from reduced SO_2 and NO_X emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 6 is $26.00 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 6 is $57.26 billion. The estimated total NPV is provided for additional information, however DOE primarily relies upon the NPV of consumer benefits when determining whether a proposed standard level is economically justified.

At TSL 6, for the largest product classes, which are 3, 5, 5A, and 7 and together account for approximately 67 percent of annual shipments, there is a life cycle cost savings of $8.09, $19.14, $115.76, and $94.68 and a payback period of 8.7 years, 7.7 years, 5.7 years and 5.7 years, respectively. However, for these product classes, the fraction of customers experiencing a net LCC cost is 63.6 percent, 58.3 percent, 33.2 percent and 35.7 percent due to increases in first cost of $152.02, $137.71, $142.35, and $125.15, respectively. Overall, a majority of refrigerators, refrigerator-freezers, and freezers consumers (53.3 percent) would experience a net cost and the average LCC savings would be negative for PC 11A, PC 17, and PC 18. Additionally, 29 percent of low-income households with a side-by-side refrigerator-freezer (represented by PC 7 and used by 19 percent of low-income households) would experience a net cost.

At TSL 6, the projected change in INPV ranges from a decrease of $1.71 billion to a decrease of $1.23 billion, which correspond to decreases of 34.4 percent and 25.7 percent, respectively. Industry conversion costs could reach $2.25 billion as manufacturers work to redesign their portfolio of model offerings and re-tool entire factories to comply with amended standards at TSL 6.

DOE estimates that approximately 1 percent of refrigerator, refrigerator-freezer, and freezer current annual shipments meet the max-tech levels. At TSL 6, only a few manufacturers offer any standard-size products that meet the efficiencies required. For PC 3, which accounts for approximately 25 percent of annual shipments, no OEMs currently offer products that meet the efficiency level required. For PC 5, which accounts for approximately 21 percent of annual shipments, DOE estimates that only one out of 23 OEMs currently offers products that meet the efficiency level required. For PC 7, which accounts for approximately 11 percent of annual shipments, only one out of the 11 OEMs currently offers products that meet the efficiency level required.

At max-tech, manufacturers would likely need to implement all of the most efficient design options in the engineering analysis. In interviews, manufacturer indicated they would redesign all product platforms and dramatically update manufacturing facilities to meet max-tech for all approximately 16.7 million annual shipments of refrigerators, refrigerator-freezers, and freezers.

In particular, increased incorporation of VIPs could increase the expense of adapting manufacturing plants. As discussed in section IV.J.2.c of this document, DOE expects manufacturers would need to adopt VIP technology to improve thermal insulation while minimizing loss to the interior volume for their products. Extensive incorporation of VIPs requires significant capital expenditures due to the need for more careful product handling and conveyor, increased warehousing requirements, investments in tooling necessary for the VIP installation process, and adding production line capacity to compensate for more time-intensive manufacturing associated with VIPs. Manufacturers with facilities that have limited space and few options to expand may consider greenfield projects. In interviews, several manufacturers expressed concerns about their ability to produce sufficient quantities of refrigerators, refrigerator-freezers, and freezers at max-tech given the required scale of investment, redesign effort, and 3-year compliance timeline.

The Secretary tentatively concludes that at TSL 6 for refrigerators, refrigerator-freezers, and freezers, 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 potential reduction in INPV and the lack of manufacturers currently offering products meeting the efficiency levels required at this TSL. At TSL 6, a majority of refrigerator, refrigerator-freezer, and freezers consumer (53.3 percent) would experience a net cost and the average LCC savings would be negative for PC 11A, PC 17, and PC 18. Additionally, manufacturers would need to make significant upfront investments to update product lines and manufacturing facilities.

Manufacturers expressed concern that they would not be able to complete product and production line updates within the 3-year conversion period. Consequently, the Secretary has tentatively concluded that TSL 6 is not economically justified.

DOE then considered TSL 5 for refrigerators, refrigerator-freezers, and freezers. For classes other than refrigerator-freezers with bottom-mounted freezers and through-the-door ice service (PC 5A), this TSL represents efficiency levels less than max-tech. TSL 5 represents similar design option as max-tech, but generally incorporates the use of high-efficiency rather than maximum-efficiency VSCs, incorporates VIPs in fewer product classes, and incorporates less VIP surface area for the product classes requiring the use of VIPs as compared to TSL 6. TSL 5 would save an estimated 5.30 quads of energy, an amount DOE considers significant. Under TSL 5, the NPV of consumer benefit would be $6.64 billion using a discount rate of 7 percent, and $20.40 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 5 are 179 Mt of CO_2, 83.1 thousand tons of SO_2, 274 thousand tons of NO_X, 0.54 tons of Hg, 1,205 thousand tons of CH_4, and 1.90 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions (associated with the average SC-GHG at a 3-percent discount rate) at TSL 5 is $8.15 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 5 is $5.33 billion using a 7-percent discount rate and $14.20 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, health benefits from reduced SO_2 and NO_X emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 5 is $20.12

billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 5 is $42.74 billion. The estimated total NPV is provided for additional information, however DOE primarily relies upon the NPV of consumer benefits when determining whether a proposed standard level is economically justified.

At TSL 5, for the largest product classes, which are 3, 5, 5A, and 7, there is a life cycle cost savings of $36.04, $49.73, $115.76, and $101.33 and a payback period of 5.3 years, 4.8 years, 5.7 years and 5.0 years, respectively. For these product classes, the fraction of customers experiencing a net LCC cost is 36.2 percent, 23.4 percent, 33.2 percent and 28.5 percent due to increases in first cost of $49.86, $55.81, $142.35, and $100.28, respectively. Overall, 27.5 percent of refrigerators, refrigerator-freezers, and freezers consumers would experience a net cost and the average LCC savings are positive for all product classes.

At TSL 5, an estimated 12 percent of all low-income households experience a net cost, including less than 10 percent of low-income households with a top-mount or single-door refrigerator-freezer (represented by PC 3 and used by 72 percent of low-income households) and 23 percent of low-income households with a side-by-side refrigerator-freezer (represented by PC 7 and used by 19 percent of low-income households). While 23 percent of low-income PC 7 consumers experience a net cost at TSL5, more than half of those consumers experience a net cost of $30 or less and low-income PC 7 consumers experience an average LCC savings of $134.54, larger average LCC savings than at any lower TSL. Further, across all consumers, TSL 5 represents the largest average LCC savings for PC 7 of any TSL.

At TSL 5, the projected change in INPV ranges from a decrease of $1.0 billion to a decrease of $792.8 million, which correspond to decreases of 20.2 percent and 16.0 percent, respectively. DOE estimates that industry must invest $1.32 billion to comply with standards set at TSL 5.

DOE estimates that approximately 18 percent of refrigerator, refrigerator-freezer, and freezer annual shipments meet the TSL 5 efficiencies. For standard-size refrigerator-freezers, which account for approximately 70 percent of total annual shipments, approximately 5 percent of shipments meet the efficiencies required at TSL 5. Compared to max-tech, more manufacturers offer standard-size refrigerator-freezer products that meet the required efficiencies, however, many manufacturers do not offer products that meet this level. Of the 23 OEMs offering PC 3 products, two offer models that meet the efficiency level required. Of the 23 OEMs offering PC 5 products, 13 offer models that meet the efficiency level required. Of the 11 OEMs offering PC 7 products, one offers models that meet the efficiency level required.

The manufacturers that do not currently offer models that meet TSL 5 efficiencies would need to develop new product platforms. Updates could include incorporating variable defrost, BLDC evaporator fan motors, and high-efficiency VSCs. Additionally, some product classes – notably, high-volume PCs 5, 5A, and 7 – could require the use of VIPs. As discussed in section IV.J.2.c of this document, the inclusion of VIPs in product design necessitates large investments in tooling and significant changes to production plants. Furthermore, given that only 5 percent of current standard-size refrigerator-freezer shipments meet TSL 5 efficiency levels, the manufacturers that are currently able to meet TSL 5 would need to scale up manufacturing capacity of compliant models.

DOE anticipates conversion costs as high as $1.32 billion as the majority of product platforms in the industry would require redesign and investment.

DOE requests data on manufacturers' ability to complete investments necessary to adapt product designs and production facilities within the 3-year compliance timeline at TSL 5. Further, DOE requests comment on the specific limitations, including specific financial impacts on manufacturers, that would limit industry's ability to adapt to amended standards at TSL 5.

Some stakeholders raised concerns about the availability of VSCs necessary to meet TSL 5. (GE, No.38 at p.3; AHAM, No.31 at p.10) In particular, those stakeholders worried that current supply constraints on VSCs would continue through the compliance date and those constraints would be exacerbated by amended standards. The concern was not shared by all stakeholders. One manufacturer suggested that more than one-third of the US refrigerator market already uses VSCs and that the technology is becoming more accessible and more affordable (Samsung, No.32 at p.2). Additional information on the VSC supply chain, including current suppliers, current constraints, and the potential impacts of regulation certainty, would help DOE determine the validity of VSC availability concerns at TSL 5.

DOE requests comment on whether regulatory certainty and a 3-year compliance period would allow for manufacturers and suppliers to establish sufficient supply availability of VSCs for the refrigerators, refrigerator-freezers, and freezers industry at TSL 5.

After considering the analysis and weighing the benefits and burdens, the Secretary has tentatively concluded that a standard set at TSL 5 for refrigerators, refrigerator-freezers, and freezers would be economically justified. At this TSL, the average LCC savings are positive for all product classes for which an amended standard is considered. An estimated 27.5 percent of all refrigerator, refrigerator-freezer, and freezer consumers experience a net cost, which is a significantly lower percentage than under TSL 6. An estimated 12 percent of all low-income households experience a net cost, including less than 10 percent of low-income households with a top-mount or single-door refrigerator-freezer (represented by PC 3 and used by 72 percent of low-income households) and 23 percent of low-income households with a side-by-side refrigerator-freezer (represented by PC 7 and used by 19 percent of low-income households). DOE notes that low-income PC 7 consumers experience a greater average net benefit at TSL 5, with larger average LCC savings, than at any lower TSL. Across all consumers, TSL 5 represents the largest average LCC savings for PC 7 of any TSL. The FFC national energy savings are significant and the NPV of consumer benefits is positive at TSL 5 using both a 3-percent and 7-percent discount rate. Notably, the benefits to consumers vastly outweigh the cost to manufacturers. At TSL 5, the NPV of consumer benefits, even measured at the more conservative discount rate of 7 percent is over 6 times higher than the maximum estimated manufacturers' loss in INPV. The standard levels at TSL 5 are economically justified even without weighing the estimated monetary value of emissions reductions. When those emissions reductions are included – representing $8.15 billion in climate benefits (associated with the average SC-GHG at a 3-percent discount rate), and $14.20 billion (using a 3-percent discount rate) or $5.33

billion (using a 7-percent discount rate) in health benefits – the rationale becomes stronger still.

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. Although DOE has not conducted a comparative analysis to select the proposed energy conservation standards, DOE notes 19 percent of low-income households have a side-by-side refrigerator-freezer (represented by PC 7) and that an estimated 23 percent of low-income PC 7 households experience a net cost at TSL 5, whereas an estimated 14 percent of low-income households with a side-by-side refrigerator-freezer experience a net cost at TSL 4. However, the average LCC savings for low-income PC 7 consumers are $19.48 higher at TSL 5 than at TSL 4. Further, compared to TSL 4, it is estimated that TSL 5 would result in additional FFC national energy savings of 0.40 quads and additional health benefits of $1.07 billion (using a 3-percent discount rate) or $0.40 billion (using a 7-percent discount rate). The national consumer NPV similarly increases at TSL 5, compared to TSL 4, by $0.04 billion using a 7-percent discount rate and $0.63 billion using a 3-percent discount rate. These additional savings and benefits at TSL 5 are significant. DOE considers the impacts to be, as a whole, economically justified at TSL 5.

Although DOE considered proposed amended standard levels for refrigerators, refrigerator-freezers, and freezers by grouping the efficiency levels for each product class into TSLs, DOE evaluates all analyzed efficiency levels in its analysis. For all product classes other than product class 7, the proposed standard level represents the maximum energy savings that does not result in a large percentage of consumers experiencing a net LCC cost. For product class 7, the proposed standard level represents the maximum energy savings that does not represent a significant potential burden for more than 25 percent of low-income households with side-by-side refrigerator-freezers, and less than 15 percent of all low-income households. The ELs at the proposed standard level result in positive LCC savings for all product classes, significantly reduce the number of consumers experiencing a net cost, and reduce the decrease in INPV and conversion costs to the point where DOE has tentatively concluded they are economically justified, as discussed for TSL 5 in the preceding paragraphs.

Therefore, based on the previous considerations, DOE proposes to adopt the energy conservation standards for refrigerators, refrigerator-freezers, and freezers at TSL 5. The proposed amended energy conservation standards for refrigerators, refrigerator-freezers, and freezers, which are expressed as kWh/year, are shown in Table V.47.

Table V.47 Proposed Amended Energy Conservation Standards for Refrigerators, Refrigerator-Freezers, and Freezers

Product class	**Equations for maximum energy use (kWh/yr)**	
	Based on AV (ft^3)	Based on av (L)
1. Refrigerator-freezers and refrigerators other than all-refrigerators with manual defrost	6.79AV + 191.3	0.240av + 191.3
1A. All-refrigerators - manual defrost	5.77AV + 164.6	0.204av + 164.6
2. Refrigerator-freezers—partial automatic defrost	(6.79AV + 191.3)*K2	(0.240av + 191.3)*K2
3. Refrigerator-freezers—automatic defrost with top-mounted freezer	6.86AV + 198.6 + 28I	0.242av + 198.6 + 28I

3-BI. Built-in refrigerator-freezer—automatic defrost with top-mounted freezer	8.24AV + 238.4 + 28I	0.291av + 238.4 + 28I
3A. All-refrigerators - automatic defrost	(6.01AV + 171.4)*K3A	(0.212av + 171.4)*K3A
3A-BI. Built-in All-refrigerators - automatic defrost	(7.22AV + 205.7)*K3ABI	(0.255av + 205.7)*K3ABI
4. Refrigerator-freezers—automatic defrost with side-mounted freezer	6.89AV + 241.2 + 28I	0.243av + 241.2 + 28I
4-BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer	8.79AV + 307.4 + 28I	0.310av + 307.4 + 28I
5. Refrigerator-freezers—automatic defrost with bottom-mounted freezer	(7.61AV + 272.6)*K5 + 28I	(0.269av + 272.6)*K5 + 28I
5-BI. Built-In Refrigerator-freezers—automatic defrost with bottom-mounted freezer	(8.65AV + 309.9)*K5BI + 28I	(0.305av + 309.9)*K5BI + 28I
5A. Refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service	(7.26AV + 329.2)*K5A	(0.256av + 329.2)*K5A
5A-BI. Built-in refrigerator-freezer - automatic defrost with bottom-mounted freezer with through-the-door ice service	(8.21AV + 370.7)*K5ABI	(0.290av + 370.7)*K5ABI
6. Refrigerator-freezers—automatic defrost with top-mounted freezer with through-the-door ice service	7.14AV + 280.0	0.252av + 280.0
7. Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service	(6.92AV + 305.2)*K7	(0.244av + 305.2)*K7
7-BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer	(8.82AV + 384.1)*K7BI	(0.311av + 384.1)*K7BI
8. Upright freezers with manual defrost	5.57AV + 193.7	0.197av + 193.7
9. Upright freezers with automatic defrost	7.76AV + 205.5 + 28I	0.274av + 205.5 + 28I
9-BI. Built-In Upright freezers with automatic defrost	9.37AV + 247.9 + 28I	0.331av + 247.9 + 28I
10. Chest freezers and all other freezers except compact freezers	7.29AV + 107.8	0.257av + 107.8
10A. Chest freezers with automatic defrost	10.24AV + 148.1	0.362av + 148.1
11. Compact refrigerator-freezers and refrigerators other than all-refrigerators with manual defrost	7.68AV + 214.5	0.271av + 214.5
11A. Compact all-refrigerators - manual defrost	6.66AV + 186.2	0.235av + 186.2

12. Compact refrigerator-freezers—partial automatic defrost	(7.68AV + 214.5)*K12	(0.271av + 214.5)*K12
13. Compact refrigerator-freezers—automatic defrost with top-mounted freezer	10.62AV + 305.3 + 28I	0.375av + 305.3 + 28I
13A. Compact all-refrigerators - automatic defrost	(8.25AV + 233.4)*K13A	(0.291av + 233.4)*K13A
14. Compact refrigerator-freezers—automatic defrost with side-mounted freezer	6.14AV + 411.2 + 28I	0.217av + 411.2 + 28I
15. Compact refrigerator-freezers—automatic defrost with bottom-mounted freezer	10.62AV + 305.3 + 28I	0.375av + 305.3 + 28I
16. Compact upright freezers with manual defrost	7.35AV + 191.8	0.260av + 191.8
17. Compact upright freezers with automatic defrost	9.15AV + 316.7	0.323av + 316.7
18. Compact chest freezers	7.86AV + 107.8	0.278av + 107.8

AV = Total adjusted volume, expressed in ft^3, as determined in appendices A and B of subpart B of 10 CFR part 430.
av = Total adjusted volume, expressed in Liters.
I = 1 for a product with an automatic icemaker and = 0 for a product without an automatic icemaker.
Door Coefficients (e.g., K3A) are as defined in the table below.

Table V.48 Description of Door Coefficients for Proposed Maximum Energy Use Equations for Refrigerators, Refrigerator-freezers, and Freezers

<table>
<tr><th>Door Coefficient</th><th>Products with a Transparent Door</th><th>Products without a Transparent Door with a Door-in-Door</th><th>Products without a Transparent Door or Door-in-Door with Added External Doors</th></tr>
<tr><td>K2</td><td>N/A</td><td>N/A</td><td>1 + 0.02 * (N_d - 1)</td></tr>
<tr><td>K3A</td><td rowspan="10">1.10</td><td rowspan="3">N/A</td><td rowspan="3">N/A</td></tr>
<tr><td>K3ABI</td></tr>
<tr><td>K13A</td></tr>
<tr><td>K5</td><td rowspan="6">1.06</td><td rowspan="2">1 + 0.02 * (N_d - 2)</td></tr>
<tr><td>K5BI</td></tr>
<tr><td>K5A</td><td rowspan="2">1 + 0.02 * (N_d - 3)</td></tr>
<tr><td>K5ABI</td></tr>
<tr><td>K7</td><td rowspan="2">1 + 0.02 * (N_d - 2)</td></tr>
<tr><td>K7BI</td></tr>
<tr><td>K12</td><td>N/A</td><td>N/A</td><td>1 + 0.02 * (N_d - 1)</td></tr>
<tr><td colspan="4">N_d is the number of external doors</td></tr>
</table>

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.49 shows the annualized values for refrigerators, refrigerator-freezers, and freezers under TSL 5, expressed in 2021$. The results under the primary estimate are as follows.

Using a 7-percent discount rate for consumer benefits and costs and NOx and SO_2 reduction benefits, and a 3-percent discount rate case for GHG social costs, the estimated cost of the proposed standards for refrigerators, refrigerator-freezers, and freezers is $730.0 million per year in increased equipment costs, while the estimated annual benefits are $1.4317 billion from reduced equipment operating costs, $467.9 million from GHG reductions, and $563.3 million from reduced NO_X and SO_2 emissions. In this case, the net benefit amounts to $1.7329 billion per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the proposed standards for refrigerators, refrigerator-freezers, and freezers is $707.4 million per year in increased equipment costs, while the estimated annual benefits are $1.8786 billion in reduced operating costs, $467.9 million from GHG reductions, and $815.2 million from reduced NO_X and SO_2 emissions. In this case, the net benefit amounts to $2.4543 billion per year.

Table V.49 Annualized Benefits and Costs of Proposed Energy Conservation Standards for Refrigerators, Refrigerator-Freezers, and Freezers (TSL 5)

	Million 2021$/year		
	Primary Estimate	**Low-Net-Benefits Estimate**	**High-Net-Benefits Estimate**
3% discount rate			
Consumer Operating Cost Savings	1,878.6	1,745.5	2,030.6
Climate Benefits*	467.9	453.4	482.4
Health Benefits**	815.2	790.3	840.1
Total Benefits†	3,161.7	2,989.3	3,353.1
Consumer Incremental Product Costs‡	707.4	774.3	681.3
Net Monetized Benefits	2,454.3	2,215.0	2,671.9
7% discount rate			
Consumer Operating Cost Savings	1,431.7	1,339.6	1,534.2
Climate Benefits* (3% discount rate)	467.9	453.4	482.4
Health Benefits**	563.3	547.4	579.1
Total Benefits†	2,462.9	2,340.4	2,595.7
Consumer Incremental Product Costs	730.0	788.4	706.3
Net Monetized **Benefits**	1,732.9	1,552.0	1,889.4

Note: This table presents the costs and benefits associated with refrigerators, refrigerator-freezers, and freezers shipped in 2027–2056. These results include benefits to consumers which accrue after 2056 from the products shipped in 2027–2056. The Primary, Low Net Benefits, and High Net Benefits Estimates utilize projections of energy prices from the *AEO2022* Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental equipment costs reflect a medium decline rate in the Primary Estimate, a low decline rate in the Low Net Benefits Estimate, and a high decline rate in the High Net Benefits Estimate. The methods used to derive projected price trends are explained in section IV.H.3. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

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

D. Reporting, Certification, and Sampling Plan

Manufacturers, including importers, must use product-specific certification templates to certify compliance to DOE. For refrigerators, refrigerator-freezers, and freezers, the certification template reflects the general certification requirements specified at 10 CFR 429.12 and the product-specific requirements specified at 10 CFR 429.14. As discussed in the previous paragraphs, DOE is not proposing to amend the product-specific certification requirements for these products.

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 is an economically 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 TSD for this rulemaking.

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) requires preparation of an initial regulatory flexibility analysis ("IRFA") for any rule that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by E.O. 13272, "Proper Consideration of Small Entities in Agency Rulemaking," 67 FR 53461 (Aug. 16, 2002), DOE published procedures and policies on February 19, 2003, to ensure that the potential impacts of its rules on small entities are properly considered during the rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of the General Counsel's website (*energy.gov/gc/office-general-counsel*). DOE has prepared the following IRFA for the products that are the subject of this rulemaking.

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

1. Description of Reasons Why Action Is Being Considered

DOE is proposing amended energy conservation standards for refrigerators, refrigerator-freezers, and freezers. EPCA prescribed energy conservation standards for these products (42 U.S.C. 6295(b)(1)-(2)), and directed DOE to conduct three cycles of future rulemakings to whether to amend these standards. (42 U.S.C. 6295(b)(3)(A)(i), (b)(3)(B), and (b)(4)). DOE has completed these rulemakings. EPCA further provides that, not later than 6 years after the issuance of any final rule establishing or amending a standard, DOE must publish either a notice of determination that standards for the product do not need to be amended, or a NOPR including new proposed energy conservation standards (proceeding to a final rule, as appropriate). (42 U.S.C. 6295(m)(1)) This rulemaking is in accordance with DOE's obligations under EPCA.

2. Objectives of, and Legal Basis for, Rule

EPCA authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. Title III, Part B of EPCA established the

Energy Conservation Program for Consumer Products Other Than Automobiles. These products include refrigerators, refrigerator-freezers, and freezers, the subject of this document. (42 U.S.C. 6292(a)(1)) EPCA prescribed energy conservation standards for these products (42 U.S.C. 6295(b)(1)-(2)), and directed. DOE to conduct three cycles of future rulemakings to whether to amend these standards. (42 U.S.C. 6295(b)(3)(A)(i), (b)(3)(B), and (b)(4)). DOE has completed these rulemakings. EPCA further provides that, not later than 6 years after the issuance of any final rule establishing or amending a standard, DOE must publish either a notice of determination that standards for the product do not need to be amended, or a NOPR including new proposed energy conservation standards (proceeding to a final rule, as appropriate). (42 U.S.C. 6295(m)(1))

3. Description on Estimated Number of Small Entities Regulated

DOE reviewed this proposed rule under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. 68 FR 7990. DOE conducted a market survey to identify potential small manufacturers of refrigerators, refrigerator-freezers, and freezers. DOE began its assessment by reviewing DOE's CCD,[93] California Energy Commission's Modernized Appliance Efficiency Database System ("MAEDbS"),[94] individual company websites, and prior refrigerator, refrigerator-freezer, and freezer rulemakings to identify manufacturers of the covered product. DOE then consulted publicly available data, such as manufacturer websites,

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[93] U.S. Department of Energy's Compliance Certification Database is available at: *www.regulations.doe.gov/certification-data/#q=Product_Group_s%3A** (Last accessed March 25, 2022).
[94] California Energy Commission's Modernized Appliance Efficiency Database System is available at: *cacertappliances.energy.ca.gov/Pages/ApplianceSearch.aspx* (Last accessed March 25, 2022).

manufacturer specifications and product literature, import/export logs (*e.g.*, bills of lading from Panjiva[95]), and basic model numbers, to identify original equipment manufacturers ("OEMs") of covered refrigerators, refrigerator-freezers, and freezers. DOE further relied on public data and subscription-based market research tools (*e.g.*, Dun & Bradstreet reports[96]) to determine company, location, headcount, and annual revenue. DOE also asked industry representatives if they were aware of any small manufacturers during manufacturer interviews. DOE screened out companies that do not offer products covered by this rulemaking, do not meet the SBA's definition of a "small business," or are foreign-owned and operated.

DOE initially identified 49 OEMs that sell refrigerators, refrigerator-freezers, or freezers in the United States. Of the 49 OEMs identified, DOE tentatively determined that one company qualifies as a small business and is not foreign-owned and operated.

DOE reached out to the small business and invited them to participate in a voluntary interview. The small business did not consent to participate in a formal MIA interview. DOE also requested information about small businesses and potential impacts on small businesses while interviewing larger manufacturers.

[95] S&P Global. Panjiva Market Intelligence is available at: *panjiva.com/import-export/United-States* (Last accessed May 5, 2022).
[96] D&B Hoovers | Company Information | Industry Information | Lists, *app.dnbhoovers.com/* (Last accessed August 24, 2022).

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

The one small business identified has 45 refrigerator, refrigerator-freezer, and freezer models certified in DOE's CCD. Of those 45 models, 43 models are compact-size refrigerators, refrigerator-freezers, or freezers (34 PC 13A models, three PC 15 models, and six PC 17 models). The remaining two models are standard-size built-in refrigerator-freezer models (PC 3A-BI). Of the 34 PC 13A models, 22 models meet the efficiency required at TSL 5. For PC 15, PC 17, and PC 3A-BI, this small manufacturer only offers models at the current DOE baseline efficiency and, therefore, does not offer any products that meet the proposed TSL 5 efficiencies (i.e., 10 percent reduction in energy use from the current DOE baseline). To meet the required efficiencies, DOE expects this small manufacturer would likely need to implement variable defrost and variable-speed compressors, along with other design options across all their product platforms. Some capital conversion costs may be necessary for additional tooling and new stations to test more variable-speed compressors. Product conversion costs may be necessary for developing, qualifying, sourcing, and testing new components. DOE estimated conversion costs for this small manufacturer by using model counts to scale-down the industry conversion costs. DOE estimates that the small manufacturer may incur $400,000 in capital conversion costs and $490,000 in product conversion costs related to redesigning their products to meet proposed amended standards. Based on subscription-based market research reports,[97] the small business has an annual revenue of

[97] D&B Hoovers | Company Information | Industry Information | Lists, *app.dnbhoovers.com/* (Last accessed August 24, 2022).

approximately $85.3 million. The total conversion costs of $890,000 are approximately 0.3 percent of company revenue over the 3-year conversion period.

DOE seeks comments, information, and data on the number of small businesses in the industry, the names of those small businesses, and their market shares by product class. DOE also requests comment on the potential impacts of the proposed standards on small manufacturers.

5. Duplication, Overlap, and Conflict with Other Rules and Regulations

DOE is not aware of any rules or regulations that duplicate, overlap, or conflict with the proposed rule.

6. Significant Alternatives to the Rule

The discussion in the previous section analyzes impacts on small businesses that would result from DOE's proposed rule, represented by TSL 5. In reviewing alternatives to the proposed rule, DOE examined energy conservation standards set at lower efficiency levels. While TSL 1, TSL 2, TSL 3, and TSL 4 would reduce the impacts on small business manufacturers, it would come at the expense of a reduction in energy savings. TSL 1 achieves 56 percent lower energy savings compared to the energy savings at TSL 5. TSL 2 achieves 46 percent lower energy savings compared to the energy savings at TSL 5. TSL 3 achieves 24 percent lower energy savings compared to the energy savings at TSL 5. TSL 4 achieves 8 percent lower energy savings compared to the energy savings at TSL 5.

Based on the presented discussion, establishing standards at TSL 5 balances the benefits of the energy savings at TSL 5 with the potential burdens placed on refrigerator, refrigerator-freezer, and freezer manufacturers, including small business manufacturers.

Accordingly, DOE does not propose one of the other TSLs considered in the analysis, or the other policy alternatives examined as part of the regulatory impact analysis and included in chapter 17 of the NOPR TSD.

Additional compliance flexibilities may be available through other means. EPCA provides that a manufacturer whose annual gross revenue from all of its operations does not exceed $8 million may apply for an exemption from all or part of an energy conservation standard for a period not longer than 24 months after the effective date of a final rule establishing the standard. (42 U.S.C. 6295(t)) Additionally, manufacturers subject to DOE's energy efficiency standards may apply to DOE's Office of Hearings and Appeals for exception relief under certain circumstances. Manufacturers should refer to 10 CFR part 430, subpart E, and 10 CFR part 1003 for additional details.

C. Review Under the Paperwork Reduction Act

Manufacturers of refrigerators, refrigerator-freezers, and freezers must certify to DOE that their products comply with any applicable energy conservation standards. In certifying compliance, manufacturers must test their products according to the DOE test procedures for refrigerators, refrigerator-freezers, and freezers, including any amendments adopted for those test procedures. DOE has established regulations for the certification and recordkeeping requirements for all covered consumer products and commercial equipment, including refrigerators, refrigerator-freezers, and freezers. (See generally 10 CFR part 430). The collection of information requirement for the certification and recordkeeping is subject to review and approval by OMB under the Paperwork Reduction Act ("PRA"). This requirement has been approved by OMB under OMB control number 1910-1400. Public reporting burden for the certification is estimated to average 35 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the PRA, unless that collection of information displays a currently valid OMB Control Number.

D. Review Under the National Environmental Policy Act of 1969

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

E. Review Under Executive Order 13132

E.O. 13132, "Federalism," 64 FR 43255 (Aug. 10, 1999), imposes certain requirements on Federal agencies formulating and implementing policies or regulations that preempt State law or that have federalism implications. The Executive order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and to carefully assess the necessity for such actions. The Executive order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. DOE has examined this proposed rule and has tentatively determined that it would not have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of this proposed rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297) Therefore, no further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of E.O. 12988, "Civil Justice Reform," imposes on Federal agencies the general duty to adhere to the following requirements: (1) eliminate drafting errors and ambiguity, (2) write regulations to minimize litigation, (3) provide a clear legal standard for affected conduct rather than a general standard, and (4) promote simplification and burden reduction. 61 FR 4729 (Feb. 7, 1996). Regarding the review required by section 3(a), section 3(b) of E.O. 12988 specifically requires that Executive agencies make every reasonable effort to ensure that the regulation: (1) clearly specifies the preemptive effect, if any, (2) clearly specifies any effect on existing Federal law or regulation, (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction, (4) specifies the retroactive effect, if any, (5) adequately defines key terms, and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of Executive Order 12988 requires executive agencies to review regulations in light of applicable standards in section 3(a) and section 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, this proposed rule meets the relevant standards of E.O. 12988.

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 ("UMRA") requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Pub. L. 104-4, section 201 (codified at 2 U.S.C. 1531). For a proposed regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a proposed "significant intergovernmental mandate," and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect them. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820. DOE's policy statement is also available at *www.energy.gov/sites/prod/files/gcprod/documents/umra_97.pdf*.

Although this proposed rule does not contain a Federal intergovernmental mandate, it may require expenditures of $100 million or more in any one year by the private sector. Such expenditures may include: (1) investment in research and development and in capital expenditures by refrigerator, refrigerator-freezer, and freezer manufacturers in the years between the final rule and the compliance date for the new standards and (2) incremental additional expenditures by consumers to purchase higher-efficiency refrigerators, refrigerator-freezers, and freezers, starting at the compliance date for the applicable standard.

Section 202 of UMRA authorizes a Federal agency to respond to the content requirements of UMRA in any other statement or analysis that accompanies the proposed rule. (2 U.S.C. 1532(c)) The content requirements of section 202(b) of UMRA relevant to a private sector mandate substantially overlap the economic analysis requirements that apply under section 325(o) of EPCA and Executive Order 12866. The **SUPPLEMENTARY INFORMATION** section of this NOPR and the TSD for this proposed rule respond to those requirements.

Under section 205 of UMRA, the Department is obligated to identify and consider a reasonable number of regulatory alternatives before promulgating a rule for which a written statement under section 202 is required. (2 U.S.C. 1535(a)) DOE is required to select from those alternatives the most cost-effective and least burdensome alternative that achieves the objectives of the proposed rule unless DOE publishes an explanation for doing otherwise, or the selection of such an alternative is inconsistent with law. As required by 42 U.S.C. 6295(m), this proposed rule would establish amended energy conservation standards for refrigerators, refrigerator-freezers, and freezers that are designed to achieve the maximum improvement in energy efficiency that DOE has determined to be both technologically feasible and economically justified, as required by 42 U.S.C. 6295(o)(2)(A) and 6295(o)(3)(B). A full discussion of the alternatives considered by DOE is presented in chapter 17 of the TSD for this proposed rule.

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

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

I. Review Under Executive Order 12630

Pursuant to E.O. 12630, "Governmental Actions and Interference with Constitutionally Protected Property Rights," 53 FR 8859 (Mar. 15, 1988), DOE has determined that this proposed rule would not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution.

J. Review Under the Treasury and General Government Appropriations Act, 2001

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516 note) provides for Federal agencies to review most disseminations of information to the public under information quality guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (Feb. 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). Pursuant to OMB Memorandum M-19-15, Improving Implementation of the Information Quality Act (April 24, 2019), DOE published updated guidelines which are available at *www.energy.gov/sites/prod/files/2019/12/f70/DOE%20Final%20Updated%20IQA%20Guidelines%20Dec%202019.pdf*. DOE has reviewed this NOPR under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

E.O. 13211, "Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use," 66 FR 28355 (May 22, 2001), requires Federal agencies to prepare and submit to OIRA at OMB, a Statement of Energy Effects for any proposed significant energy action. A "significant energy action" is defined as any action by an agency that promulgates or is expected to lead to promulgation of a final rule, and that (1) is a significant regulatory action under Executive Order 12866, or any successor order; and (2) is likely to have a significant adverse effect on the supply, distribution, or use of energy, or (3) is designated by the Administrator of OIRA as a significant energy action. For any proposed significant energy action, the agency must give a detailed statement of any adverse effects on energy supply, distribution, or use should the proposal be implemented, and of reasonable alternatives to the action and their expected benefits on energy supply, distribution, and use.

DOE has tentatively concluded that this regulatory action, which proposes amended energy conservation standards for refrigerators, refrigerator-freezers, and freezers 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.[98] 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.[99]

VII. Public Participation

A. Attendance at the Public Meeting

The time and date of the webinar meeting are listed in the **DATES** section at the beginning of this document. Webinar registration information, participant instructions, and information about the capabilities available to webinar participants will be published on DOE's website at *www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=37*. Participants are responsible for ensuring their systems are compatible with the webinar software.

[98] 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 August 24, 2022).
[99] The report is available at *www.nationalacademies.org/our-work/review-of-methods-for-setting-building-and-equipment-performance-standards*.

B. Procedure for Submitting Prepared General Statements for Distribution

Any person who has plans to present a prepared general statement may request that copies of his or her statement be made available at the public meeting. Such persons may submit requests, along with an advance electronic copy of their statement in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format, to the appropriate address shown in the **ADDRESSES** section at the beginning of this document. The request and advance copy of statements must be received at least one week before the public meeting and are to be emailed. Please include a telephone number to enable DOE staff to make follow-up contact, if needed.

C. Conduct of the Public Meeting

DOE will designate a DOE official to preside at the 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 public meeting. There shall not be discussion of proprietary information, costs or prices, market share, or other commercial matters regulated by U.S. antitrust laws. After the public meeting, interested parties may submit further comments on the proceedings, as well as on any aspect of the rulemaking, until the end of the comment period.

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

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

A transcript of the public meeting will be included in the docket, which can be viewed as described in the *Docket* section at the beginning of this document and will be accessible on the DOE website. In addition, any person may buy a copy of the transcript from the transcribing reporter.

D. Submission of Comments

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

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

However, your contact information will be publicly viewable if you include it in the comment itself or in any documents attached to your comment. Any information that you do not want to be publicly viewable should not be included in your comment, nor in any document attached to your comment. Otherwise, persons viewing comments will see only first and last names, organization names, correspondence containing comments, and any documents submitted with the comments.

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

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

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

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

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

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

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

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

E. Issues on Which DOE Seeks Comment

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

(1) DOE requests comments on its proposal to consolidate the presentation of maximum allowable energy use for products of classes that may or may not have an automatic icemaker.

(2) DOE requests comment on its proposal for establishing energy use allowances for multiple doors and/or specialty doors. Should such an energy use allowance structure be established, and, if so, are the proposed energy use allowance levels appropriate? If they are not appropriate, DOE requests input on what the energy use allowance values should be, with supporting data to demonstrate that the alternative levels suggested are justified.

(3) DOE requests comments on the proposed definitions to clarify transparent door and door-in-door features. If the proposed definitions are not appropriate, DOE requests comment on what specific changes should be made to the definitions, or what other definitions are necessary, so that they would appropriately describe the intended specialized doors.

(4) DOE seeks comment on the method for estimating manufacturing production costs and on the resulting cost-efficiency curves.

(5) DOE requests comment on its markups analysis and the underlying assumptions, including price elasticities specific to the market for new refrigeration products and any potential effects from a market for second refrigerators or second-hand products.

(6) DOE requests comment on its methodology to develop UAFs and also requests data on actual energy use for standard-size consumer refrigerators, refrigerator-freezers, and freezers in the field to further inform the UAF development for subsequent rounds of this rulemaking.

(7) DOE requests comment on the overall methodology and results of the LCC and PBP analyses.

(8) DOE requests comment on its methodology to develop market share distributions by adjusted volume in the compliance year for each PC with two representative volumes, as well as data to further inform these distributions in subsequent rounds of this rulemaking.

(9) DOE requests comment and data on its assumption that installation costs do not change as a function of EL for refrigeration products.

(10) DOE requests comment on its assumption that maintenance costs do not change as a function of EL for refrigeration products. DOE also requests comment and data on its methodology for determining repair costs by PC and EL.

(11) DOE requests comment and data on the assumptions and methodology used to calculate refrigerator, refrigerator-freezer, and freezer survival probabilities. DOE requests comment and data on source of second refrigerators, whether from new purchase, conversion of surviving first refrigerators, or second-hand markets. DOE also welcomes any information indicating whether or not the service lifetime of refrigeration products differs by efficiency level.

(12) DOE requests comment on its methodology to develop market share distributions by EL for each PC and representative unit for the no-new-standards case in the compliance year, as well as data to further inform these distributions in subsequent rounds of this rulemaking. DOE also requests comment on the assumption that the current efficiency distribution would remain fixed over the analysis period, and data to inform an efficiency trend by PC.

(13) DOE requests comment on the overall methodology and results of the shipments analysis.

(14) DOE requests comment on its assumption of no efficiency trend and seeks historical product efficiency data.

(15) DOE requests comment on assumptions made in the energy use scaling for non-representative product classes in the National Impacts Analysis.

(16) DOE requests comment on the overall methodology and results of the consumer subgroup analysis.

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

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

(19) DOE seeks comment on whether manufacturers expect manufacturing capacity constraints would limit product availability to consumers in the timeframe of the amended standard compliance date (2027). In particular, DOE requests information on the product classes and associated efficiency levels that would delay manufacturer's ability to comply with a standard due to the extent of factory investments associated with VIP.

(20) DOE requests data on the availability of VSCs in the timeframe of the standard (2027). Additionally, DOE requests comment on the impact of international regulations on availability of VSCs for the domestic refrigerator, refrigerator-freezer, and freezer market.

(21) DOE requests comment on the potential impacts on domestic, low-volume manufacturers at the TSLs presented in this NOPR.

(22) DOE requests information regarding the impact of cumulative regulatory burden on manufacturers of refrigerators, refrigerator-freezers, and freezers associated with multiple DOE standards or product-specific regulatory actions of other Federal agencies.

(23) DOE seeks comment on its analysis of wall thickness increases for product classes 10, 11A, and 18 along with its preliminary conclusions that consumer utility will not be impacted.

(24) DOE requests data on manufacturers' ability to complete investments necessary to adapt product designs and production facilities within the 3-year compliance timeline at TSL 5. Further, DOE requests comment on the specific limitations, including specific financial impacts on manufacturers, that would limit industry's ability to adapt to amended standards at TSL 5.

(25) DOE requests comment on whether regulatory certainty and a 3-year compliance period would allow for manufacturers and suppliers to establish sufficient supply availability of VSCs for the refrigerators, refrigerator-freezers, and freezers industry at TSL 5.

(26) DOE seeks comments, information, and data on the number of small businesses in the industry, the names of those small businesses, and their market shares by product class. DOE also requests comment on the potential impacts of the proposed standards on small manufacturers.

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

VIII. Approval of the Office of the Secretary

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

List of Subjects

10 CFR Part 430

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, Imports, Incorporation by reference, Intergovernmental relations, Small businesses.

10 CFR Part 431

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

Signing Authority

This document of the Department of Energy was signed on February 9, 2023, by Francisco Alejandro Moreno, Acting Assistant Secretary for Energy Efficiency and Renewable Energy, pursuant to delegated authority from the Secretary of Energy. That document with the original signature and date is maintained by DOE. For administrative purposes only, and in compliance with requirements of the Office of the Federal Register, the undersigned DOE Federal Register Liaison Officer has been authorized to sign and submit the document in electronic format for publication, as an official document of the Department of Energy. This administrative process in no way alters the legal effect of this document upon publication in the *Federal Register*.

Signed in Washington, DC, on February 9, 2023

X FRANCISCO MORENO

Digitally signed by FRANCISCO MORENO
Date: 2023.02.09 17:55:23 -05'00'

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

For the reasons set forth in the preamble, DOE proposes to amend part 430 of chapter II, subchapter D, of title 10 of the Code of Federal Regulations, as set forth below:

PART 430 - ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

1. The authority citation for part 430 continues to read as follows:

Authority: 42 U.S.C. 6291-6309; 28 U.S.C. 2461 note.

2. Amend appendix A to subpart B of part 430 by:

a. In section 3. Definitions, by adding, in alphabetical order, definitions for ”Door-in-door” and “Transparent door”;

b. In section 5.3:

(i) Removing paragraphs (a) and (f), and;

(ii) Redesignating paragraphs (b) through (e) as paragraphs (a) through (d); and

c. Adding new sections 5.4 and 5.5.

The additions read as follows.

Appendix A to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Refrigerators, Refrigerator-Freezers, and Miscellaneous Refrigeration Products

* * * * *

3. * * *

Door-in-door means a set of doors or an outer door and inner drawer for which—

(a) Both doors (or both the door and the drawer) must be opened to provide access to the interior through a single opening;

(b) Gaskets for both doors (or both the door and the drawer) are exposed to external ambient conditions on the outside around the full perimeter of the respective openings; and

(c) The space between the two doors (or between the door and the drawer) achieves temperature levels consistent with the temperature requirements of the interior compartment to which the door-in-door provides access.

* * * * *

Transparent door means a door for which 75 percent or more of the surface area is glass or another transparent material.

* * * * *

5.4 Icemaker Energy Use

(a) For refrigerators and refrigerator-freezers: To demonstrate compliance with the energy conservation standards at 10 CFR 430.32(a) applicable to products manufactured on or after September 15, 2014, but before the compliance date of any amended standards published after January 1, 2022, IET, expressed in kilowatt-hours per cycle, equals 0.23 for a product with one or more automatic icemakers and otherwise equals 0 (zero). To demonstrate compliance with any amended standards published after January 1, 2022, IET, expressed in kilowatt-hours per cycle, is as defined section 5.9.2.1 of HRF-1-2019.

(b) For miscellaneous refrigeration products: To demonstrate compliance with the energy conservation standards at 10 CFR 430.32(aa) applicable to products manufactured on or after October 28, 2019, IET, expressed in kilowatt-hours per cycle, equals 0.23 for a product with one or more automatic icemakers and otherwise equals 0 (zero).

5.5 Triangulation Method

If the three-point interpolation method of section 5.2(b) of this appendix is used for setting temperature controls, the average per-cycle energy consumption shall be defined as follows:

$E = E_X + IET$

Where:

E is defined in section 5.9.1.1 of HRF-1-2019;

IET is defined in section 5.4 of this appendix; and

E_X is defined and calculated as described in appendix M, section M4(a) of AS/NZS 4474.1:2007. The target temperatures t_{xA} and t_{xB} defined in section M4(a)(i) of AS/NZS 4474.1:2007 shall be the standardized temperatures defined in section 5.6 of HRF-1-2019.

* * * * *

3. Amend appendix B to subpart B of part 430 by:

a. In section 5.3:

(i) Removing paragraph (a); and

(ii) Redesignating paragraphs (b) and (c) as paragraphs (a) and (b); and;

b. Adding new section 5.4.

The additions read as follows:.

Appendix B to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Freezers

*   *   *   *   *

5.4 Icemaker Energy Use

For freezers: To demonstrate compliance with the energy conservation standards at 10 CFR 430.32(a) applicable to products manufactured on or after September 15, 2014 but before the compliance date of any amended standards published after January 1, 2022, IET, expressed in kilowatt-hours per cycle, equals 0.23 for a product with one or more automatic icemakers and otherwise equals 0 (zero). To demonstrate compliance with any amended standards published after January 1, 2022, IET, expressed in kilowatt-hours per cycle, is as defined in section 5.9.2.1 of HRF-1-2019.

*   *   *   *   *

4. Amend §430.32 by revising paragraph (a) to read as follows:

§430.32 Energy and water conservation standards and their compliance dates.

*   *   *   *   *

(a) *Refrigerators/refrigerator-freezers/freezers*. These standards do not apply to refrigerators and refrigerator-freezers with total refrigerated volume exceeding 39 cubic feet (1104 liters) or freezers with total refrigerated volume exceeding 30 cubic feet (850 liters). The energy standards as determined by the equations of the following table(s) shall be rounded off to the nearest kWh per year. If the equation calculation is halfway between the nearest two kWh per year values, the standard shall be rounded up to the higher of these values.

The following standards remain in effect from September 15, 2014, until [*date 3 years after the publication of the final rule*].

Product Class	**Equations for Maximum Energy Use (kWh/yr)**	
	based on AV (ft^3)	based on av (L)
1. Refrigerators and refrigerator-freezers with manual defrost.	7.99AV + 225.0	0.282av + 225.0
1A. All-refrigerators—manual defrost.	6.79AV + 193.6	0.240av + 193.6
2. Refrigerator-freezers—partial automatic defrost	7.99AV + 225.0	0.282av + 225.0
3. Refrigerator-freezers—automatic defrost with top-mounted freezer without an automatic icemaker.	8.07AV + 233.7	0.285av + 233.7
3-BI. Built-in refrigerator-freezer—automatic defrost with top-mounted freezer without an automatic icemaker.	9.15AV + 264.9	0.323av + 264.9
3I. Refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic icemaker without through-the-door ice service.	8.07AV + 317.7	0.285av + 317.7
3I-BI. Built-in refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic icemaker without through-the-door ice service.	9.15AV + 348.9	0.323av + 348.9
3A. All-refrigerators—automatic defrost.	7.07AV + 201.6	0.250av + 201.6
3A-BI. Built-in All-refrigerators—automatic defrost.	8.02AV + 228.5	0.283av + 228.5
4. Refrigerator-freezers—automatic defrost with side-mounted freezer without an automatic icemaker.	8.51AV + 297.8	0.301av + 297.8
4-BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer without an automatic icemaker.	10.22AV + 357.4	0.361av + 357.4
4I. Refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker without through-the-door ice service.	8.51AV + 381.8	0.301av + 381.8

4I-BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker without through-the-door ice service.	10.22AV + 441.4.2	0.361av + 441.4
5. Refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker.	8.85AV + 317.0	0.312av + 317.0
5-BI. Built-In Refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker.	9.40AV + 336.9	0.332av + 336.9
5I. Refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker without through-the-door ice service.	8.85AV + 401.0	0.312av + 401.0
5I-BI. Built-In Refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker without through-the-door ice service.	9.40AV + 420.9	0.332av + 420.9
5A. Refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service.	9.25AV + 475.4	0.327av + 475.4
5A-BI. Built-in refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service.	9.83AV + 499.9	0.347av + 499.9
6. Refrigerator-freezers—automatic defrost with top-mounted freezer with through-the-door ice service.	8.40AV + 385.4	0.297av + 385.4
7. Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service.	8.54AV + 432.8	0.302av + 431.1
7-BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service.	10.25AV + 502.6	0.362av + 502.6
8. Upright freezers with manual defrost.	5.57AV + 193.7	0.197av + 193.7
9. Upright freezers with automatic defrost without an automatic icemaker.	8.62AV + 228.3	0.305av + 228.3
9I. Upright freezers with automatic defrost with an automatic icemaker.	8.62AV + 312.3	0.305av + 312.3
9-BI. Built-In Upright freezers with automatic defrost without an automatic icemaker.	9.86AV + 260.9	0.348av + 260.6
9I-BI. Built-In Upright freezers with automatic defrost with an automatic icemaker	9.86AV + 344.9	0.348av + 344.9
10. Chest freezers and all other freezers except compact freezers.	7.29AV + 107.8	0.257av + 107.8
10A. Chest freezers with automatic defrost.	10.24AV + 148.1	0.362av + 148.1
11. Compact refrigerators and refrigerator-freezers with manual defrost.	9.03AV + 252.3	0.319av + 252.3
11A.Compact refrigerators and refrigerator-freezers with manual defrost.	7.84AV + 219.1	0.277av + 219.1
12. Compact refrigerator-freezers—partial automatic defrost	5.91AV + 335.8	0.209av + 335.8
13. Compact refrigerator-freezers—automatic defrost with top-mounted freezer.	11.80AV + 339.2	0.417av + 339.2
13I. Compact refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic icemaker.	11.80AV + 423.2	0.417av + 423.2
13A. Compact all-refrigerator—automatic defrost.	9.17AV + 259.3	0.324av + 259.3

14. Compact refrigerator-freezers—automatic defrost with side-mounted freezer.	6.82AV + 456.9	0.241av + 456.9
14I. Compact refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker.	6.82AV + 540.9	0.241av + 540.9
15. Compact refrigerator-freezers—automatic defrost with bottom-mounted freezer.	11.80AV + 339.2	0.417av + 339.2
15I. Compact refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker.	11.80AV + 423.2	0.417av + 423.2
16. Compact upright freezers with manual defrost.	8.65AV + 225.7	0.306av + 225.7
17. Compact upright freezers with automatic defrost.	10.17AV + 351.9	0.359av + 351.9
18. Compact chest freezers.	9.25AV + 136.8	0.327av + 136.8

AV=Total adjusted volume, expressed in ft^3, as determined in appendices A and B of subpart B of this part.
av=Total adjusted volume, expressed in Liters.

The following standards apply to products manufacturer starting on [*date 3 years after the publication of the final rule*].

Product class	**Equations for maximum energy use (kWh/yr)**	
	Based on AV (ft^3)	Based on av (L)
1. Refrigerator-freezers and refrigerators other than all-refrigerators with manual defrost	6.79AV + 191.3	0.240av + 191.3
1A. All-refrigerators - manual defrost	5.77AV + 164.6	0.204av + 164.6
2. Refrigerator-freezers—partial automatic defrost	(6.79AV + 191.3)*K2	(0.240av + 191.3)*K2
3. Refrigerator-freezers—automatic defrost with top-mounted freezer	6.86AV + 198.6 + 28I	0.242av + 198.6 + 28I

3-BI. Built-in refrigerator-freezer—automatic defrost with top-mounted freezer	8.24AV + 238.4 + 28I	0.291av + 238.4 + 28I
3A. All-refrigerators - automatic defrost	(6.01AV + 171.4)*K3A	(0.212av + 171.4)*K3A
3A-BI. Built-in All-refrigerators - automatic defrost	(7.22AV + 205.7)*K3ABI	(0.255av + 205.7)*K3ABI
4. Refrigerator-freezers—automatic defrost with side-mounted freezer	6.89AV + 241.2 + 28I	0.243av + 241.2 + 28I
4-BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer	8.79AV + 307.4 + 28I	0.310av + 307.4 + 28I
5. Refrigerator-freezers—automatic defrost with bottom-mounted freezer	(7.61AV + 272.6)*K5 + 28I	(0.269av + 272.6)*K5 + 28I
5-BI. Built-In Refrigerator-freezers—automatic defrost with bottom-mounted freezer	(8.65AV + 309.9)*K5BI + 28I	(0.305av + 309.9)*K5BI + 28I
5A. Refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service	(7.26AV + 329.2)*K5A	(0.256av + 329.2)*K5A
5A-BI. Built-in refrigerator-freezer - automatic defrost with bottom-mounted freezer with through-the-door ice service	(8.21AV + 370.7)*K5ABI	(0.290av + 370.7)*K5ABI
6. Refrigerator-freezers—automatic defrost with top-mounted freezer with through-the-door ice service	7.14AV + 280.0	0.252av + 280.0
7. Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service	(6.92AV + 305.2)*K7	(0.244av + 305.2)*K7
7-BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer	(8.82AV + 384.1)*K7BI	(0.311av + 384.1)*K7BI
8. Upright freezers with manual defrost	5.57AV + 193.7	0.197av + 193.7
9. Upright freezers with automatic defrost	7.76AV + 205.5 + 28I	0.274av + 205.5 + 28I
9-BI. Built-In Upright freezers with automatic defrost	9.37AV + 247.9 + 28I	0.331av + 247.9 + 28I
10. Chest freezers and all other freezers except compact freezers	7.29AV + 107.8	0.257av + 107.8
10A. Chest freezers with automatic defrost	10.24AV + 148.1	0.362av + 148.1
11. Compact refrigerator-freezers and refrigerators other than all-refrigerators with manual defrost	7.68AV + 214.5	0.271av + 214.5
11A. Compact all-refrigerators - manual defrost	6.66AV + 186.2	0.235av + 186.2

12. Compact refrigerator-freezers—partial automatic defrost	(7.68AV + 214.5)*K12	(0.271av + 214.5)*K12
13. Compact refrigerator-freezers—automatic defrost with top-mounted freezer	10.62AV + 305.3 + 28I	0.375av + 305.3 + 28I
13A. Compact all-refrigerators - automatic defrost	(8.25AV + 233.4)*K13A	(0.291av + 233.4)*K13A
14. Compact refrigerator-freezers—automatic defrost with side-mounted freezer	6.14AV + 411.2 + 28I	0.217av + 411.2 + 28I
15. Compact refrigerator-freezers—automatic defrost with bottom-mounted freezer	10.62AV + 305.3 + 28I	0.375av + 305.3 + 28I
16. Compact upright freezers with manual defrost	7.35AV + 191.8	0.260av + 191.8
17. Compact upright freezers with automatic defrost	9.15AV + 316.7	0.323av + 316.7
18. Compact chest freezers	7.86AV + 107.8	0.278av + 107.8

AV = Total adjusted volume, expressed in ft^3, as determined in appendices A and B of subpart B of 10 CFR part 430.
av = Total adjusted volume, expressed in Liters.
I = 1 for a product with an automatic icemaker and = 0 for a product without an automatic icemaker.
Door Coefficients (e.g. K3A) are as defined in the table.

<table>
<tr><th>Door Coefficient</th><th>Products with a Transparent Door</th><th>Products without a Transparent Door with a Door-in-Door</th><th>Products without a Transparent Door or Door-in-Door with Added External Doors</th></tr>
<tr><td>K2</td><td>N/A</td><td>N/A</td><td>1 + 0.02 * (N_d - 1)</td></tr>
<tr><td>K3A</td><td rowspan="10">1.10</td><td rowspan="3">N/A</td><td rowspan="3">N/A</td></tr>
<tr><td>K3ABI</td></tr>
<tr><td>K13A</td></tr>
<tr><td>K5</td><td rowspan="7">1.06</td><td rowspan="2">1 + 0.02 * (N_d - 2)</td></tr>
<tr><td>K5BI</td></tr>
<tr><td>K5A</td><td rowspan="2">1 + 0.02 * (Nd - 3)</td></tr>
<tr><td>K5ABI</td></tr>
<tr><td>K7</td><td rowspan="2">1 + 0.02 * (Nd - 2)</td></tr>
<tr><td>K7BI</td></tr>
<tr><td>K12</td><td>N/A</td><td>N/A</td><td>1 + 0.02 * (N_d - 1)</td></tr>
<tr><td colspan="4">N_d is the number of external doors</td></tr>
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