**DEPARTMENT OF ENERGY**

**10 CFR Part 430**

**[EERE–2017–BT–STD–0003]**

**RIN 1904–AF56**

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

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

**ACTION:** Direct final rule.

**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. In this direct final rule, the U.S. Department of Energy (''DOE'') is adopting amended energy conservation standards for refrigerators, refrigerator-freezers, and freezers. DOE has determined that the amended energy conservation standards for these products would result in significant conservation of energy, and are technologically feasible and economically justified.

**DATES:** The effective date of this rule is May 16, 2024. The incorporation by reference of certain material listed in the rule was approved by the Director as of May 21, 2014, and November 12, 2021. If adverse comments are received by May 6, 2024, and DOE determines that such comments may provide a reasonable basis for withdrawal of the direct final rule under 42 U.S.C. 6295(o), a timely withdrawal of this rule will be published in the **Federal Register**. If no such adverse comments are received, compliance with the amended standards established for refrigerators, refrigerator-freezers, and freezers in this direct final rule is required on and after January 31, 2029, for the product classes listed in Table I.1 and January 31, 2030, for the product classes listed in Table I.2.

**ADDRESSES:** The docket for this rulemaking, which includes **Federal Register** notices, public meeting attendee lists and transcripts, 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.

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

**FOR FURTHER INFORMATION CONTACT:**

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**SUPPLEMENTARY INFORMATION:**

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## I. Synopsis of the Direct Final Rule

The Energy Policy and Conservation Act, Public Law 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 direct final rule. (42 U.S.C. 6292(a)(7))

Pursuant to EPCA, any new or amended energy conservation standard must, among other things, 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 significant conservation of energy. (42 U.S.C. 6295(o)(3)(B))

In light of the above and under the authority provided by 42 U.S.C. 6295(p)(4), DOE is issuing this direct final rule amending energy conservation standards for refrigerators, refrigerator-freezers, and freezers.

The adopted standard levels in this direct final rule were proposed in a letter submitted to DOE jointly by groups representing manufacturers, energy and environmental advocates, consumer groups, and a utility. This letter, titled ''Energy Efficiency Agreement of 2023'' (hereafter, the ''Joint Agreement''),[3] recommends specific energy conservation standards for refrigerators, refrigerator-freezers, and freezers that, in the commenters' view, would satisfy the EPCA requirements in 42 U.S.C. 6295(o). DOE subsequently received letters of support from states including California, Massachusetts, and New York [4] and utilities including San Diego Gas and Electric (''SDG&E'') and Southern California Edison (''SCE'') [5] advocating for the adoption of the recommended standards and a follow-up letter from the parties to the Joint Agreement that more specifically described the recommended standards for refrigerators, refrigerator-freezers, and freezers, and their rationale for entering into a negotiation to develop them.[6]

In accordance with the direct final rule provisions at 42 U.S.C. 6295(p)(4), DOE has determined that the recommendations contained in the Joint Agreement are compliant with 42 U.S.C. 6295(o). As required by 42 U.S.C. 6295(p)(4)(A)(i), DOE is also simultaneously publishing a notice of proposed rulemaking (''NOPR'') that contains identical standards to those adopted in this direct final rule. Consistent with the statute, DOE is providing a 110-day public comment period on the direct final rule. (42 U.S.C. 6295(p)(4)(B)) If DOE determines that any comments received provide a reasonable basis for withdrawal of the direct final rule under 42 U.S.C. 6295(o) or any other applicable law, DOE will publish the reasons for withdrawal and continue the rulemaking under the NOPR. (42 U.S.C. 6295(p)(4)(C)) *See* section II.A of this document for more details on DOE's statutory authority.

The amended standards that DOE is adopting in this direct final rule are the efficiency levels recommended in the Joint Agreement (shown in Tables I.1 and I.2) expressed in terms of kilowatt hours per year (''kWh/yr'') as measured according to DOE's current refrigerator, refrigerator-freezer, and freezer test procedures codified at title 10 of the Code of Federal Regulations (''CFR''), part 430, subpart B, appendices A (''appendix A'') and B (''appendix B'').

The amended standards recommended in the Joint Agreement are represented as trial standard level (''TSL'') 4 in this document (hereinafter the ''Recommended TSL'') and are described in section V.A of this document. These standards apply to all products listed in Table I.1 and manufactured in, or imported into the United States starting on January 31, 2029, and all products listed in Table I.2 and manufactured in, or imported into, the United States starting on January 31, 2030.

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

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

[3] This document is available in the docket at: *www.regulations.gov/document/EERE-2017-BT-STD-0003-0103.*

[4] This document is available in the docket at: *www.regulations.gov/document/EERE-2017-BT-STD-0003-0104.*

[5] This document is available in the docket at: *www.regulations.gov/comment/EERE-2017-BT-STD-0003-0107.*

[6] This document is available in the docket at: *www.regulations.gov/document/EERE-2017-BT-STD-0003-0105.*

TABLE I.1—ENERGY CONSERVATION STANDARDS FOR CONSUMER REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS WITH CORRESPONDING DOOR COEFFICIENT TABLE

[Compliance starting January 31, 2029]

| Product class ("PC") | Equations for maximum energy use (kWh/yr) | |
|---|---|---|
| | Based on AV ($ft^3$) | Based on av (L) |
| 3–BI. Built-in refrigerator-freezer—automatic defrost with top-mounted freezer. | 8.24AV + 238.4 + 28I | 0.291av + 238.4 + 28I. |
| 3A–BI. Built-in All-refrigerators—automatic defrost | (7.22AV + 205.7)*K3ABI | (0.255av + 205.7)*K3ABI. |
| 4–BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer. | (8.79AV + 307.4)*K4BI + 28I | (0.310av + 307.4)*K4BI + 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. | (7.76AV + 351.9)*K5A | (0.274av + 351.9)*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. |
| 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–BI. Built-In Upright freezers with automatic defrost | (9.37AV + 247.9)*K9BI + 28I | (0.331av + 247.9)*K9BI + 28I. |
| 9A–BI. Built-In Upright freezers with automatic defrost with through-the-door ice service. | 9.86AV + 288.9 | 0.348av + 288.9. |
| 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. | 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 | (5.32AV + 302.2)*K12 | (0.188av + 302.2)*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.,* K3ABI) are as defined in the following table.

| 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 |
|---|---|---|---|
| K3ABI | 1.10 | 1.0 | 1.0. |
| K4BI | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 2). |
| K5BI | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 2). |
| K5A | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 3). |
| K5ABI | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 3). |
| K7BI | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 2). |
| K9BI | 1.0 | 1.0 | 1 + 0.02 * ($N_d$ − 1). |
| K12 | 1.0 | 1.0 | 1 + 0.02 * ($N_d$ − 1). |
| K13A | 1.10 | 1.0 | 1.0. |

**Notes:**
[1] $N_d$ is the number of external doors.
[2] The maximum $N_d$ values are 2 for K12, 3 for K9BI, and 5 for all other K values.

TABLE I.2—ENERGY CONSERVATION STANDARDS FOR CONSUMER REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS WITH CORRESPONDING DOOR COEFFICIENT TABLE

[Compliance starting January 31, 2030]

| Product class | Equations for maximum energy use (kWh/yr) | |
|---|---|---|
| | Based on AV (ft³) | 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. |
| 3A. All-refrigerators—automatic defrost | (6.01AV + 171.4)*K3A | (0.212av + 171.4)*K3A. |
| 4. Refrigerator-freezers—automatic defrost with side-mounted freezer. | (7.28AV + 254.9)*K4 + 28I | (0.257av + 254.9)*K4 + 28I. |
| 5. Refrigerator-freezers—automatic defrost with bottom-mounted freezer. | (7.61AV + 272.6)*K5 + 28I | (0.269av + 272.6)*K5 + 28I. |
| 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. | (7.31AV + 322.5)*K7 | (0.258av + 322.5)*K7. |
| 9. Upright freezers with automatic defrost | (7.33AV + 194.1)*K9 + 28I | (0.259av + 194.1)*K9 + 28I. |

AV = Total adjusted volume, expressed in ft³, 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 following table.

| 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 | 1.0 | 1.0 | 1 + 0.02 * ($N_d$ − 1). |
| K4 | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 2). |
| K3A | 1.10 | 1.0 | 1.0. |
| K5 | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 2). |
| K7 | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 2). |
| K9 | 1.0 | 1.0 | 1 + 0.02 * ($N_d$ − 1). |

**Notes:**
[1] $N_d$ is the number of external doors.
[2] The maximum $N_d$ values are 2 for K2, and 5 for all other K values.

*A. Benefits and Costs to Consumers*

Table I.3 summarizes DOE's evaluation of the economic impacts of the adopted 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").[7] 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 ENERGY CONSERVATION STANDARDS ON CONSUMERS OF REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS

[The recommended TSL]

| Product class | Average LCC savings (2022$) | Simple payback period (years) |
|---|---|---|
| PC 3 | 50.91 | 4.8 |
| PC 5 | 55.23 | 5.6 |
| PC 5BI | 91.13 | 2.1 |
| PC 5A | 133.27 | 4.1 |
| PC 7 | 142.56 | 1.6 |
| PC 9 | 56.17 | 6.6 |
| PC 10 | N/A | N/A |
| PC 11A (residential) | 8.35 | 2.1 |

[7] 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).

TABLE I.3—IMPACTS OF ENERGY CONSERVATION STANDARDS ON CONSUMERS OF REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS—Continued

[The recommended TSL]

| Product class | Average LCC savings (2022$) | Simple payback period (years) |
|---|---|---|
| PC 11A (commercial) | 3.16 | 3.2 |
| PC 17 | 36.86 | 4.1 |
| PC 18 | 23.55 | 4.1 |

**Note:** The compliance year for the Recommended TSL (*i.e.,* TSL 4) varies by product class:
2029: PCs 5BI, 5A, 10, 11A, 17, and 18.
2030: PCs 3, 5, 7, and 9.

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

*B. Impact on Manufacturers*[8]

The industry net present value (''INPV'') is the sum of the discounted cash flows to the industry from the base year (2023) through the end of the analysis period, which is 30 years from the analyzed compliance date.[9] 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 $4.91 billion.[10] Under the adopted standards, which align with the Recommended TSL for refrigerators, refrigerator-freezers, and freezers, DOE estimates the change in INPV to range from −10.3 percent to −7.8 percent, which is approximately −$504.4 million to −$383.5 million. In order to bring products into compliance with amended standards, it is estimated that industry will incur total conversion costs of $830.3 million.

DOE's analysis of the impacts of the adopted standards on manufacturers is described in sections IV.J and V.B.2 of this document.

*C. National Benefits and Costs*

DOE's analyses indicate that the adopted 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 amended standards (2029–2058 for the product classes listed in Table I.1 and 2030–2059 for the product classes listed in Table I.2), amount to 5.6 quadrillion British thermal units (''Btu''), or quads.[11] This represents a savings of 11 percent relative to the energy use of these products in the case without amended standards (referred to as the ''no-new-standards case'').

The cumulative net present value (''NPV'') of total consumer benefits of the standards for refrigerators, refrigerator-freezers, and freezers ranges from $9.0 billion (at a 7-percent discount rate) to $27.0 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 2029–2058 for the product classes listed in Table I.1 and 2030–2059 for the product classes listed in Table I.2.

In addition, the adopted standards for refrigerators, refrigerator-freezers, and freezers are projected to yield significant environmental benefits. DOE estimates that the standards will result in cumulative emission reductions (over the same period as for energy savings) of 100.8 million metric tons (''Mt'')[12] of carbon dioxide (''$CO_2$''), 31.6 thousand tons of sulfur dioxide (''$SO_2$''), 186.1 thousand tons of nitrogen oxides (''$NO_X$''), 846.5 thousand tons of methane (''$CH_4$''), 1.0 thousand tons of nitrous oxide (''$N_2O$''), and 0.2 tons of mercury (''Hg'').[13]

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''). DOE used interim SC–GHG values developed by an Interagency Working Group on the Social Cost of Greenhouse Gases (''IWG'').[14] 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 $5.0 billion. DOE does not have a single central SC–GHG point estimate and it emphasizes the importance and value of considering the benefits calculated using all four sets of SC–GHG estimates.

DOE estimated the monetary health benefits of $SO_2$ and $NO_X$ emissions reductions, using benefit-per-ton estimates from the scientific literature, as discussed in section IV.L of this document. DOE estimated the present value of the health benefits would be $3.4 billion using a 7-percent discount rate, and $9.8 billion using a 3-percent

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

[9] DOE's analysis period extends 30-years from the compliance year. The analysis period ranges from 2023–2056 for the no-new-standards case and all TSLs, except for TSL 4 (the Recommended TSL). The analysis period for TSL 4 ranges from 2023–2058 for the product classes listed in Table I.1 and 2023–2059 for the product classes listed in Table I.2.

[10] The no-new-standards case INPV of $4.91 billion reflects the sum of discounted free cash flows from 2023–2056 (from direct final rule publication to 30 years from the 2027 compliance date) plus a discounted terminal value.

[11] 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 of this document.

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

[13] DOE calculated emissions reductions relative to the no-new-standards-case, which reflects key assumptions in the *Annual Energy Outlook 2023* (''*AEO2023*''). *AEO2023* represents current Federal and State legislation and final implementation of regulations as of the time of its preparation. See section IV.K of this document for further discussion of *AEO2023* assumptions that affect air pollutant emissions.

[14] To monetize the benefits of reducing GHG emissions this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990* published in February 2021 by the IWG (''February 2021 SC–GHG TSD''). *www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf.*

discount rate.[15] 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 monetized benefits and costs expected to result from the amended standards for refrigerators, refrigerator-freezers, and freezers. There are other important unquantified effects, including certain unquantified climate benefits, unquantified public health benefits from the reduction of toxic air pollutants and other emissions, unquantified energy security benefits, and distributional effects, among others.

TABLE I.4—SUMMARY OF MONETIZED BENEFITS AND COSTS OF ADOPTED ENERGY CONSERVATION STANDARDS FOR REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS

[The recommended TSL]

| | Billion (2022$) |
|---|---|
| **3% discount rate** | |
| Consumer Operating Cost Savings | 36.4 |
| Climate Benefits * | 5.0 |
| Health Benefits ** | 9.8 |
| Total Benefits † | 51.2 |
| Consumer Incremental Product Costs ‡ | 9.4 |
| Net Benefits | 41.8 |
| Change in Producer Cashflow (INPV) ‡‡ | (0.50)–(0.38) |
| **7% discount rate** | |
| Consumer Operating Cost Savings | 14.0 |
| Climate Benefits * (3% discount rate) | 5.0 |
| Health Benefits ** | 3.4 |
| Total Benefits † | 22.5 |
| Consumer Incremental Product Costs ‡ | 5.0 |
| Net Benefits | 17.5 |
| Change in Producer Cashflow (INPV) ‡‡ | (0.50)–(0.38) |

**Note:** This table presents present value (in 2022$) of the costs and benefits associated with refrigerators, refrigerator-freezers, and freezers shipped in 2029–2058 for the product classes listed in Table I.1 and shipped in 2030–2059 for the product classes listed in Table I.2. These results include benefits which accrue after 2058/9 from the products shipped in 2029/30–2058/9.

* 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; however DOE emphasizes the importance and value of considering the benefits calculated using all four sets of SC–GHG estimates. To monetize the benefits of reducing GHG emissions, this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990* published in February 2021 by the IWG.

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

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

‡‡ Operating Cost Savings are calculated based on the life-cycle costs analysis and national impact analysis as discussed in detail below. *See* sections IV.F and IV.H of this document. DOE's national impact analysis ("NIA") includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the product and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (the MIA). *See* section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. Change in INPV is calculated using the industry weighted average cost of capital value of 9.1 percent that is estimated in the manufacturer impact analysis (*see* chapter 12 of the direct final rule technical support document ("TSD") for a complete description of the industry weighted average cost of capital). For refrigerators, refrigerator-freezers, and freezers, those values are −$504 million to −$383 million. DOE accounts for that range of likely impacts in analyzing whether a TSL is economically justified. *See* section V.C of this document. DOE is presenting the range of impacts to the INPV under two markup scenarios: the Preservation of Gross Margin scenario, which is the manufacturer markup scenario used in the calculation of Consumer Operating Cost Savings in this table, and the Preservation of Operating Profit scenario, where DOE assumed manufacturers would not be able to increase per-unit operating profit in proportion to increases in manufacturer production costs. DOE includes the range of estimated INPV in the above table, drawing on the MIA explained further in section IV.J of this document, to provide additional context for assessing the estimated impacts of this direct final rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A–4 and E.O. 12866. If DOE were to include the INPV into the net benefit calculation for this direct final rule, the net benefits would range from $41.3 billion to $41.4 billion at 3-percent discount rate and would range from $17.0 billion to $17.1 billion at 7-percent discount rate. Parentheses ( ) indicate negative values.

[15] 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.

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.[16]

The national operating cost savings are domestic private U.S. consumer monetary savings that occur as a result of purchasing the covered products and are measured for the lifetime of refrigerators, refrigerator-freezers, and freezers shipped in 2029–2058 for the product classes listed in Table I.1 and shipped in 2030–2059 for the product classes listed in Table I.2. The benefits associated with reduced emissions achieved as a result of the adopted standards are also calculated based on the lifetime of refrigerators, refrigerator-freezers, and freezers shipped in 2029–2058 for the product classes listed in Table I.1 and shipped in 2030–2059 for the product classes listed in Table I.2. Total benefits for both the 3-percent and 7-percent cases are presented using the average GHG social costs with 3-percent discount rate. Estimates of SC–GHG values are presented for all four discount rates in section IV.L of this document.

Table I.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 $NO_X$ and $SO_2$ emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the standards adopted in this rule is $590.5 million per year in increased equipment costs, while the estimated annual monetized benefits are $1.7 billion in reduced equipment operating costs, $303.8 million in climate benefits, and $410.6 million in health benefits. In this case, the net benefit would amount to $1.8 billion per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the standards is $567.5 million per year in increased equipment costs, while the estimated annual monetized benefits are $2.2 billion in reduced operating costs, $303.8 million in climate benefits, and $592.9 million in health benefits. In this case, the net benefit would amount to $2.5 billion per year.

TABLE I.5—ANNUALIZED MONETIZED BENEFITS AND COSTS OF ADOPTED STANDARDS FOR REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS

[TSL 4, the recommended TSL]

| | Million (2022$/year) | | |
|---|---|---|---|
| | Primary estimate | Low-net-benefits estimate | High-net-benefits estimate |
| **3% discount rate** | | | |
| Consumer Operating Cost Savings | 2,200.5 | 2,023.9 | 2,326.6 |
| Climate Benefits * | 303.8 | 291.8 | 307.9 |
| Health Benefits ** | 592.9 | 569.7 | 600.7 |
| Total Benefits † | 3,097.2 | 2,885.4 | 3,235.2 |
| Consumer Incremental Product Costs ‡ | 567.5 | 666.6 | 547.8 |
| Net Benefits | 2,529.6 | 2,218.8 | 2,687.4 |
| Change in Producer Cashflow (INPV) ‡‡ | (49)–(37) | (49)–(37) | (49)–(37) |
| **7% discount rate** | | | |
| Consumer Operating Cost Savings | 1,667.0 | 1,541.9 | 1,758.5 |
| Climate Benefits * (3% discount rate) | 303.8 | 291.8 | 307.9 |
| Health Benefits ** | 410.6 | 395.8 | 415.7 |
| Total Benefits † | 2,381.4 | 2,229.5 | 2,482.0 |
| Consumer Incremental Product Costs ‡ | 590.5 | 677.9 | 569.6 |
| Net Benefits | 1,790.9 | 1,551.6 | 1,912.5 |
| Change in Producer Cashflow (INPV) ‡‡ | (49)–(37) | (49)–(37) | (49)–(37) |

**Note:** This table presents present value (in 2022$) of the costs and benefits associated with refrigerators, refrigerator-freezers, and freezers shipped in 2029–2058 for the product classes listed in Table I.1 and shipped in 2030–2059 for the product classes listed in Table I.2. These results include benefits which accrue after 2056 from the products shipped in 2029–2058 for the product classes listed in Table I.1 and shipped in 2030–2059 for the product classes listed in Table I.2. The Primary, Low Net Benefits, and High Net Benefits Estimates utilize projections of energy prices from the *AEO2023* Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental equipment costs reflect a medium decline rate in the Primary Estimate, a low decline rate in the Low Net Benefits Estimate, and a high decline rate in the High Net Benefits Estimate. The methods used to derive projected price trends are explained in 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; however, DOE emphasizes the importance and value of considering the benefits calculated using all four sets of SC–GHG estimates. To monetize the benefits of reducing GHG emissions, this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane.*

[16] 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.,* 2020 or 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.

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

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

‡‡ Operating Cost Savings are calculated based on the life-cycle costs analysis and national impact analysis as discussed in detail below. *See* sections IV.F and IV.H of this document. DOE's NIA includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the product and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (the MIA). *See* section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. The annualized change in INPV is calculated using the industry weighted average cost of capital value of 9.1 percent that is estimated in the manufacturer impact analysis (*see* chapter 12 of the direct final rule TSD for a complete description of the industry weighted average cost of capital). For refrigerators, refrigerator-freezers, and freezers, those values are −$48.7 million to −$37.0 million. DOE accounts for that range of likely impacts in analyzing whether a TSL is economically justified. *See* section V.C of this document. DOE is presenting the range of impacts to the INPV under two manufacturer markup scenarios: the Preservation of Gross Margin scenario, which is the manufacturer markup scenario used in the calculation of Consumer Operating Cost Savings in this table, and the Preservation of Operating Profit Markup scenario, where DOE assumed manufacturers would not be able to increase per-unit operating profit in proportion to increases in manufacturer production costs. DOE includes the range of estimated annualized change in INPV in the above table, drawing on the MIA explained further in section IV.J of this document, to provide additional context for assessing the estimated impacts of this direct final rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A–4 and E.O. 12866. If DOE were to include the INPV into the annualized net benefit calculation for this direct final rule, the annualized net benefits would range from $2,480.9 million to $2,492.6 million at 3-percent discount rate and would range from $1,742.2 million to $1,753.9 million at 7-percent discount rate. Parentheses ( ) indicate negative values.

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

*D. Conclusion*

DOE has determined that the Joint Agreement was submitted jointly by interested persons that are fairly representative of relevant points of view, in accordance with 42 U.S.C. 6295(p)(4)(A). After considering the recommended standards and weighing the benefits and burdens, DOE has determined that the recommended standards are in accordance with 42 U.S.C. 6295(o), which contains the criteria for prescribing new or amended standards. Specifically, the Secretary has determined that the adoption of the recommended standards would result in the significant conservation of energy and is the maximum improvement in energy efficiency that is technologically feasible and economically justified. In determining whether the recommended standards are economically justified, the Secretary has determined that the benefits of the recommended standards exceed the burdens. The Secretary has further concluded that the recommended standards, when considering the benefits of energy savings, positive NPV of consumer benefits, emission reductions, the estimated monetary value of the emissions reductions, and positive average LCC savings, would yield benefits that outweigh the negative impacts on some consumers and on manufacturers, including the conversion costs that could result in a reduction in INPV for manufacturers.

Using a 7-percent discount rate for consumer benefits and costs and $NO_X$ and $SO_2$ reduction benefits, and a 3-percent discount rate case for GHG social costs, the estimated cost of the standards for refrigerators, refrigerator-freezers, and freezers is $590.5 million per year in increased product costs, while the estimated annual monetized benefits are $1.7 billion in reduced product operating costs, $303.8 million in climate benefits, and $410.6 million in health benefits. The net monetized benefit amounts to $1.8 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.[17] For example, some covered products and equipment have most of their energy consumption occur during periods of peak energy demand. The impacts of these products on the energy infrastructure can be more pronounced than products with relatively constant demand. Accordingly, DOE evaluates the significance of energy savings on a case-by-case basis.

As previously mentioned, the standards are projected to result in estimated national energy savings of 5.6 quads (full-fuel cycle (''FFC'')), the equivalent of the primary annual energy use of 37 million homes. In addition, they are projected to reduce $CO_2$ emissions by 100.8 Mt. Based on these findings, DOE has determined the energy savings from the standard levels adopted in this direct final rule are ''significant'' within the meaning of 42 U.S.C. 6295(o)(3)(B). A more detailed discussion of the basis for these conclusions is contained in the remainder of this document and the accompanying TSD.[18]

Under the authority provided by 42 U.S.C. 6295(p)(4), DOE is issuing this direct final rule amending the energy conservation standards for refrigerators, refrigerator-freezers, and freezers. Consistent with this authority, DOE is also simultaneously publishing elsewhere in this **Federal Register** a NOPR proposing standards that are identical to those contained in this direct final rule. See 42 U.S.C. 6295(p)(4)(A)(i).

## II. Introduction

The following section briefly discusses the statutory authority underlying this direct final 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 energy conservation standards for these products (42 U.S.C. 6295(b)(1)), and directed DOE to conduct future rulemakings to determine whether to amend these standards. (42 U.S.C. 6295(b)(3)) EPCA further provides that, not later than 6 years after the issuance of any final rule establishing or

[17] 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).

[18] The TSD is available in the docket for this rulemaking at *www.regulations.gov/docket/EERE-2017-BT-STD-0003/document.*

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 in limited instances 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(Ir)) 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 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 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 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 determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A) and 42 U.S.C. 6295(o)(3)(B)) Furthermore, DOE may not adopt any standard that would not result in the significant conservation of energy. (42 U.S.C. 6295(o)(3)(B))

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, as codified, 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, as codified, 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))

EPCA specifies requirements when promulgating an energy conservation standard for a covered product that has two or more subcategories. A rule prescribing an energy conservation standard for a type (or class) of product must specify a different standard level for a type or class of products 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 consider such factors as the utility to the consumer of such a 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))

Additionally, pursuant to the amendments contained in the Energy Independence and Security Act of 2007 (''EISA 2007''), Public Law 110–140, final rules for new or amended energy conservation standards promulgated after July 1, 2010, are 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 and standards for refrigerators, refrigerator-freezers, and freezers address standby mode and off mode energy use, as do the amended standards adopted in this direct final rule.

Finally, EISA 2007 amended EPCA, in relevant part, to grant DOE authority to issue a final rule (*i.e.,* a ''direct final rule'') establishing an energy conservation standard upon receipt of a statement submitted jointly by interested persons that are fairly representative of relevant points of view (including representatives of manufacturers of covered products, States, and efficiency advocates), as determined by the Secretary, that contains recommendations with respect to an energy or water conservation standard. (42 U.S.C. 6295(p)(4)) Pursuant to 42 U.S.C. 6295(p)(4), the Secretary must also determine whether a jointly-submitted recommendation for an energy or water conservation standard satisfies 42 U.S.C. 6295(o) or 42 U.S.C. 6313(a)(6)(B), as applicable.

The direct final rule must be published simultaneously with a NOPR that proposes an energy or water conservation standard that is identical to the standard established in the direct final rule, and DOE must provide a public comment period of at least 110 days on this proposal. (42 U.S.C. 6295(p)(4)(A)–(B)) While DOE typically provides a comment period of 60 days on proposed standards, for a NOPR accompanying a direct final rule, DOE provides a comment period of the same length as the comment period on the direct final rule—*i.e.,* 110 days. Based on the comments received during this period, the direct final rule will either become effective, or DOE will withdraw it not later than 120 days after its issuance if: (1) one or more adverse comments is received, and (2) DOE determines that those comments, when viewed in light of the rulemaking record related to the direct final rule, may provide a reasonable basis for withdrawal of the direct final rule under 42 U.S.C. 6295(o), 42 U.S.C. 6313(a)(6)(B), or any other applicable law. (42 U.S.C. 6295(p)(4)(C)) Receipt of an alternative joint recommendation may also trigger a DOE withdrawal of the direct final rule in the same manner. (*Id.*)

DOE has previously explained its interpretation of its direct final rule authority. In a final rule amending the Department's ''Procedures, Interpretations and Policies for Consideration of New or Revised Energy Conservation Standards for Consumer Products'' at 10 CFR part 430, subpart C, appendix A, DOE noted that it may issue standards recommended by interested persons that are fairly representative of relative points of view as a direct final rule when the recommended standards are in accordance with 42 U.S.C. 6295(o) or 6313(a)(6)(B), as applicable. 86 FR 70892, 70912 (Dec. 13, 2021). But the direct final rule provision in EPCA does not impose additional requirements applicable to other standards rulemakings, which is consistent with the unique circumstances of rules issued as consensus agreements under DOE's direct final rule authority. *Id.* DOE's discretion remains bounded by its statutory mandate to adopt a standard that results in the maximum improvement in energy efficiency that is technologically feasible and economically justified—a requirement found in 42 U.S.C. 6295(o). *Id.* As such, DOE's review and analysis of the Joint Agreement is limited to whether the recommended standards satisfy the criteria in 42 U.S.C. 6295(o).

*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 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).

2. Current Test Procedure

On December 23, 2019, DOE published a test procedure NOPR (''December 2019 TP NOPR'') proposing to amend residential refrigerator, refrigerator-freezer, and freezer test procedure. 84 FR 70842. On October 12, 2021, DOE published a test procedure final rule (''October 2021 TP Final Rule'') establishing test procedures for refrigerators, refrigerator-freezers, and freezers, at 10 CFR part 430, subpart B, appendices A (''appendix A'') and B (''appendix B''). 86 FR 56790. The test procedure adopted the latest version of the relevant industry standard published by the Association of Home Appliance Manufacturers (''AHAM''), updated in 2019, AHAM Standard HRF–1, ''Energy and Internal Volume of Refrigerating Appliances'' (''HRF–1–2019''). 10 CFR 430.3(i)(4). The standard levels proposed in the NOPR are based on the annual energy use (''AEU'') metrics as measured according to appendices A and B.

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

The National Appliance Energy Conservation Act of 1987 (''NAECA''), Public Law 100–12, amended EPCA to establish prescriptive standards for refrigeration products, with requirements that DOE conduct two cycles of rulemakings to determine whether to amend these standards (42 U.S.C. 6295 (b)(1), (2), (3)(A)(i), and (3)(B)–(C)). DOE completed the first of these rulemaking cycles in 1989 and 1990 by adopting amended performance standards for all refrigeration products manufactured on or after January 1, 1993. 54 FR 47916 (November 17, 1989); 55 FR 42845 (October 24, 1990). DOE completed a second rulemaking cycle to amend the standards for refrigeration products by issuing a final rule in 1997, which adopted the current standards for these products. 62 FR 23102 (April 28, 1997).

In 2005, DOE granted a petition, submitted by a coalition of state governments, utility companies, consumer and low-income advocacy groups, and environmental and energy efficiency organizations, requesting a rulemaking to amend the standards for residential refrigerator-freezers. DOE then conducted limited analyses to examine the technological and economic feasibility of amended standards at the ENERGY STAR levels that were in effect for 2005 for the two most popular product classes of refrigerator-freezers. These analyses not only identified potential energy savings, benefits, and burdens from such standards, but also assessed other issues related to them.

DOE initiated a rulemaking and also published a notice announcing the availability of the framework document and a public meeting to discuss the document in September 2008. It also requested public comment on the published document. 73 FR 54089 (September 18, 2008). The framework document described the procedural and analytical approaches that DOE anticipated using to evaluate energy conservation standards for refrigeration products and identified various issues to resolve during the rulemaking. DOE published a final rule on September 15, 2011, to satisfy the statutory requirement that DOE publish a final rule to determine whether to amend the standards for refrigeration products manufactured in 2014. (42 U.S.C. 6295(b)(4)) The limited 2005 analyses served as background for the more extensive analysis conducted for final rule published on September 15, 2011. 76 FR 57516.

4. The Joint Agreement

On September 25, 2023, DOE received a joint statement (*i.e.,* the Joint Agreement) recommending standards for refrigerators, refrigerator-freezers, and freezers that was submitted by groups representing manufacturers, energy and environmental advocates, consumer groups, and a utility.[19] In addition to the recommended standards for refrigerators, refrigerator-freezers, and freezers, the Joint Agreement also included separate recommendations for several other covered products.[20] And, while acknowledging that DOE may implement these recommendations in separate rulemakings, the Joint Agreement also stated that the recommendations were recommended as a complete package and each recommendation is contingent upon the other parts being implemented. DOE understands this to mean that the Joint Agreement is contingent upon DOE initiating rulemaking processes to adopt all of the recommended standards in the agreement. That is distinguished from an agreement where issuance of an amended energy conservation standard for a covered product is contingent on issuance of amended energy conservation standards for the other covered products. If the Joint Agreement were so construed, it would conflict with the anti-backsliding provision in 42 U.S.C. 6295(o)(1), because it would imply the possibility that, if DOE were unable to issue an amended standard for a certain product, it would have to withdraw a previously issued standard for one of the other products. The anti-backsliding provision, however, prevents DOE from withdrawing or amending an energy conservation standard to be less stringent. As a result, DOE will be proceeding with individual rulemakings that will evaluate each of the recommended standards separately under the applicable statutory criteria. The Joint Agreement recommends amended standard levels for refrigerators, refrigerator-freezers, and freezers as presented in Table II.3. (Joint Agreement, No. 103 at p. 4) Details of the Joint Agreement recommendations for other products are provided in the Joint Agreement posted in the docket.[21]

TABLE II.3—RECOMMENDED AMENDED ENERGY CONSERVATION STANDARDS FOR RESIDENTIAL REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS

| Product class | Level (Based on AV (ft$^3$)) | Compliance date |
|---|---|---|
| 1. Refrigerator-freezers and refrigerators other than all-refrigerators with manual defrost. | 6.79AV + 191.3 | January 31, 2030. |
| 1A. All-refrigerators—manual defrost | 5.77AV + 164.6. | |
| 2. Refrigerator-freezers—partial automatic defrost | (6.79AV + 191.3)*K2. | |
| 3. Refrigerator-freezers—automatic defrost with top-mounted freezer. | 6.86AV + 198.6 +28I. | |
| 3A. All-refrigerators—automatic defrost | (6.01AV + 171.4)*K3A. | |
| 4. Refrigerator-freezers—automatic defrost with side-mounted freezer. | 7.28AV + 254.9 | January 31, 2030. |
| 5. Refrigerator-freezers—automatic defrost with bottom-mounted freezer. | (7.61AV +272.6)*K5 + 28I | January 31, 2030. |
| 5A. Refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service. | (7.76AV + 351.9)*K5A | January 31, 2029. |
| 6. Refrigerator-freezers—automatic defrost with top-mounted freezer with through-the-door ice service. | 7.14AV + 280.0 | January 31, 2030. |
| 7. Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service. | (7.31AV + 322.5)*K7 | January 31, 2030. |
| 8. Upright freezers with manual defrost | 5.57AV + 193.7 | January 31, 2029. |
| 9. Upright freezers with automatic defrost | 7.33AV + 194.1 + 28I | January 31, 2030. |
| 10. Chest freezers and all other freezers except compact freezers | 7.29AV + 107.8 | January 31, 2029. |
| 10A. Chest freezers with automatic defrost | 10.24AV + 148.1 | January 31, 2029. |
| 11. Compact refrigerator-freezers and refrigerators other than all-refrigerators with manual defrost. | 7.68AV + 214.5 | January 31, 2029. |
| 11A. Compact all-refrigerators—manual defrost | 6.66AV + 186.2. | |
| 12. Compact refrigerator-freezers—partial automatic defrost | (5.32AV + 302.2)*K12 | January 31, 2029. |
| 13. Compact refrigerator-freezers—automatic defrost with top-mounted freezer. | 10.62AV + 305.3 +28I | January 31, 2029. |
| 13A. Compact all-refrigerators—automatic defrost | (8.25AV + 233.4)*K13A. | |
| 14. Compact refrigerator-freezers—automatic defrost with side-mounted freezer. | 6.14AV + 411.2 + 28I. | |
| 15. Compact refrigerator-freezers—automatic defrost with bottom-mounted freezer. | 10.62AV + 305.3 + 28I. | |
| 16. Compact upright freezers with manual defrost | 7.35AV + 191.8 | January 31, 2029. |
| 17. Compact upright freezers with automatic defrost | 9.15AV + 316.7 | January 31, 2029. |
| 18. Compact chest freezers | 7.86AV + 107.8 | January 31, 2029. |

[19] The signatories to the Joint Agreement include AHAM, American Council for an Energy-Efficient Economy, Alliance for Water Efficiency, Appliance Standards Awareness Project, Consumer Federation of America, Consumer Reports, Earthjustice, National Consumer Law Center, Natural Resources Defense Council, Northwest Energy Efficiency Alliance, and Pacific Gas and Electric Company. Members of AHAM's Major Appliance Division that manufacture the affected products include: Alliance Laundry Systems, LLC; Asko Appliances AB; Beko US Inc.; Brown Stove Works, Inc.; BSH; Danby Products, Ltd.; Electrolux Home Products, Inc.; Elicamex S.A. de C.V.; Faber; Fotile America; GEA, a Haier Company; L'Atelier Paris Haute Design LLG; LG Electronics USA; Liebherr USA, Co.; Midea America Corp.; Miele, Inc.; Panasonic Appliances Refrigeration Systems (PAPRSA) Corporation of America; Perlick Corporation; Samsung; Sharp Electronics Corporation; Smeg S.p.A; Sub-Zero Group, Inc.; The Middleby Corporation; U-Line Corporation; Viking Range, LLC; and Whirlpool.

[20] The Joint Agreement contained recommendations for 6 covered products: refrigerators, refrigerator-freezers, and freezers; clothes washers; clothes dryers; dishwashers; cooking products; and miscellaneous refrigeration products.

[21] The term sheet is available in the docket at: *www.regulations.gov/document/EERE-2017-BT-STD-0003-0103.*

TABLE II.3—RECOMMENDED AMENDED ENERGY CONSERVATION STANDARDS FOR RESIDENTIAL REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS—Continued

| Product class | Level (Based on AV (ft³)) | Compliance date |
|---|---|---|
| 3–BI. Built-in refrigerator-freezer—automatic defrost with top-mounted freezer. | 8.24AV + 238.4 + 28I | January 31, 2029. |
| 3A–BI. Built-in All-refrigerators—automatic defrost | (7.22AV + 205.7)*K3ABI. | |
| 4–BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer. | 8.79AV + 307.4 + 28I | January 31, 2029. |
| 5–BI. Built-In Refrigerator-freezers—automatic defrost with bottom-mounted freezer. | (8.65AV + 309.9)*K5BI + 28I | January 31, 2029. |
| 5A–BI. Built-in refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service. | (8.21AV + 370.7)*K5ABI | January 31, 2029. |
| 7–BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer. | (8.82AV + 384.1)*K7BI | January 31, 2029. |
| 9–BI. Built-In Upright freezers with automatic defrost | 9.37AV + 247.9 + 28I | January 31, 2029. |
| 9A–BI. NEW PRODUCT CLASS: Upright built-in freezer w/auto defrost and through-door-ice. | 9.86AV + 288.9 | January 31, 2029. |

AV = Total adjusted volume, expressed in ft³, 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 Table I.2.

| 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 | 1.10 | N/A | N/A. |
| K13A | 1.10 | N/A | N/A. |
| K4 | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 2). |
| K4BI | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 2). |
| K5 | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 2). |
| K5BI | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 2). |
| K5A | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 3). |
| K5ABI | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 3). |
| K7 | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 2). |
| K7BI | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 2). |
| K9 | N/A | N/A | 1 + 0.02 * ($N_d$ − 1). |
| K9BI | N/A | N/A | 1 + 0.02 * ($N_d$ − 1). |
| K12 | N/A | N/A | 1 + 0.02 * ($N_d$ − 1). |

**Note:** $N_d$ is the number of external doors.

DOE notes that it was conducting a rulemaking to consider amending the standards for refrigerators, refrigerator-freezers, and freezers when the Joint Agreement was submitted. As part of that process, on February 27, 2023, DOE published a NOPR and announced a public webinar (''February 2023 NOPR'') seeking comment on its proposed amended standard to inform its decision consistent with its obligations under EPCA and the Administrative Procedure Act (''APA''). 88 FR 12452. DOE held a public webinar on April 11, 2023, to discuss and receive comments on the NOPR and NOPR TSD. The NOPR TSD is available at: *www.regulations.gov/document/EERE-2017-BT-STD-0003-0045.*

Although DOE is adopting the Joint Agreement as a direct final rule and no longer proceeding with its own rulemaking, DOE did consider relevant comments, data, and information obtained during that rulemaking process in determining whether the recommended standards from the Joint Agreement are in accordance with 42 U.S.C. 6295(o). Any discussion of comments, data, or information in this direct final rule that were obtained during DOE's own prior rulemaking will include a parenthetical reference that provides the location of the item in the public record.[22]

## III. General Discussion

DOE is issuing this direct final rule after determining that the recommended standards submitted in the Joint Agreement meet the requirements in 42 U.S.C. 6295(p)(4). More specifically, DOE has determined that the recommended standards were submitted by interested persons that are fairly representative of relevant points of view and the recommended standards satisfy the criteria in 42 U.S.C. 6295(o).

### *A. Scope of Coverage*

This direct final rule covers those consumer products that meet the definition of ''refrigerator, refrigerator-freezer, and freezer'' as codified at 10 CFR 430.2.

When evaluating and establishing energy conservation standards, DOE divides covered products into product classes by the type of energy used, or by capacity, or based upon performance-related features that justify a higher or lower standard. (42 U.S.C. 6295(q)) In making a determination whether a performance-related feature justifies a

[22] 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 *www.regulations.gov*). The references are arranged as follows: (commenter name, comment docket ID number, page of that document).

different standard, DOE must consider such factors as the utility of the feature to the consumer and other factors DOE determines are appropriate. *Id.*

The Joint Agreement proposed special door and multi-door energy allowances for product classes if manufacturers offer models with those features. Energy allowances applied to energy use equations correspond to performance-related features that would then justify new product classes for those configurations with special door and multi-door designs. The proposed approach also embeds within the energy use equations the difference between classes that are otherwise identical except for presence of an icemaker, using a logical variable I (equal to 1 for a product with an icemaker and equal to 0 for a product without an icemaker) multiplied by the constant icemaker energy use adder.

The structure simplification and amendments in the Joint Agreement are consistent with those proposed by DOE in the February 2023 NOPR. Based on the comments received in response to the February 2023 NOPR and DOE's evaluation of the Joint Agreement, the direct final rule adopts these changes. *See* section IV.A.1 of this document for further detail and discussion regarding the product classes analyzed in this direct final rule.

## *B. Fairly Representative of Relevant Points of View*

Under the direct final rule provision in EPCA, recommended energy conservation standards must be submitted by interested persons that are fairly representative of relevant points of view (including representatives of manufacturers of covered products, States, and efficiency advocates) as determined by DOE. (42 U.S.C. 6295(p)(4)(A)) With respect to this requirement, DOE notes that the Joint Agreement included a trade association, AHAM, which represents 20 manufacturers of refrigerators, refrigerator-freezers, and freezers. The Joint Agreement also included environmental and energy-efficiency advocacy organizations, consumer advocacy organizations, and a gas and electric utility company. Additionally, DOE received a letter in support of the Joint Agreement from the States of New York, California, and Massachusetts (*see* comment No. 104). DOE also received a letter in support of the Joint Agreement from the gas and electric utility, SDG&E, and the electric utility, SCE (*see* comment No. 107). As a result, DOE has determined that the Joint Agreement was submitted by interested persons who are fairly representative of relevant points of view.

## *C. Technological Feasibility*

### 1. General

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

After DOE has determined that particular technology options are technologically feasible, it further evaluates each technology option in light of the following additional screening criteria: (1) practicability to manufacture, install, and service; (2) adverse impacts on product utility or availability; (3) adverse impacts on health or safety and (4) unique-pathway proprietary technologies. Section 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 direct final rule 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(o)(2)(A)) 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 rulemaking are described in section IV.C of this document and in chapter 5 of the direct final rule 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 amended standards (2027–2056 for all TSLs other than TSL 4; for TSL 4, 2029–2058 for the product classes listed in Table I.1 and 2030–2059 for the product classes listed in Table I.2).[23] The savings are measured over the entire lifetime of products purchased in the 30-year analysis 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 models to estimate national energy savings (''NES'') from potential amended 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 national energy savings in terms of primary energy savings, which is the savings in the energy that is used to generate and transmit the site electricity. For natural gas, the primary energy savings are considered to be equal to the site energy savings. DOE also calculates NES in terms of full-fuel cycle (''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.[24] DOE's approach is based on the calculation of an FFC multiplier for each of the energy types used by covered products or

[23] DOE also presents a sensitivity analysis that considers impacts for products shipped in a 9-year period.

[24] 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).

equipment. For more information on FFC energy savings, *see* section IV.H.2 of this document.

2. Significance of Savings

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

The significance of energy savings offered by a new or amended energy conservation standard cannot be determined without knowledge of the specific circumstances surrounding a given rulemaking.[25] For example, some covered products and equipment have most of their energy consumption occur during periods of peak energy demand. The impacts of these products on the energy infrastructure can be more pronounced than products with relatively constant demand. 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.

As stated, the standard levels adopted in this direct final rule are projected to result in national energy savings of 5.6 quads (FFC), the equivalent of the primary annual energy use of 37 million homes. Based on the amount of FFC savings, the corresponding reduction in emissions, and need to confront the global climate crisis, DOE has determined the energy savings from the standard levels adopted in this direct final rule are ''significant'' within the meaning of 42 U.S.C. 6295(o)(3)(B).

*E. Economic Justification*

1. Specific Criteria

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

a. Economic Impact on Manufacturers and Consumers

In determining the impacts of potential amended standards 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 payback period (''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 cost (including energy, maintenance, and repair expenditures) discounted over the lifetime of the product. The LCC analysis requires a variety of inputs, such as product prices, product energy consumption, energy prices, maintenance and repair costs, product lifetime, and discount rates appropriate for consumers. To account for uncertainty and variability in specific inputs, such as product lifetime and discount rate, DOE uses a distribution of values, with probabilities attached to each value.

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

For its LCC and PBP analysis, DOE assumes that consumers will purchase the covered products in the first year of compliance with new or amended standards. The LCC savings for the considered efficiency levels are calculated relative to the case that reflects projected market trends in the absence of new or amended standards. DOE's LCC and PBP analysis is discussed in further detail in section IV.F of this document.

c. Energy Savings

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

d. Lessening of Utility or Performance of Products

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 adopted 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 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

[25] 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).

competition likely to result from a 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 direct final rule to the Attorney General with a request that the Department of Justice (''DOJ'') provide its determination on this issue. DOE will consider DOJ's comments on the rule in determining whether to withdraw the direct final rule. DOE will also publish and respond to the DOJ's comments in the **Federal Register** in a separate document.

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 adopted 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 adopted 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 effect potential amended 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 of this document.

## IV. Methodology and Discussion of Related Comments

This section addresses the analyses DOE has performed for this rulemaking with regard to refrigerators, refrigerator-freezers, and freezers. Separate subsections address each component of DOE's analyses, including relevant comments DOE received during its separate rulemaking to amend the energy conservation standards for refrigerators, refrigerator-freezers, and freezers prior to receiving the Joint Agreement.

DOE used several analytical tools to estimate the impact of the standards considered in this document. The first tool is a spreadsheet that calculates the LCC savings and PBP of potential amended or new energy conservation standards. The national impacts analysis uses a second spreadsheet set that provides shipments projections and calculates national energy savings and net present value of total consumer costs and savings expected to result from potential energy conservation standards. DOE uses the third spreadsheet tool, the Government Regulatory Impact Model (''GRIM''), to assess manufacturer impacts of potential standards. These three spreadsheet tools are available on the DOE website for this rulemaking: *www.regulations.gov/docket/EERE-2017-BT-STD-0003.* Additionally, DOE used output from the latest version of the Energy Information Administration's (''EIA's'') *Annual Energy Outlook* (''*AEO*'') for the emissions and utility impact analyses.

*A. Market and Technology Assessment*

DOE develops information in the market and technology assessment that provides an overall picture of the market for the products concerned, including the purpose of the products, the industry structure, manufacturers, market characteristics, and technologies used in the products. This activity includes both quantitative and qualitative assessments, based primarily on publicly available information. The subjects addressed in the market and technology assessment for this rulemaking include (1) a determination of the scope of the rulemaking and product classes, (2) manufacturers and industry structure, (3) existing efficiency programs, (4) shipments information, (5) market and industry trends, and (6) technologies or design options that could improve the energy efficiency of refrigerators, refrigerator-freezers, and freezers. The key findings of DOE's market assessment are summarized in the following sections. *See* chapter 3 of the direct final rule TSD for further discussion of the market and technology assessment.

1. Product Classes

The Joint Agreement specifies 32 product classes for refrigerators, refrigerator-freezers, and freezers. (Joint Agreement, No. 103 at p. 15–16) In particular, the Joint Agreement recommends a consolidated product class representation which incorporates icemaker energy adders and door allowances into the energy use equations for product classes in which they are applicable. In addition, the Join Agreement proposes a new product class—upright built-in freezers with automatic defrost and through-the-door ice service (''9A–BI''). (*Id.*) In this direct final rule, DOE is adopting the product classes from the Joint Agreement, as listed in Table IV.1.

TABLE IV.1—RECOMMENDED AMENDED ENERGY CONSERVATION STANDARDS FOR RESIDENTIAL REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS

| Product class |
| --- |
| 1. Refrigerator-freezers and refrigerators other than all-refrigerators with manual defrost. |
| 1A. All-refrigerators—manual defrost. |
| 2. Refrigerator-freezers—partial automatic defrost. |
| 3. Refrigerator-freezers—automatic defrost with top-mounted freezer. |
| 3A. All-refrigerators—automatic defrost. |
| 4. Refrigerator-freezers—automatic defrost with side-mounted freezer. |
| 5. Refrigerator-freezers—automatic defrost with bottom-mounted freezer. |
| 5A. Refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service. |
| 6. Refrigerator-freezers—automatic defrost with top-mounted freezer with through-the-door ice service. |
| 7. Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service. |
| 8. Upright freezers with manual defrost. |
| 9. Upright freezers with automatic defrost. |
| 10. Chest freezers and all other freezers except compact freezers. |
| 10A. Chest freezers with automatic defrost. |
| 11. Compact refrigerator-freezers and refrigerators other than all-refrigerators with manual defrost. |
| 11A. Compact all-refrigerators—manual defrost. |
| 12. Compact refrigerator-freezers—partial automatic defrost. |
| 13. Compact refrigerator-freezers—automatic defrost with top-mounted freezer. |
| 13A. Compact all-refrigerators—automatic defrost |
| 14. Compact refrigerator-freezers—automatic defrost with side-mounted freezer. |
| 15. Compact refrigerator-freezers—automatic defrost with bottom-mounted freezer. |
| 16. Compact upright freezers with manual defrost. |
| 17. Compact upright freezers with automatic defrost. |
| 18. Compact chest freezers. |
| 3–BI. Built-in refrigerator-freezer—automatic defrost with top-mounted freezer. |
| 3A–BI. Built-in All-refrigerators—automatic defrost. |
| 4–BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer. |
| 5–BI. Built-In Refrigerator-freezers—automatic defrost with bottom-mounted freezer. |
| 5A–BI. Built-in refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service. |
| 7–BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer. |
| 9–BI. Built-In Upright freezers with automatic defrost. |
| 9A–BI. NEW PRODUCT CLASS: Upright built-in freezer w/auto defrost and through-door-ice. |

DOE further notes that product classes established through EPCA's direct final rule authority are not subject to the criteria specified at 42 U.S.C. 6295(q)(1) for establishing product classes. Nevertheless, in accordance with 42 U.S.C. 6295(o)(4)—which is applicable to direct final rules—DOE has concluded that the standards adopted in this direct final rule will not result in the unavailability in any covered product type (or class) of performance characteristics, features, sizes, capacities, and volumes that are substantially the same as those generally available in the United States currently.[26] DOE's findings in this regard are discussed in detail in section V.B.4 of this document.

[26] EPCA specifies that DOE may not prescribe an amended or new standard if the Secretary finds (and publishes such finding) that 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 at the time of the Secretary's finding. (42 U.S.C. 6295(o)(4))

a. Product Classes With Automatic Icemakers

The Joint Agreement includes a proposed simplification of maximum allowable energy and would 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 energy use equations will, 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 does not combine classes that are the same other than the presence of an icemaker, but does simplify the list of classes and representation of their maximum allowable energy use, providing for each set of classes with and without ice makers a single equation for maximum energy use. (88 FR 12452)

DOE is adopting the Joint Agreement proposal to express the maximum allowable energy use for any set of classes differing only in whether the class includes an icemaker or not within a single equation. The single equation does this by including the icemaker energy use adder multiplied by logical variable I that is set equal to 1 for a product with an icemaker present and 0 for a product without an icemaker.

b. Special Door and Multi-Door Designs

The Joint Agreement made recommendations to establish new product classes for models that implement special and multi-door designs. The standards for these product classes include energy allowances (*i.e.,* specific increases in maximum allowable energy use) corresponding to the specific performance-related features (*i.e.,* door-in-door designs, transparent doors, and multi-door designs). The allowances include a 2-percent energy use allowance for each externally opening door in excess of the typical minimum for the class, a 6-percent total energy use allowance for a product with a door-in-door feature implemented in one or more of its doors, and a 10-percent total energy use allowance for a product with a transparent door or doors.

In this direct final rule, DOE is implementing the recommended special door and multi-door energy allowances. DOE's direct rulemaking authority under 42 U.S.C. 6295(p)(4) is constrained only by the requirements of 42 U.S.C. 6295(o), which does not include the product class requirements in 42 U.S.C. 6295(q). DOE is relying on the product classes provided in the Joint Agreement for consideration in this rule, but DOE notes that special doors (*i.e.,* transparent doors and door-in-door features) and multi-door setups constitute performance-related features that provide consumer utility when implemented. Transparent doors allow for partial view into the interior of fresh food compartments without the need for a door opening. Door-in-door features generally allow for access to a partially separated fresh food compartment without the need to fully expose the main interior fresh food compartment. Multi-door setups provide at least one additional externally opening door accessing either an existing compartment or a separate compartment, thus providing additional options for storage and access to food for the consumer.

Furthermore, DOE's analysis of these features suggests that special door and multi-door designs impact energy usage with some combinations accounting for additional energy consumption of up to 25 percent (based on CERA simulations).[27] DOE notes that the additional energy usage results from additional thermal load associated with additional gasket length necessary for multi-door and door-in-door features, and associated with the higher thermal conductivity of transparent doors compared to solid doors of the same size. DOE also proposed similar special door and multi-door energy allowances in the February 2023 NOPR and finds that the recommended allowances in the Joint Agreement are justifiable on a similar basis in light of the analysis DOE performed to develop the allowances proposed in the NOPR. *See* chapter 5 of the direct final rule TSD for more information on DOE's analysis of special door and multi-door features.

[27] CERA is an updated version of the Environmental Protection Agency's Refrigerator Analysis (''ERA'') program. Earlier versions have been used in previous refrigerator, refrigerator-freezer, and freezer energy conservation standards rulemaking. CERA allows for the simulation of thermal load on refrigerators, refrigerator-freezers, and freezers based of the inputs given for various parameters including cabinet design, compartment dimensions, door design, operating temperatures, controls, anti-sweat heat, and more. More information regarding the software is found in the direct final rule TSD.

For the reasons previously discussed, DOE is adopting the Joint Agreement recommendations to establish new product classes for models that implement special and multi-door designs.

Energy Use Allowance—Application

AHAM, Sub Zero Group, Inc. (''Sub Zero''), and Samsung also recommended that DOE apply the door coefficient to PC 4, PC 4–BI, PC 9, and PC 9–BI, as these classes have products offering multi-door setups or special doors that provide similar customer utility. (AHAM, No. 69 at p. 8; Sub Zero, No. 77 at p. 4; Samsung, No. 78 at p. 3) True Manufacturing (''TRUE'') similarly stated that PC 4I and PC 4, and any other product classes with transparent doors, should have the same transparent door allowance as PC 5A and PC 5. (TRUE, No. 57 at pp. 1–2)

DOE's assessment regarding the energy impact of designs featuring multi-door and special door setups warranted the proposal of energy allowances for classes where such features are offered. DOE reviewed the market and requested input from commenters related to existing models on the market in an effort to assess the prevalence of multi-door designs or special doors in products on the market today and concluded that there likely exist such models in PC 4I, PC 4I–BI, PC 9, and PC 9–BI that implement multi-door setups, special doors, or both. Therefore, DOE is adopting the multi-door and transparent door energy allowances for PC 4, PC 4I, PC 4–BI, PC 4I–BI, PC 9, and PC 9–BI consistent with feature availability. PC 4, PC 4I, PC 4–BI, and PC 4I–BI will be eligible for transparent door and multi-door allowances, while PC 9, and PC 9–BI will be eligible for the multi-door allowance. The magnitude and application of the allowances adopted for the aforementioned product classes are consistent with those recommended in the Joint Agreement. DOE notes that PC 4 and PC 4–BI will be eligible for a 2 percent allowance for each additional door for products without a transparent door or door-in-door with added external doors, a 6 percent allowance for products without a transparent door with a door-in-door, or a 10 percent transparent door allowance for the use of a qualifying transparent door. PC 9 and PC 9–BI will be eligible for a 2 percent allowance for each additional door up to two additional doors.

Energy Use Allowance—Definitions

The Joint Agreement includes the following recommended definition for a transparent door:

• *Transparent door* means a door for which 40 percent or more of the surface area—as determined based on the area of the transparent portion of the door divided by the product of the maximum width and height dimension of the door—is transparent to allow viewing into the refrigerated compartment.
• *Conceptually,* the parties recommend that DOE clarify that products with only very small door or drawers that are transparent should not be included in this definition—*i.e.,* the door must be large enough to justify the allowance.

Upon further consideration of the February 2023 NOPR proposed transparent door definition, the feedback received from stakeholders, and the Joint Agreement submitted by interested parties, including AHAM, DOE conducted further market research into available models with transparent panels, generating a list of models from various manufacturers and product classes representative of the units currently on the market that implement transparent doors. From this list, DOE determined transparent panel and door area based on product literature, in-person measurements, or use of scaled photographs. DOE then determined the percentage of the door covered by the transparent area for each model considered. DOE found that the transparent door on a French door configuration typically had roughly 40 percent or more of the total outer door area transparent, consistent with the percentage recommended in the Joint Agreement. Other configurations, such as two door bottom-mount refrigerator-freezers and compact refrigerators had 54 percent or more of their outer door area transparent. Based on this assessment and consideration of the Joint Agreement recommendations, DOE is adopting a modified definition from the February 2023 NOPR for transparent doors to better align with the products on the market, as follows:

Transparent door means an external fresh food compartment door which meets the following criteria:

• The area of the transparent portion of the door is at least 40 percent of the area of the door.
• The area of the door is at least 50 percent of the sum of the areas of all the external doors providing access to the fresh food compartments and cooler compartments.
• For the purposes of this evaluation, the area of a door is determined as the product of the maximum height and maximum width dimensions of the door, not considering potential extension of flaps used to provide a seal to adjacent doors.

DOE notes that this amended transparent door definition not only aligns with the typical implementation on the market, as previously described, but also is a more straightforward approach compared to those recommended and referenced by commenters. Specifically, DOE expects that the suggested approach based on the internal cabinet dimensions has some potential for questions about interpretation, given the fact that the interior dimensions could vary from the front of the cabinet to the rear. This could lead to varying internal cabinet area determinations. Therefore, in order to eliminate this potential variation, DOE is adopting the above definition and approach that simplifies the determination of the transparent door area by measuring and determining the area of the transparent portion divided by the product of the maximum height and width dimensions of the door.

Energy Use Allowance—Summary

In summary, in this direct final rule DOE is adopting the multi-door and special door energy use allowances as proposed in the Joint Agreement, with the specified amendments as previously discussed.

c. Addition of Product Class 9A–BI

The Joint Agreement recommends the addition of a new product class 9A–BI (*i.e.,* built-in upright freezers with automatic defrost and with through-the-door ice service) and specific energy efficiency standards for the new product class. The current energy conservation standards for freezers do not include a separate product class for products of this configuration, and DOE has not previously considered establishing a separate product class for them because it has not been aware of the existence of such products on the market, nor has it previously been notified by any manufacturer of the potential introduction of such a product. Under the current product class structure, any such product would most appropriately fit into current class 9I–BI (*i.e.,* built-in upright freezers with automatic defrost with an automatic icemaker), since there is no class that fits this description and also has through-the-door ice service. Hence, in the absence of a product class for this configuration, such products would be subject to the current PC 9I–BI standards, which would, under the approach for designating classes and standards provided in this direct final rule, correspond to class grouping 9–BI with the icemaker variable I in the standards equation equal to 1, indicating addition of the 28 kWh/year icemaker energy use.

Considering that the recommendation carries support from a broad cross-section of interests, including trade associations representing these manufacturers, environmental and energy-efficiency advocacy organizations, consumer advocates, and electric utility providers as well as the support of several States, DOE believes it appropriate to adopt this new product class, 9A–BI. DOE notes that the addition of a PC 9A–BI, as suggested by the Joint Agreement, is warranted as the application of a through-the-door icemaker constitutes a performance related feature with consumer utility and is likely to be introduced on the market in the near future.

DOE notes the standard as recommended by the Joint Agreement for PC 9A–BI is 5 percent higher than that of PC 9I–BI (built-in upright freezers with automatic defrost with an automatic icemaker). When considering class 9A–BI and 9I–BI, the key difference is the addition of through-the-door ice service, and the potential additional thermal load associated with its addition. Therefore, the 5 percent adjustment between 9I–BI and 9A–BI can be attributed mainly to the addition of through-the-door ice service. When comparing recommended standards to other product classes in which the key difference is the addition of through-the-door ice (*i.e.,* 5I vs. 5A and 4I vs. 7), the 5 percent adjustment remains consistent with DOE's adopted standards. As a result of this consistency, DOE believes the recommended standard is appropriate in its application.

Given the indication from the aforementioned stakeholders that such a product class standard would be beneficial in its implementation, the classification of through-the-door ice as a performance related feature, and the recommendation's consistency with the other adopted standards, DOE is adopting a PC 9A–BI standard in this direct final rule.

*See* section V of this document for more information regarding the TSL configuration and discussion of the adopted level for this product class. *See* chapter 5 of the direct final rule TSD for more discussion regarding the addition of this product class.

2. Technology Options

In the preliminary market analysis and technology assessment, DOE identified 37 technology options initially determined 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 NOPR

*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.

TABLE IV.1—TECHNOLOGY OPTIONS IDENTIFIED IN THE NOPR—Continued

| |
|---|
| *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. |

## *B. Screening Analysis*

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

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

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

(3) *Impacts on product utility.* If a technology is determined to have a significant adverse impact on the utility of the product to subgroups of consumers, or result in the unavailability of any covered product type with performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as products generally available in the United States at the time, it will not be considered further.

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

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

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

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

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

### 1. Screened-Out Technologies

In conducting the screening analysis for this direct final rule, DOE considered comments it had received in response to the screening analysis conducted for the February 2023 NOPR.

In the February 2023 NOPR, DOE screened out the technologies presented in Table II.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.

TABLE IV.2—TECHNOLOGIES SCREENED-OUT IN THE NOPR

| |
|---|
| 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. |
| 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. |

TABLE IV.2—TECHNOLOGIES SCREENED-OUT IN THE NOPR—Continued

| |
|---|
| Improved VIPs. |
| Inert Blowing Fluid $CO_2$. |

GEA recommended that DOE screen out ''improved resistivity of foam,'' which is primarily hydrofluoro-olefin (''HFO'') foams, as a technology option. GEA stated that HFO foams represent a unique and proprietary technology pathway and that the two listed by DOE in the February 2023 NOPR TSD—Solstice LBA and Ecomate—should be excluded through the technology screening analysis. GEA stated that Solstice LBA, an HFO foam blowing agent is only produced by a single manufacturer, Honeywell, and should therefore be screened out from consideration in DOE's technology assessment in this rulemaking. GEA noted that Ecomate has no proven commercialization in modern consumer refrigerators or freezers. (GEA, No. 75 at pp. 4–5)

As discussed in the February 2023 NOPR, HFO foams are retained as a design option and passed the screening analysis because the technology option meets the five criteria previously mentioned. While GEA notes Ecomate has no proven commercialization in modern consumer refrigerators or freezer, as discussed in more detail in section 3.4.2.1 of the February 2023 NOPR TSD, improved resistivity foams such as Solstice have been implemented in refrigerator-freezer models in the United States, as of at least 2014 [28] and DOE has not received information regarding negative impacts to product utility or impracticability to manufacture or service products using improved resistivity foam. Some of the improved blowing agents reviewed by DOE (*e.g.,* $CO_2$) have been found to be non-flammable and lower in GWP than traditional insulation. DOE acknowledges that Solstice LBA is patented by Honeywell but included other potential technologies such as added carbon black and $CO_2$ blowing agents in its assessment. Therefore, as a technology option, DOE maintains that HFO foams meet the prerequisites to be included past the screening analysis. However, because DOE could not determine the type of foam used in the directly analyzed models from teardowns or based on the feedback from manufacturers, DOE found that there was an insufficient basis to implement this design option as a means to increase energy efficiency in either the February 2023 NOPR or this direct final rule analysis.

An individual commented that microchannel condensers should not be retained as a design option, citing issues with implementation in the HVAC industry. The individual also stated that increased insulation thickness should not be retained as a design option, citing lessening of consumer utility. (Individual Commenter, No. 59 at p. 1)

DOE has observed implementation of microchannel heat exchangers in PC 5I, PC 5A, and several built-in product classes. DOE has also received no information regarding negative impacts in consumer utility or safety, and therefore, DOE retained microchannel condensers as a design option in this analysis As with the HFO foam design option, while microchannel condensers passed the screening analysis, this design option was not included as a design pathway to achieve higher efficiency levels in the direct final rule analysis due to potential system operation drawbacks including irregular refrigerant distribution, greater refrigerant-side pressure drop, and greater air-side pressure drop.[29]

DOE expects that increased insulation thickness would impact either the interior or exterior dimensions of a refrigerator, refrigerator-freezer, or freezer, and as a result did not consider increased insulation thickness as a design option to achieve the higher efficiency levels for standard-size refrigerator-freezers. However, DOE expects that there is potential to increase insulation thickness for some types of freezers and compact refrigerators, given their typical use in in spaces that allow increased exterior dimensions, and therefore continues to consider increased thickness as a design option to achieve higher efficiency levels for PC 10, PC 11A, and PC 18.

2. Remaining Technologies

Through a review of each technology, DOE concludes that all of the other identified technologies listed in section IV.B.1 met all five screening criteria to be examined further as design options in DOE's direct final rule analysis. In summary, DOE did not screen out the following technology options:

TABLE IV.3—TECHNOLOGIES REMAINING IN THE DIRECT FINAL RULE

| |
|---|
| *Insulation:* |
| 1. Improved resistivity of insulation (insulation type. |
| 2. Increased insulation thickness. |
| 3. Gas-filled insulation panels. |
| 4. Vacuum-insulated panel. |
| *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. |

[28] Whirlpool. ''Whirlpool Corporation Partners with Honeywell, Announces Use of Next Generation Solstice® Liquid Blowing Agent in U.S. Refrigerators,'' January 2014. *www.prnewswire.com/news-releases/whirlpool-corporation-partners-with-honeywell-announces-use-of-next-generation-solstice-liquid-blowing-agent-in-us-refrigerators-241489581.html* (accessed July 13, 2023).

[29] Rametta, R.S., Boeng, J., and Melo, C. ''Theoretical and Experimental Evaluation of Microchannel Condensers Applied to Household Refrigerators,'' *International Refrigeration and Air Conditioning Conference,* 2018, Paper 1843.

TABLE IV.3—TECHNOLOGIES REMAINING IN THE DIRECT FINAL RULE—Continued

| |
|---|
| 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 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). For additional details, *see* chapter 4 of the direct final rule TSD.

*C. Engineering Analysis*

The purpose of the engineering analysis is to establish the relationship between the efficiency and cost of 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/equipment at efficiency levels above 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 either to establish ''gap fill'' levels (to bridge large gaps between other identified efficiency levels) and/or to extrapolate to the ''max-tech'' level (particularly in cases where the ''max-tech'' level exceeds the maximum efficiency level currently available on the market).

In defining the efficiency levels for this direct final rule, DOE considered comments it had received in response to the efficiency levels proposed in the February 2023 NOPR.

For its analysis in this rulemaking, 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 PC 3, PC 5, PC 5A, PC 5-BI, PC 7, PC 9, PC 10, PC 11A, and PC 18 were tested and torn down to provide information to lay the groundwork for the analysis. Other product classes such as 9-BI (and the new PC 9A-BI recommended by the Joint Agreement) were not directly analyzed as a part of DOE's analysis, as they were not deemed sufficiently representative of the market. A number of other product classes were indirectly analyzed, based on relevant directly analyzed product classes. DOE's analysis for PC-9BI, for example, is based on the directly analyzed PC 9.

DOE used design option analysis techniques to extend the analysis to higher efficiency levels and to fill any efficiency level gaps. DOE generally focuses its analysis on product classes with higher market share as their energy impact and associated energy savings are the most significant. Therefore, for this direct final rule analysis DOE chose to test and teardown units from the product classes listed above that represent a significant market share, and extrapolated the analysis to all other product classes that were not directly analyzed, as appropriate.

a. Built-In Products

For the analysis supporting this direct final rule, DOE used an assessment of PC 5-BI (built-in refrigerator-freezer with bottom-mounted freezer) to address built-in products. DOE conducted analysis for a representative 5-BI product and compared it to analysis conducted for freestanding models of class 5. DOE concluded that a built-in model that is comparable to a freestanding model except the built-in configuration would have 5 percent higher energy use. Therefore, for example, the potential reduction in energy use for built-in PC 5 units would be 5 percent lower than their freestanding counterparts, based on the implementation of the same design options to satisfy a higher efficiency level. DOE has applied this 5-percent differential in selecting standard levels for other built-in classes for which DOE did not conduct direct analysis (*e.g.,* PC 3A, PC 7, and PC 9). More information on the analysis of built-in product classes is available in the direct final rule TSD.

b. 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. When selecting units for the analysis DOE selects units at baseline from various manufacturers for each directly analyzed product class.

In determining the baseline efficiency level for this direct final rule analysis, DOE maintained the same approach as the February 2023 NOPR, and considered the current Federal energy conservation standards as the baseline level, expressed as maximum annual energy consumption as a function of the product's adjusted volume, adjusting for the change in the automatic icemaker energy contribution for product classes that include this feature. The current standards incorporate an 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. DOE adjusted the baseline energy usage levels for each class to account for the planned revision in the test procedure to reduce the icemaker energy use adder to 28 kWh/yr.[30]

DOE directly analyzed a sample of market representative models from within nine product classes from multiple manufactures. For most product classes a single representative adjusted volume was analyzed, though for PC 3, PC 5, and PC 11, DOE directly analyzed two representative adjusted volumes within the product class. DOE tested and tore down 13 baseline units to provide a basis for development of the cost-efficiency curves. DOE's analysis assumed that all baseline models implement R-600a refrigerant, based on feedback during manufacturer interviews suggesting the industry has or is in the process of shifting to low-GWP refrigerants, in particular away from R-134a, in accordance with regulatory efforts to phasedown of hydrofluorocarbons.[31] Further information on the design characteristics of specific analyzed baseline models is summarized in the direct final rule TSD.

BSH disagreed with DOE's use of HFO foam as representative of a baseline refrigerator, refrigerator-freezer, and/or freezer's insulation in the February 2023 NOPR, citing high environmental impact of the insulation, and encouraged DOE to remove HFO foam from baseline analysis. (BSH, No. 64 at pp. 1-2) AHAM also suggested that considering HFO foam at baseline efficiency levels is inappropriate and result in an artificially high baseline efficiency, excessively stringent standards for high-volume product classes, and negative environmental impacts. (AHAM, No. 69 at pp. 4-5)

DOE was unable to determine the type of insulation used in teardown models and subsequently considered PU insulation at the baseline level for all product classes in the February 2023 NOPR and in this direct final rule. Furthermore, as described in section IV.B.2 of this document, DOE retained the improved insulation resistivity design option (*i.e.,* HFOs) through the screening analysis, though DOE did not utilize it as a design to achieve higher efficiency levels in the engineering analysis. DOE further notes, that BSH and AHAM are parties to the Joint Agreement and are supportive of the recommended standard adopted in this direct final rule.

c. Higher Efficiency Levels

For this direct final rule, DOE maintained the same approach as the February 2023 NOPR, and analyzed up to five incremental efficiency levels beyond the baseline for each of the analyzed product classes. For PC 3 and PC 7, DOE considered an efficiency level at roughly 5 percent more efficient than the current energy conservation standard. For all product classes, DOE considered a level near 10 percent more efficient than the current energy conservation standard, equivalent to the current ENERGY STAR® level for refrigerators, refrigerator-freezers, and freezers.[32] DOE then extended the efficiency levels (''ELs'') in steps of close to 5 percent of the current energy conservation standard up to EL 4, using applicable technologies as discussed in sections IV.A.2 and IV.B of this document. Finally, for all product classes, EL 5 represents ''max-tech,'' using design option analysis to extend the analysis beyond EL 4 using all applicable design options, including the most efficient variable-speed compressors available on the market, and considerable use of vacuum-insulated panels (''VIPs'') in key areas of the cabinet walls and doors. The efficiency levels analyzed beyond the baseline are shown in Table IV.4.

[30] *See* the October 12, 2021, final rule for test procedures for refrigeration products for more information regarding the adoption of the 28 kWh/yr icemaker adder. 86 FR 56790.

[31] *See www.regulations.gov/document/EPA-HQ-OAR-2021-0044-0223* for more information regarding the environmental protection agency's final rule regarding the phasedown of hydrofluorocarbons.

[32] EnergyStar, ''Refrigerators & Freezers Key Product Criteria,'' *www.energystar.gov/products/appliances/refrigerators/key_product_criteria* (accessed July 14, 2023).

TABLE IV.4—INCREMENTAL EFFICIENCY LEVELS FOR ANALYZED PRODUCTS

[% Energy use less than baseline][33]

| Product Class (AV, ft) | Standard-size refrigerator | | | | | | | Standard-size freezers | | Compact refrigerators and freezers | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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% | * 10% | 5% | * 10% | * 10% | * 10% | * 10% | * 10% | 10% |
| EL 2 | * 10% | * 10% | * 13% | * 11% | 16% | 15% | * 10% | 15% | 15% | 15% | 15% | 15% | 15% |
| EL 3 | 15% | 15% | 18% | 15% | 22% | 16% | 15% | 20% | 20% | 20% | 20% | 20% | 20% |
| EL 4 | 20% | 20% | 20% | 17% | .................... | .................... | 19% | 25% | 23% | 32% | 30% | .................... | 30% |
| EL 5 | 27% | 28% | .................... | .................... | .................... | .................... | 22% | .................... | .................... | .................... | .................... | .................... | .................... |

* Efficiencies at or slightly better than the ENERGY STAR® efficiency of 10%

** Percentages are based on a 3-door configuration.

d. VIP Analysis and Max-Tech Levels

As discussed in the previous section, DOE's NOPR analysis considered the use of VIPs placed throughout the side walls and doors at max-tech levels for many product classes.

AHAM disagreed with the extent of VIP use at higher efficiency levels in the engineering analysis, asserting that DOE overestimates the use and impact of VIPs in its analysis, despite acknowledging the technology's limitations. AHAM cited panel cost, in the form of labor and production costs, which are significant due to complex installation requirements, processing controls, and quality checks. AHAM also cited lower effectiveness in smaller units due to ''edge effects'' (*i.e.,* heat around the edges caused by the membrane film that forms the walls of the VIP). AHAM suggested that DOE not overestimate the impact of VIPs in its analysis, considering that VIPs are not used in a majority of products and manufacturers have reported varied levels of success using the technology. (AHAM, No. 69 at pp. 5–6)

DOE's implementation of VIPs in the analyses at each stage of this rulemaking is based on a combination of the best information gathered from multiple sources related to cost, use, and energy efficiency impacts. DOE did not specifically account for edge effect impacts on thermal load for compact refrigerator, refrigerator-freezer, or freezer models in its analysis. Regarding VIP pricing, DOE estimated VIP panel, installation, processing, and quality check costs based on a number of discussions with refrigerator manufacturers, VIP producers, and market research. DOE conducted additional interviews and research in support of this direct final rule, which further supported and solidified the VIP cost estimates.

In manufacturer interviews, DOE also gathered information regarding the implementation of VIPs (*e.g.,* locations, number of panels, panel area), and based on that information, DOE performed simulations to estimate the energy impacts using CERA. CERA allowed DOE to analyze the thermal load impact on a fresh food and/or freezer cabinet due to different placements of VIP paneling throughout a cabinet (*e.g.,* side panels, doors, or both). DOE then compared the results from these simulations to existing research into load reductions (which estimates energy savings at around 30 percent) [34] and based on both sources, estimated that the full implementation of VIPs in existing cabinets can reduce heat load by up to 23 percent. DOE did not specifically account for edge effect impacts on thermal load for compact refrigerator, refrigerator-freezer, or freezer models in its analysis. However, DOE notes that the engineering analysis halves the thermal load impact as observed in simulations in order to be conservative with energy savings and to account for factors that are not captured in testing and/or simulation (*e.g.,* differences in VIP core material, VIP installation method and location). DOE also notes VIPs are not implemented in most classes until efficiency levels above that proposed in the February 2023 NOPR and adopted in this direct final rule.

Sub Zero commented that as a small, low-volume manufacturer of niche built-in style refrigeration products, it is concerned that the standards proposed in the February 2023 NOPR will create a significant supply chain burden for them, as components like vacuum insulation panels are supplied by a limited number of manufacturers, which will impede their ability to deliver products to their consumers in a timely manner. Sub Zero requested that DOE reduce the stringency level of adopted standards for built-in products, to reduce these concerns. (Sub Zero, No. 77 at p. 2)

To better characterize and understand the VIP market, DOE conducted research and interviewed relevant VIP manufacturers to gather more data regarding the current global VIP market, and to identify any potential supply chain constraints related to the adoption of more stringent energy conservation standards. DOE estimates that the current demand for VIPs in the U.S. refrigerator market is roughly 1 to 3 million VIP panels, whereas the global supply for VIPs is estimated to exceed 10 million panels. Despite relatively low demand for VIPs in the U.S. market, there is notable VIP use in the European and Asian markets, with supply available from at least three major VIP manufacturers. Based on the information gathered, DOE expects that VIP production lines can be quickly scaled up to meet demand of future amended standards (within 1 to 2 years depending on the specific VIP design), well within 3-year lead time between publication of amended standards and the compliance date for those standards.

In response to stakeholder feedback on the February 2023 NOPR, DOE carefully considered the use of VIPs in its analysis, generally implementing VIPs at the highest efficiency levels as one of the last design options considered. Therefore, based on the engineering analysis and its consideration of VIPs, DOE expects that to meet the adopted standards, manufacturers are likely to implement VIPs only in PC 5 (for three-door, 30 AV configuration) and PC 5A, with partial VIP usage for both classes.

e. Variable-Speed Compressor Supply Chain

Numerous commenters on the February 2023 NOPR suggested that supply chains for VIPs and variable-speed compressor (''VSC'') may not support the quantities of those components that may be required at the efficiency levels proposed in the NOPR. AHAM recommended that DOE conduct a review of component availability and supply chain capacity for VSCs given the general global market trends for increasingly stringent standards for cooling appliances, including both air conditioning and refrigeration. (AHAM, No. 69 at p. 5) Whirlpool further noted that the proposed standards may result in increased component costs to manufacturers due to those same supply chain constraints, especially given that VSCs would be necessary for nearly all evaluated product classes. (Whirlpool, No. 70 at p. 5) Sub Zero also expressed concern that the proposed standards will create a significant supply chain burden for small, low-volume manufacturer of niche market built-in style refrigeration products because VSCs are provided by a limited number of suppliers. Sub Zero commented that the proposed standards will impede the ability of these small manufacturers to deliver to their niche consumers in a timely manner. (Sub Zero, No. 77 at p. 2)

Samsung supported DOE's proposed energy conservation standards for refrigerators, refrigerator-freezers, and freezers and the use of VSC technology as a significant energy-saving option. Samsung stated that there is already significant market availability of VSCs, and a regulatory certainty and 3-year compliance period would provide ample time for manufacturers and suppliers to establish sufficient supply availability of VSCs. (Samsung, No. 78 at p. 2)

In response to these comments, DOE interviewed relevant compressor manufacturers to gather information

[33] DOE notes the recommended TSL for this direct final rule is TSL 4, discussed further in section V.A of this document.

[34] ''Development of Nanoporous Materials for the Production of Vacuum-Insulated Panels (VIPs),'' European Commission, January 2017. Available at *cordis.europa.eu/article/id/190833-insulation-nanomaterials-for-energyefficient-refrigerators* (last accessed October 15, 2020).

regarding the level of VSC implementation that would be required at the efficiency levels in this rule, the current and predicted supply of VSCs into the U.S. market, the predicted time to ramp up production of VSCs, and pricing of VSC compressors and components. DOE notes that the VSC compressors focused on in this supply chain analysis differ from those utilized in air conditioners and other non-related cooling appliances. VSC compressors utilized in refrigerators, refrigerator-freezers, and freezers are generally different designs, are manufactured in different factories, and are generally produced by different manufacturers. Thus, based on the information provided by these manufacturers, DOE has determined that the industry is able to meet the increased demand of VSCs amid likely growing demand in the U.S. market.

Based on manufacturer interviews, DOE estimates the current total global demand for refrigerator, refrigerator-freezer, and freezer compressors (all compressors, not just VSCs) is 230 million. Total compressor production capacity is much higher than demand, with global capacity for compressors estimated at over 400 million. Globally, there has been a shift towards VSC utilization in response to increasing energy efficiency regulations in the European Union (''EU'') and Japan. Estimates project upwards of a quarter of the global market and a third of the U.S. market currently utilize VSCs in refrigerators, refrigerator-freezers, and freezers. Considering the U.S. market accounts for an estimated 12 million consumer refrigeration products, a conservative estimate puts U.S. current demand for VSC compressors at roughly 4 million.

Given DOE's understanding of the compressor marketplace, the expected time to build capacity to meet the new demand is expected to be significantly shorter than the 5 and 6-year lead time between direct final rule publication and the compliance date, with estimates ranging from 8 months to 1 year. Compressor manufacturers indicated that VSC production capacity has been increasing by 7 million per year between 2018 and 2022. Additionally, high-efficiency VSC compressor designs are already developed and do not require additional qualification testing before production. Research and development (''R&D'') time to develop compressor designs is not required and thus would not be a factor affecting availability.

DOE is aware that there have been supply constraints for VSCs recently due to issues with electronic component supply caused by the COVID–19 pandemic. Specifically, Chinese manufacturing and shipping of compressors decreased significantly during COVID-related lockdowns throughout the country between 2020 and 2022. Due to China's outsized impact on global supply, the effects of lockdowns were felt globally. Now that lockdowns have ended, however, the affected factories are open again and in production. Compressor manufacturers also indicated that they have been modifying sourcing strategies, in many cases establishing their own electronic component assembly lines in order to protect against potential future issues that could affect supply and production of VSCs.

In considering all of the information provided by relevant manufacturers of VSCs, DOE believes that significant increases in VSCs in the U.S. market aligned with the standard levels adopted in this direct final rule are well within the production capacity of the compressor industry. DOE further notes, that AHAM, Whirlpool, Sub Zero, and Samsung are parties to the Joint Agreement and are supportive of the recommended standard adopted in this direct final rule.

f. Product Classes 11 and 12 Alignment

The Joint Agreement recommended that DOE adopt a level of 10 percent energy savings relative to the current PC 12 standard. In light of the recommendation outlined in the Joint Agreement, and in consideration of comments received in response to the February 2023 NOPR, DOE is adopting a percentage increase in efficiency for PC 12 at 10 percent lower relative to the current standard. Additionally, as recommended in the Joint Agreement and proposed in the February 2023 NOPR, DOE is including a multi-door energy use allowance for PC 12 for products with two doors.

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 direct final rule analysis, 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. 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 to calibrate the analysis to certified or measured energy use of specific available models where possible, while allowing a broader range of potential efficiency levels to be considered.

The resulting bill of materials provides the basis for the manufacturer production cost (''MPC'') estimates.

To account for manufacturers' non-production costs and profit margin, DOE applies a multiplier (the manufacturer markup) to the MPC. The resulting manufacturer selling price (''MSP'') is the price at which the manufacturer distributes a unit into commerce. DOE developed an average manufacturer markup by examining the annual Securities and Exchange Commission (''SEC'') 10–K reports filed by publicly traded manufacturers primarily engaged in appliance manufacturing and whose combined product range includes refrigerators, refrigerator-freezers, and freezers.

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 analyzed 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. To estimate the MPCs necessary to achieve higher efficiency levels, in particular those beyond the highest-efficiency products in the test sample, DOE considered design options that were most likely to be considered and implemented by manufacturers to achieve the higher efficiency levels. Based on input from manufacturers and an understanding of the markets, DOE then estimated the costs associated with those design option to determine the MPCs at each of the analyzed efficiency levels.

The efficiency levels and design option progression for the analyzed standard-size refrigerator-freezers are presented in Table IV.5. The cells in the table list the design options that DOE considered at each higher efficiency level as compared with the next-lower efficiency level. Similarly, the efficiency levels and design options for standard-size freezers and Compact refrigerators, refrigerator-freezers are presented in Table IV.6. The MPCs for the analyzed product classes across the considered efficiency levels are presented in Tables IV.7 and IV.8. *See* chapter 5 of the direct final rule TSD for additional detail on the engineering analysis.

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-Energy Efficiency Ratio (EER) Single Speed Compressor. | Higher-EER Single Speed Compressor. | Highest-EER Single Speed 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 Single Speed Compressor. | Variable Defrost; Higher-EER Single Speed Compressor. | Higher-EER Compressor; Variable-speed compressor system[3]. | 66% of Max-tech VIP[4]. | VIP side walls and doors. |
| 5 (23.0):[2] | | | | | |
| EL Percent[1] | 8% | 13% | 18% | 20%.. | |
| Design Options Added. | Higher-EER Single Speed Compressor. | Brushless-DC Evaporator Fan Motor; Higher-EER compressor Variable-speed compressor system[3]. | Highest-EER Compressor; 50% of Max-tech VIP. | VIP side walls and doors.. | |
| 5 (30.0):[2] | | | | | |
| EL Percent[1] | 7% | 11% | 15% | 17%.. | |
| Design Options Added. | Variable Speed Compressor System[6]. | Higher-EER Compressor;[6] Brushless-DC Evaporator Fan Motor; 50% of Max-tech VIP[6]. | Higher-EER Compressor; 50% of Max-tech VIP. | Highest-EER Compressor; VIP side walls and doors.. | |
| 5–BI (26.0): | | | | | |
| EL Percent[1] | 10% | 15% | 16%.. | | |
| Design Options Added. | Variable-speed compressor system[3]. | 50% of Max-tech VIP[4] | VIP side walls and doors.. | | |
| 5A (35.0):[2] | | | | | |
| EL Percent[1] | 11% | 16% | 22%.. | | |
| Design Options Added. | Higher-EER Compressor; Variable-speed compressor system[3]. | Highest-EER Compressor; Variable Speed Compressor System; 42% of Max-tech VIP[4]. | VIP side walls and doors.. | | |
| 7 (31.5): | | | | | |
| EL Percent[1] | 5% | 10% | 15% | 19% | 22%. |
| Design Options Added. | Highest-EER Single Speed Compressor. | Brushless-DC Evaporator Fan Motor; Variable-speed compressor system[3]. | Highest-EER Variable Speed compressor system. | 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—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 | Switch to forced-convection condenser; Brushless-DC Condenser and Evaporator fans. | Highest-EER Compressor; Variable-speed compressor system[2]. | 37% 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; Brushless-DC Evaporator Fan. | Highest-EER Compressor; Variable-speed compressor system. | VIP door. |
| 11A (1.7): | | | | |
| EL Percent[1] | 10% | 15% | 20% | 32%. |

TABLE IV.6—EFFICIENCY LEVELS AND DESIGN OPTIONS FOR ANALYZED STANDARD-SIZE FREEZERS AND COMPACT REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS—Continued

| Product class (AV[4]) | EL1 | EL2 | EL3 | EL4 |
|---|---|---|---|---|
| Design Options Added | Wall thickness increase | Higher-EER Single Speed Compressor. | Higher-EER Single Speed Compressor; VIP sides and door. | Highest-EER Single Speed Compressor. |
| 11A (4.4): | | | | |
| EL Percent[1] | 10% | 15% | 20% | 30%. |
| Design Options Added | Higher-EER Single Speed Compressor | Wall thickness increase | Higher-EER Single Speed 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 Compressor; 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 Single Speed Compressor | Wall thickness increase | Highest-EER Single Speed 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.7—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 | $368.51 | $375.65 | $377.11 | $378.79 | $434.79 | $464.09 |
| Incremental MPC | $0.00 | $7.14 | $8.60 | $10.28 | $66.28 | $95.58 |
| 3 (21.0): | | | | | | |
| EL Percent[1] | 0% | 5% | 10% | 15% | 20% | 28% |
| MPC | $454.50 | $456.08 | $473.88 | $498.64 | $544.91 | $570.09 |
| Incremental MPC | $0.00 | $1.59 | $19.38 | $44.14 | $90.42 | $115.59 |
| 5 (23.0):[2] | | | | | | |
| EL Percent[1] | 0% | 8% | 13% | 18% | 20% | |
| MPC | $662.58 | $678.47 | $696.39 | $736.57 | $755.49 | |
| Incremental MPC | $0.00 | $15.89 | $33.81 | $73.99 | $92.91 | |
| 5 (30.0):[2] | | | | | | |
| EL Percent[1] | 0% | 7% | 11% | 15% | 17% | |
| MPC | $705.12 | $740.80 | $763.71 | $774.63 | $807.62 | |
| Incremental MPC | $0.00 | $35.68 | $58.58 | $69.51 | $102.50 | |
| 5–BI (26.0): | | | | | | |
| EL Percent[1] | 0% | 10% | 15% | 16% | | |
| MPC | $829.20 | $848.87 | $883.70 | $918.52 | | |
| Incremental MPC | $0.00 | $19.67 | $54.50 | $89.32 | | |
| 5A (35.0):[2] | | | | | | |
| EL Percent[1] | 0% | 11% | 16% | 22% | | |
| MPC | $765.69 | $786.68 | $824.44 | $871.93 | | |
| Incremental MPC | $0.00 | $21.00 | $58.75 | $106.24 | | |
| 7 (31.5): | | | | | | |
| EL Percent[1] | 0% | 5% | 10% | 15% | 19% | 22% |
| MPC | $669.60 | $671.85 | $691.36 | $692.20 | $750.52 | $770.32 |
| Incremental MPC | $0.00 | $2.26 | $21.77 | $22.60 | $80.92 | $100.72 |

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

TABLE IV.8—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] | $536.45 | $553.18 | $585.43 | $614.85 | $652.63 |
| Incremental MPC | $0.00 | $16.73 | $48.97 | $78.40 | $116.17 |

TABLE IV.8—COST-EFFICIENCY CURVES FOR STANDARD-SIZE FREEZERS AND COMPACT REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS—Continued

| Product class (AV [2]) | EL0 | EL1 | EL2 | EL3 | EL4 |
| --- | --- | --- | --- | --- | --- |
| 10 (26.0): | | | | | |
| EL Percent [1] | 0% | 10% | 15% | 20% | 23% |
| MPC | $522.18 | $553.37 | $577.47 | $579.41 | $602.71 |
| Incremental MPC | $0.00 | $31.19 | $55.29 | $57.23 | $80.53 |
| 11A (1.7): | | | | | |
| EL Percent [1] | 0% | 10% | 15% | 20% | 32% |
| MPC | $146.55 | $151.55 | $152.77 | $176.94 | $181.26 |
| Incremental MPC | $0.00 | $5.00 | $6.22 | $30.38 | $34.70 |
| 11A (4.4): | | | | | |
| EL Percent [1] | 0% | 10% | 15% | 20% | 30% |
| MPC | $212.15 | $214.64 | $220.57 | $231.84 | $289.23 |
| Incremental MPC | $0.00 | $2.49 | $8.42 | $19.69 | $77.08 |
| 17 (9.0): | | | | | |
| EL Percent [1] | 0% | 10% | 15% | 20% | |
| MPC | $268.95 | $294.85 | $318.20 | $341.55 | |
| Incremental MPC | $0.00 | $25.91 | $49.26 | $72.61 | |
| 18 (8.9): | | | | | |
| EL Percent [1] | 0% | 10% | 15% | 20% | 30% |
| MPC | $256.22 | $258.76 | $268.00 | $281.06 | $311.99 |
| Incremental MPC | $0.00 | $2.54 | $11.78 | $24.84 | $55.77 |

**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 distributes a unit into commerce. DOE developed an average manufacturer markup by examining the annual Securities and Exchange Commission (''SEC'') 10–K reports [35] filed by publicly traded manufacturers primarily engaged in appliance manufacturing and whose combined product range includes refrigerators, refrigerator-freezers, and freezers. *See* chapter 12 of the direct final rule TSD for additional detail on the manufacturer markup.

*D. Markups Analysis*

The markups analysis develops appropriate markups (*e.g.,* retailer markups, wholesaler 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 operating profit.

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.[36]

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,[37] the 2017 Annual Wholesale Trade Survey for the ''household appliances, and electrical and electronic goods merchant wholesalers'' sector to estimate wholesaler markups,[38] and the industry series for the ''residential building construction'' sector published by the 2017 Economic Census to derive general contractor markups.[39] 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,[40] the 2017 Annual Wholesale Trade Survey for the ''household appliances, and electrical and electronic goods merchant wholesalers'' sector to estimate wholesaler markups,[41] and the industry series for the ''residential building construction'' sector published by the 2017 Economic Census to derive general contractor markups.[42]

In response to the February 2023 NOPR, AHAM commented on DOE's reliance on the concept of incremental markups, stating that it is based on discredited theory, and it is in contradiction to empirical evidence provided by AHAM during the 2014

[35] 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).

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

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

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

[39] U.S. Census Bureau. 2017 Economic Census. *www.census.gov/newsroom/press-kits/2020/2017-economic-census.html.*

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

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

[42] U.S. Census Bureau. 2017 Economic Census. *www.census.gov/newsroom/press-kits/2020/2017-economic-census.html.*

NOPR for Energy Conservation Standards for Residential Dishwashers. (AHAM, No. 69 at p. 15–16)

DOE disagrees that the theory behind the concept of incremental markups is discredited. DOE's incremental markup approach assumes that an increase in profitability, which is implied by keeping a fixed markup when the product price goes up, is unlikely to be viable over time in a reasonably competitive market like household appliance retailers. The Herfindahl-Hirschman Index (HHI) reported by the 2017 Economic Census indicates that household appliance stores sector (North American Industry Classification System (NAICS) code 443141) is a competitive marketplace.[43] DOE recognizes that actors in the distribution chains are likely to seek to maintain the same markup on appliances in response to changes in manufacturer selling prices after an amendment to energy conservation standards. However, DOE believes that retail pricing is likely to adjust over time as those actors are forces to readjust their markups to reach a medium-term equilibrium in which per-unit profit is relatively unchanged before and after standards are implemented.

DOE acknowledges that markup practices in response to amended standards are complex and varying with business conditions. However, DOE's analysis necessarily considers a very simplified and hypothetical version of the world of appliance retailing: namely, a situation in which nothing changes except for those changes in appliance offerings that occur in response to amended standards. Obtaining data on markup practices in the situation described above is very challenging. Hence, DOE continues to believe that its assumption that standards do not facilitate a sustainable increase in profitability is reasonable.

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

### *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 February 2023 NOPR to address the difference in field-metered energy consumption and the DOE test results due to household-specific characteristics. 88 FR 12478–12479.

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 February 2023 NOPR, AHAM commented that DOE relies heavily on the EIA's Residential Energy Consumption Survey (''RECS'') data for estimating energy use and how consumption varies at the household level. Specifically, AHAM expressed concern that the use of RECS data to estimate energy consumption at the household level may introduce ''outlier values,'' resulting in uncertainty and inaccuracies (AHAM, No. 69 at pp. 17–18) In this direct final rule, as well as in the February 2023 NOPR, DOE did not tie the energy consumption of refrigerators, refrigerator-freezers, and freezers to RECS survey data. 88 FR 12452. No household or demographic information from RECS affects the energy consumption of a particular household. Instead, as mentioned above, DOE sampled from distributions of UAFs that were derived from field-metering studies and assigned a randomly selected UAF to each household. Randomly sampling from distributions of UAFs acknowledges the inherent uncertainty in estimating the energy use for any particular household, while capturing the aggregate impact of UAFs measured in the field, and thus better approximates the most likely distribution of field energy use values across the installed base of products than relying strictly on survey data. DOE further notes, that AHAM is a party to the Joint Agreement and is supportive of the recommended standard adopted in this direct final rule.

Chapter 7 of the direct final rule TSD provides details on DOE's energy use analysis for refrigerators, refrigerator-freezers, and freezers.

### *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

[43] 2017 Core Statistics Economic Census: Establishment and Firm Size Statistics for the U.S. (NAICS 443141).

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 (PC 11A only). DOE included commercial applications in the analysis of compact refrigerators and refrigerator-freezers (PC 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 2020 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, distribution chain markups, and sales taxes—and installation costs. Inputs to the calculation of operating expenses include annual energy consumption, energy prices and price projections, repair and maintenance costs, product lifetimes, and discount rates. DOE created distributions of values for product lifetime, discount rates, and sales taxes, with probabilities attached to each value, to account for their uncertainty and variability.

The computer model DOE uses to calculate the LCC relies on a Monte Carlo simulation to incorporate uncertainty and variability into the analysis. The Monte Carlo simulations randomly sample input values from the probability distributions and refrigerator, refrigerator-freezer, and freezer user samples. For this rulemaking, the Monte Carlo approach is implemented in Python. The model calculated the LCC 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 consumers of refrigerators, refrigerator-freezers, and freezers as if each were to purchase a new product in the first year of required compliance with new or amended standards. For all TSLs other than TSL 4 (the Recommended TSL detailed in the Joint Agreement), any amended standards were assumed to 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)) Therefore, DOE used 2027 as the first year of compliance with any amended standards for refrigerators, refrigerator-freezers, and freezers for all TSLs other than TSL 4. For TSL 4, DOE used 2029 as the first year of compliance for representative PCs 5BI, 5A, 10, 11A, 17, and 18 and 2030 as the first year of compliance for the representative PCs 3, 5, 7, and 9, consistent with the Joint Agreement.

Table IV.9 summarizes the approach and data DOE used to derive inputs to the LCC and PBP calculations. The subsections that follow provide further discussion. Details of the spreadsheet model, and of all the inputs to the LCC and PBP analyses, are contained in chapter 8 of the direct final rule TSD and its appendices.

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

| Inputs | Source/method |
|---|---|
| Product Cost | Derived by multiplying MPCs by manufacturer and retailer markups and sales tax, as appropriate. 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.<br>Variability: Based on the product class and field data. |
| Energy Prices | Electricity: Based on Edison Electric Institute (''EEI'') data for 2022.<br>Variability: Regional energy prices determined for each Census Division and large state. |
| Energy Price Trends | Based on *AEO2023* 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 (residential) and Damadoran Online (commercial). |
| Compliance Date | 2027 for all TSLs other TSL 4. For TSL 4, 2029 for PCs 5BI, 5A, 10, 11A, 17, and 18 and 2030 for PCs 3, 5, 7, and 9. |

* References for the data sources mentioned in this table are provided in the sections following the table or in chapter 8 of the direct final rule TSD.

In response to the February 2023 NOPR, an individual objected to the LCC analysis for two reasons: (1) future dollars savings are not the same as present-day dollars for purchase, which is especially problematic for low-income individuals; and (2) some in the elderly population would not live long enough to recover the incremental installed cost due to an amended standard, resulting in ''age discrimination.'' (Individual

Commenter, No. 59 at p. 2) In regard to future dollar savings vs. present-day dollar savings for low-income households, DOE's low-income consumer subgroup LCC analysis uses discount rates that are specific to low-income households, resulting in higher discount rates for these households, on average, compared to the full consumer sample used in the standard LCC analysis. See section IV.I of this document as well as chapter 11 of the direct final rule TSD for more details. In regard to the incremental installed cost for low-income consumers, DOE notes that many low-income consumers are renters who are typically not responsible for purchasing refrigeration equipment (*see* the discussion in section IV.I of this document as well as chapter 11 of the direct final rule TSD). Moreover, the low-income subgroup results indicate that low-income households, on average, are expected to experience higher LCC savings and lower payback periods than the general population (*see* the results in section V.B.1.b of this document). In regard to some individuals not living long enough to recoup the incremental installed cost due to an amended standard, DOE notes that even in such cases—which could happen to non-elderly consumers as well—the equipment would continue to reap energy savings, but for a new owner. Therefore, DOE does not believe the LCC analysis discriminates against elderly consumers relative to younger consumers in the general population.

AHAM commented that due to the skewed nature of the LCC savings results, DOE should report median values rather than mean values. (AHAM, No. 69 at p. 18) DOE notes that there are a variety of ways to characterize distributions of impacts, and DOE considers the impacts of a potential amended standard on refrigerators, refrigerator-freezers, and freezers holistically. DOE also notes that the median LCC savings for affected consumers are shown in the box-and-whisker plots in chapter 8 of the direct final rule TSD.

AHAM also commented that DOE should be conducting a purchase decision analysis in its LCC model to reflect the actual conditions and expectations of the purchaser. (AHAM, No. 69 at p. 15) In the current setup of LCC analysis, DOE is not explicitly modeling the purchase decision made by purchasers when the standard becomes effective. DOE's analysis is intended to model the range of individual outcomes likely to result from a hypothetical amended energy conservation standard at various levels of efficiency. DOE does not discount the consumer decision theory established in the broad behavioral economics field, but rather, notes that its methodological decision was made after considering the existence of various systematic market failures and their implication in rational versus actual purchase behavior. Furthermore, the outcome of the LCC is not considered in isolation, but in the context of the broader set of analyses, including the NIA. Moreover, the type of data required to facilitate a robust consumer choice modeling of a specific household appliance at the individual household level is currently lacking and AHAM did not provide much data. DOE further notes, that AHAM is a party to the Joint Agreement and is supportive of the recommended standard adopted in this direct final rule.

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.[44] DOE estimated the distribution of adjusted volumes for PC 11A based on the distribution of models from DOE's Compliance Certification Management System (''CCMS'') Database. Table IV.10 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.

TABLE IV.10—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 | 84.7 |
| 4.4 | 15.3 |

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.[45] 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 2022 as a proxy of the production cost for refrigerators, refrigerator-freezers and freezers.[46] 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 the 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 2022, 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 39.4 ±1.9 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 separate 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 with the highest efficiency single-speed compressor to an efficiency

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

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

[46] Household refrigerator and home freezer manufacturing PPI series ID: PCU3352203352202. Available at *www.bls.gov/ppi/.*

level with variable-speed compressor. DOE used PPI data on ''semiconductors and related device manufacturing'' between 1967 and 2022 to estimate the historic price trend of electronic components in the control.[47] 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 February 2023 NOPR, AHAM commented that there is no theoretical underpinning for the implementation of an experience or learning curve and the functional form it should take. In addition, AHAM stated that the data that DOE used merely represents an empirical relationship, and a clear connection between the actual products in question and the data used needs to be made. AHAM noted that there is little reason to support the concept that price learning through manufacturing efficiencies should extend beyond the labor and materials in the product itself, and that such a relationship should not hold for other cost components. (AHAM, No. 69 at pp. 16–17)

DOE notes that there is considerable empirical evidence of consistent price declines for appliances in the past few decades. Several studies examined refrigerator retail prices during different periods of time and showed that prices had been steadily falling while efficiency had been increasing, for example Dale, *et al.* (2009)[48] and Taylor, *et al.* (2015).[49] As mentioned in Taylor and Fujita (2013),[50] Federal agencies have adopted different approaches to account for ''the changing future compliance costs that might result from technological innovation or anticipated behavioral changes.'' Given the limited data availability on historical manufacturing costs broken by different components, DOE utilized the Producer Price Index (''PPI'') published by the BLS as a proxy for manufacturing costs to represent the analyzed product as a whole. While products may experience varying degrees of price learning during different product stages, DOE modeled the average learning rate based on the full historical PPI series for ''household refrigerator and home freezer manufacturing'' to capture the overall price evolution in relation to the cumulative shipments. DOE also conducted sensitivity analyses that are based on a particular segment of the PPI data for household refrigerator manufacturing to investigate the impact of alternative product price projections (low price learning and high price learning) in the NIA of this direct final rule. DOE further notes, that AHAM is a party to the Joint Agreement and is supportive of the recommended standard adopted in this direct final rule.

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.

4. Annual Energy Consumption

For each sampled household or commercial building, DOE determined the energy consumption for a refrigerator, refrigerator-freezer, or freezer 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 2022 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).[51] For the commercial sector, DOE calculated electricity prices using the methodology described in Coughlin and Beraki (2019).[52]

To estimate energy prices in future years, DOE multiplied the 2022 energy prices by the projection of annual average price changes for each of the nine census divisions from the Reference case in *AEO2023*, which has an end year of 2050.[53] To estimate price trends after 2050, DOE used the 2050 electricity prices, held constant.

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. Typically, small incremental increases in product efficiency entail no, or only minor, changes in repair and maintenance costs compared to baseline efficiency products. 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 February 2023 NOPR as well as this direct final rule, 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 September 2011 Final Rule. For each of three categories—standard-size refrigerator-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

[47] Semiconductors and related device manufacturing PPI series ID: PCU334413334413; *www.bls.gov/ppi/.*

[48] 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.

[49] 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. Available at *www.osti.gov/biblio/1235570/* (last accessed June 30, 2023).

[50] Taylor, M. and K.S. Fujita. Accounting for Technological Change in Regulatory Impact Analyses: The Learning Curve Technique. 2013. Lawrence Berkeley National Lab (LBNL), Berkeley, CA (United States). Report No. LBNL–6195E. Available at *escholarship.org/uc/3c8709p4* (last accessed July 20, 2023).

[51] Coughlin, K. and B. Beraki. 2018. Residential Electricity Prices: A Review of Data Sources and Estimation Methods. Lawrence Berkeley National Lab. Berkeley, CA. Report No. LBNL–2001169. Available at *ees.lbl.gov/publications/residential-electricity-prices-review* (last accessed July 10, 2023).

[52] Coughlin, K. and B. Beraki. 2019. Non-residential Electricity Prices: A Review of Data Sources and Estimation Methods. Lawrence Berkeley National Lab. Berkeley, CA. Report No. LBNL–2001203. Available at *ees.lbl.gov/publications/non-residential-electricity-prices* (last accessed July 10, 2023).

[53] U.S. Department of Energy—Energy Information Administration. *Annual Energy Outlook 2023 with Projections to 2050.* Washington, DC. Available at *www.eia.gov/outlooks/aeo/* (last accessed July 10, 2023).

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 0.9 percent of their total installed cost. Because high-efficiency products have a higher installed cost, their estimated average annual repair costs are also higher.

In response to the February 2023 NOPR, an individual commented that product reliability is inversely related to the number of product parts, and Strauch suggested that DOE use the MIL–HDBK–217 or the Bellcore/Telcordia reliability guides to inform its maintenance and repair cost analysis. (Individual Commenter, No. 59 at pp. 1–2) DOE appreciates the recommendation, but notes that the data required to properly use the MIL–HDBK–217 or Bellcore/Telcordia standards [54] (*e.g.,* parts count, parts stress conditions, and laboratory and field failure rates of specific parts) is unavailable in the LCC analysis. This is due to the fact that the LCC analyzes refrigerator, refrigerator-freezer, and freezer representative units as opposed to specific product models. Moreover, according to Hottinger Brüel & Kjær (''HBK'') there are a number of limitations to such empirical methods, including: (1) the data used to inform these traditional empirical models is typically outdated, (2) whereas the models assume components fail independently of each other, in some cases the overall system design is the causal factor, and (3) obtaining high-quality field and manufacturing data to inform the adjustment factors used in the models is difficult.[55] For these reasons, for this direct final rule analysis DOE continued to use the method used in the February 2023 NOPR.

AHAM also commented that failed VIPs are unrepairable in the field meaning manufacturers work to ensure VIPs will not fail prior to the end of the product's useful life. (AHAM, No. 69 at p. 6) DOE appreciates this information but notes that, due to a lack of available data, the repair cost estimates used in the LCC analysis are not component-specific.

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, RECS 2015, and RECS 2020. 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 8.8 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 11.3 years by multiplying the average lifetime of compact refrigerators by the ratio of the average lifetime of standard-size freezers (18.4 years) to the average lifetime of standard-size refrigerators and refrigerator-freezers (14.3 years).

In response to the February 2023 NOPR, an individual commented that more stringent efficiency standards reduce the service lifetime of refrigerators, refrigerator-freezers, and freezers. (Individual Commenter, No. 59 at p. 1) DOE used the latest available data to inform the lifetime distributions used in this direct final rule analysis, and DOE does not have data to corroborate a causal connection between the stringency of efficiency standards and the expected service lifetime of refrigerators, refrigerator-freezers, and freezers. Therefore, DOE continues to assume that amending the efficiency standards for refrigerators, refrigerator-freezers, and freezers will not directly impact the estimated service lifetime of these products.

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

To establish residential discount rates for the LCC analysis, DOE identified all relevant household debt or asset classes in order to approximate a consumer's opportunity cost of funds related to appliance energy cost savings. It estimated the average percentage shares of the various types of debt and equity by household income group using data from the Federal Reserve Board's triennial Survey of Consumer Finances [57] (''SCF'') starting in 1995 and ending in 2019. Using the SCF and other sources, DOE developed a distribution of rates for each type of debt and asset by income group to represent the rates that may apply in the year in which amended standards would take effect. DOE assigned each sample household a specific discount rate drawn from one of the distributions. The average rate across all types of household debt and equity and income groups, weighted by the shares of each type, is

[54] MIL–HDBK–217 is a handbook to establish and maintain consistent and uniform methods for estimating the inherent reliability of military electronic equipment and systems. Bellcore/Telcordia is a similar reliability guide for the telecommunications and electronics industry.

[55] Available at *www.hbkworld.com/en/knowledge/resource-center/articles/2022/mil-217-bellcore-telcordia-and-other-reliability-prediction-methods-for-electronic-products* (last accessed July 13, 2023).

[56] 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.

[57] U.S. Board of Governors of the Federal Reserve System. Survey of Consumer Finances. 1995, 1998, 2001, 2004, 2007, 2010, 2013, 2016, and 2019. Available at *www.federalreserve.gov/econresdata/scf/scfindex.htm* (last accessed July 10, 2023).

approximately 4 percent (the average varies by PC).

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. The average discount rate for the PC 11A commercial consumer sample is 6.8 percent.

In response to the February 2023 NOPR, AHAM commented that operating costs and the depreciation of capital investments are deductible costs for commercial end-users from Federal and State corporate income taxes. AHAM suggested that DOE should incorporate the effects of tax deductibility in the LCC analysis. (AHAM, No. 69 at p. 19) DOE responds that as noted in the comment, the estimation of commercial discount rates accounts for the tax deductibility of the energy costs and capital investment depreciation and therefore the net present value of the future operating cost savings in the LCC analysis should already reflect that effect.

In response to the February 2023 NOPR, AHAM further commented that DOE used an inappropriate discount rate in its analysis of the effects of standards on low-income households, claiming that it does not take into account issues of capital availability or the non-financial costs from a purchase. AHAM also presented data from their survey work with Bellomy Research showing that the lowest 30 percent income groups have no discretionary income to save, making it impossible for them to rebalance their balance sheets after making a purchase. (AHAM, No. 69 at p. 11)

With respect to the issue of DOE's methodology for estimating consumer discount rates, DOE maintains that the LCC is not predicting a purchase decision, which DOE assumes to be AHAM's interpretation given their focus on the availability of cash for appliance purchases. Rather, the LCC estimates the net present value of the financial impact of a given standard level over the lifetime of the product (*i.e.,* 30 years) assuming the standard-compliant product has already been installed and allows for comparison of this value across different hypothetical minimum efficiency levels. It is applied to future-year energy costs and non-energy operations and maintenance costs in order to calculate the net present value of the appliance to a household at the time of installation. The consumer discount rate reflects the opportunity cost of receiving energy cost savings in the future, rather than at the time of purchase and installation. The opportunity cost of receiving operating cost savings in future years, rather than in the first year of the modeled period, is dependent on the rate of return that could be earned if invested into an interest-bearing asset or the interest cost accrual avoided by paying down debt. Consumers in all income bins generally hold a variety of assets (*e.g.,* certificates of deposit, stocks, bonds) and debts (*e.g.,* mortgage, credit cards, vehicle loan), which vary in amount over time as consumers allocate their earnings, make new investments, etc. Thus, the consumer discount rate is estimated as a weighted average of the rates and proportions of the various types of assets and debts held by households in a given income bin, as reported by the Survey of Consumer Finances. In the low-income subgroup analysis, DOE specifically evaluated the impacts of increased efficiency on low-income households using discount rates estimated specifically for the low-income bin. DOE further notes, that AHAM is a party to the Joint Agreement and is supportive of the recommended standard adopted in this direct final rule.

*See* chapter 8 of the direct final rule 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 energy efficiency distribution of refrigerators, refrigerator-freezers, and freezers, DOE used current shipments data provided by AHAM in response to the NOPR for PCs 3, 5, 5A, 7, 9, 11A, and 18, and model counts from DOE's CCMS database for PCs 5BI, 10, and 17. (AHAM, No. 69 at pp. 2–3) 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 the compliance year 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.11. *See* chapter 8 of the direct final rule TSD for further information on the derivation of the efficiency distributions.

TABLE IV.11—NO-NEW-STANDARDS CASE EFFICIENCY DISTRIBUTIONS

| Product class | Total adjusted volume (cu. ft.) | Market share (%) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | EL 0 | EL 1 | EL 2 | EL 3 | EL 4 | EL 5 | Total * |
| 3 | 11.9 | 77.0 | 4.0 | 19.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| | 20.6 | 77.0 | 4.0 | 19.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| 5 | 23 | 90.0 | 7.0 | 2.0 | 0.5 | 0.5 | ................ | 100.0 |
| | 30 | 90.0 | 7.0 | 2.0 | 0.5 | 0.5 | ................ | 100.0 |
| 5A | 35 | 97.0 | 3.0 | 0.0 | 0.0 | ................ | ................ | 100.0 |
| 5BI | 26 | 27.0 | 51.4 | 0.0 | 21.6 | ................ | ................ | 100.0 |
| 7 | 31.5 | 85.5 | 14.5 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| 9 | 29.3 | 83.0 | 16.0 | 0.0 | 0.0 | 1.0 | ................ | 100.0 |
| 10 | 26 | 95.3 | 4.7 | 0.0 | 0.0 | 0.0 | ................ | 100.0 |
| 11A | 1.7 | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | ................ | 100.0 |
| | 4.4 | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | ................ | 100.0 |
| 17 | 9 | 19.4 | 58.2 | 13.4 | 9.0 | ................ | ................ | 100.0 |
| 18 | 8.9 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | ................ | 100.0 |

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

In the February 2023 NOPR, DOE performed a random assignment of efficiency levels to consumers in its Monte Carlo sample. 88 FR 12452, 12484–12485. While DOE acknowledges that economic factors may play a role when consumers decide on what type of refrigerator, refrigerator-freezer, or freezer 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, because it 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 limited 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.

The following discussion provides more detail about the various market failures that affect refrigeration product purchases. First, consumers are motivated by more than simple financial trade-offs. There are consumers who are willing to pay a premium for more energy-efficient products because they are environmentally conscious.[58] 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 available, and how they are presented for any given choice scenario.[59] 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.[60] Thaler, who won the Nobel Prize in Economics in 2017 for his contributions to behavioral economics, and Sunstein point out that these behavioral factors are strongest when the decisions are complex and infrequent, when feedback on the decision is muted and slow, and when there is a high degree of information asymmetry.[61] These characteristics describe almost all purchasing situations of appliances and equipment, including refrigerators, refrigerator-freezers, and freezers. The installation of a new or replacement refrigeration products is done very infrequently, as evidenced by the mean lifetime of 14.3 years for standard-size refrigerators and refrigerator-freezers and 18.4 years for standard-size freezers. Further, if the purchaser of the refrigerator, refrigerator-freezer, or freezer is not the entity paying the energy costs (*e.g.,* a building owner and tenant), there may be little to no feedback on the purchase. Additionally, there are systematic market failures that are likely to contribute further complexity to how products are chosen by consumers, as explained in the following paragraphs. The first of these market failures—the split-incentive or principal-agent problem—is likely to significantly affect refrigerators, refrigerator-freezers, and freezers. The principal-agent problem is a market failure that results when the consumer that purchases the equipment does not internalize all of the costs associated with operating the equipment. Instead, the user of the product, who has no control over the purchase decision, pays the operating costs. There is a high likelihood of split-incentive problems in the case of rental properties where the landlord makes the choice of what refrigeration product to install, whereas the renter is responsible for paying energy bills.

In addition to the split-incentive problem, there are other market failures that are likely to affect the choice of refrigerator, refrigerator-freezer, or freezer product efficiency made by consumers. For example, unplanned replacements due to unexpected failure of equipment such as refrigeration products are strongly biased toward like-for-like replacement (*i.e.,* replacing the non-functioning equipment with a similar or identical product). Time is a constraining factor during unplanned replacements, and consumers may not consider the full range of available options on the market, despite their availability. The consideration of alternative product options is far more likely for planned replacements and installations in new construction.

Additionally, Davis and Metcalf[62] conducted an experiment demonstrating that, even when consumers are presented with energy consumption information, the nature of the information available to consumers (*e.g.,* from EnergyGuide labels) results in an inefficient allocation of energy efficiency across households with different usage levels. Their findings indicate that households are likely to make decisions regarding the efficiency of the air conditioning equipment of their homes that do not result in the highest net present value for their specific usage pattern (*i.e.,* their decision is based on imperfect information and, therefore, is not necessarily optimal). Also, most consumers did not properly understand the labels (specifically whether energy consumption and cost estimates were national averages or specific to their

[58] 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 August 1, 2023).

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

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

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

[62] Davis, L.W., and G.E. Metcalf (2016): ''Does better information lead to better choices? Evidence from energy-efficiency labels,'' *Journal of the Association of Environmental and Resource Economists,* 3(3), 589–625 (available at: *www.journals.uchicago.edu/doi/full/10.1086/686252*) (last accessed August 1, 2023).

State). As such, consumers did not make the most informed decisions.

In part because of the way information is presented, and in part because of the way consumers process information, there is also a market failure consisting of a systematic bias in the perception of equipment energy usage, which can affect consumer choices. Attari *et al.*[63] show that consumers tend to underestimate the energy use of large energy-intensive appliances (such as air conditioners, dishwashers, and clothes dryers), but overestimate the energy use of small appliances (such as light bulbs). Therefore, it is possible that consumers systematically underestimate the energy use associated with refrigerators, refrigerator-freezers, and freezers, resulting in less cost-effective purchases.

These market failures affect a sizeable share of the consumer population. A study by Houde[64] indicates that there is a significant subset of consumers that appear to purchase appliances without taking into account their energy efficiency and operating costs at all.

The existence of market failures in the residential sector is well supported by the economics literature and by a number of case studies. If DOE developed an efficiency distribution that assigned 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 consumer sample would not reflect any of the market failures or behavioral factors above. Thus, DOE concludes such a distribution would not be representative of the refrigeration product market. Further, even if a specific household is not subject to the market failures above, the purchasing decision of refrigerator, refrigerator-freezer, or freezer product efficiency can be highly complex and influenced by a number of factors (*e.g.,* aesthetics) not captured by the building characteristics available in the RECS sample. These factors can lead to households or building owners 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.

There is a complex set of behavioral factors, with sometimes opposing effects, affecting the refrigeration product market. It is impractical to model every consumer decision incorporating all of these effects at this extreme level of granularity given the limited available data. Given these myriad factors, DOE estimates the resulting distribution of such a model, if it were possible, would be very scattered with high variability. It is for this reason DOE utilizes a random distribution (after accounting for efficiency market share constraints) to approximate these effects. The methodology is not an assertion of economic irrationality, but instead, it is a methodological approximation of complex consumer behavior. The analysis is neither biased toward high or low energy savings. The methodology does not preferentially assign lower-efficiency refrigeration products to households in the no-new-standards case where savings from the rule would be greatest, nor does it preferentially assign lower-efficiency refrigeration products to households in the no-new-standards case where savings from the rule would be smallest. Some consumers were assigned the refrigeration products that they would have chosen if they had engaged in perfect economic considerations when purchasing the products. Others were assigned less-efficient refrigeration products even where a more-efficient product would eventually result in life-cycle savings, simulating scenarios where, for example, various market failures prevent consumers from realizing those savings. Still others were assigned refrigeration products that were *more* efficient than one would expect simply from life-cycle costs analysis, reflecting, say, ''green'' behavior, whereby consumers ascribe independent value to minimizing harm to the environment.

10. Payback Period Analysis

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

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

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

*G. Shipments Analysis*

DOE uses projections of annual product shipments to calculate the national impacts of potential amended or new energy conservation standards on energy use, NPV, and future manufacturer cash flows.[65] The shipments model takes an accounting approach, tracking market shares of each product class and the vintage of units in the stock. Stock accounting uses product shipments as inputs to estimate the age distribution of in-service product stocks for all years. The age distribution of in-service product stocks is a key input to calculations of both the NES and NPV, because operating costs for any year depend on the age distribution of the stock. For this direct final rule, DOE excluded PC 9A—BI from the shipments analysis due to its very small shipments volume.

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

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

[64] 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 August 1, 2023).

[65] 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.

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 direct final rule 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. More detail on this methodology can be found in chapter 8 of the direct final rule TSD.

For the direct final rule analysis, DOE incorporated data from stakeholders into the shipments. Confidential aggregate historical shipments data from 2015–2022 provided by AHAM were used to calibrate the total shipments for standard-size refrigerator-freezers, compact refrigerators, upright freezers, chest freezers, and built-in refrigerator-freezers. For the direct final rule, DOE used the AHAM-provided estimates for the efficiency distributions based on shipments for standard-size refrigerator-freezers and compact freezers. (AHAM, No. 69 at pp. 2–3)

Whirlpool requested that DOE provide data to indicate that there would be no impact to appliance replacement at the proposed standard level at TSL 5. (Whirlpool, No. 85 at pp. 8–9) DOE uses a price elasticity of demand to address the impact of increased prices on shipments based on an analysis using market-level appliance data including refrigerators.[66] DOE provides the description of the price elasticity methodology in chapter 9 in the direct final rule TSD.

Chapter 9 in the direct final rule TSD provides further information on 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.[67] (''Consumer'' in this context refers to consumers of the product being regulated.) DOE calculates the NES and NPV for the potential standard levels considered based on projections of annual product shipments, along with the annual energy consumption and total installed cost data from the energy use and LCC analyses. For the present analysis, DOE projected the energy savings, operating cost savings, product costs, and NPV of consumer benefits over the lifetime of refrigerators, refrigerator-freezers, and freezers sold from 2027 through 2056 for all TSLs other than TSL 4, the Recommended TSL detailed in the Joint Agreement. For TSL 4, DOE projected the energy savings, operating cost savings, product costs, and NPV of consumer benefits over the lifetime of refrigerators, refrigerator-freezers, and freezers sold from 2029 through 2058 for the product classes listed in Table I.1 and 2030 through 2059 for the product classes listed in Table I.2.

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, which is available in the docket, 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.12 summarizes the inputs and methods DOE used for the NIA analysis for the direct final rule. Discussion of these inputs and methods follows the table. *See* chapter 10 of the direct final rule TSD for further details.

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

| Inputs | Method |
| --- | --- |
| Shipments | Annual shipments from shipments model. |
| Compliance Date of Standard | 2027 for all TSLs other than TSL 4; for TSL 4, 2029 for the product classes listed in Table I.1 and 2030 for the product classes listed in Table I.2. |
| 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 | *AEO2023* projections (to 2050) and fixed at 2050 thereafter. |
| Energy Site-to-Primary and FFC Conversion | A time-series conversion factor based on *AEO2023.* |
| Discount Rate | Three and seven percent. |
| Present Year | 2023. |

[66] Fujita, K.S. Estimating Price Elasticity using Market-Level Appliance Data. LBNL–188289. Lawrence Berkeley National Laboratory, Berkeley, CA. August 2015. Available at *escholarship.org/uc/item/1t65f9c3#main.*

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

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. 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 distribution in the compliance year. The approach is further described in chapter 10 of the direct final rule TSD.

2. National Energy Savings

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

In this direct final rule 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. Results for 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 PC 3–BI. DOE assumes the incremental cost between efficiency levels is the same for representative and non-representative product classes. *See* chapter 10 of the direct final rule TSD for more details.

In this direct final rule, for the Recommended TSL (TSL 4), the scaling of certain non-representative product classes (specifically PC 12, PC 4–BI, PC 7–BI, and PC 9–BI) has been modified from the February 2023 NOPR, consistent with the Joint Agreement. In the February 2023 NOPR, PC 12 was scaled to PC 11A with the same standard level for PC 12 as PC 11A under a given TSL. However, under the Joint Agreement, at the Recommended TSL, PC 12 is scaled differently. At TSL 4, for PC 11A, the standard is met at EL 2 and for PC 12, the standard level corresponds to EL 1 for PC 11A. Thus, for TSL 4, DOE updated its scaling for PC 12 to reflect EL 1 rather than EL 2 from PC 11A. In the February 2023 NOPR, PC 4–BI and PC 7–BI were scaled to PC 7, and the standard level under TSL 4 corresponded to EL 3 for PC 4–BI, PC 7–BI, and PC 7. Under the Joint Agreement, at TSL 4, PC 7 continues to correspond to EL 3, but PC 4–BI and PC 7–BI correspond to EL 4. Finally, in the February 2023 NOPR, PC 9—BI was scaled to PC 9, and both met the standard under TSL 4 at EL1. At TSL4, the standard for PC 9 is met at EL 2 while PC–9 BI continues to be scaled to EL 1.

Use of higher-efficiency products is sometimes associated with a direct rebound effect, which refers to an increase in utilization of the product due to the increase in efficiency. DOE 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. DOE did not receive any comments regarding this assumption in response to the February 2023 NOPR.

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 statement of policy, 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 [68] that EIA uses to prepare its *Annual Energy Outlook.* The FFC factors incorporate losses in production and delivery in the case of natural gas (including fugitive emissions) and additional energy used to produce and deliver the various fuels used by power plants. The approach used for deriving FFC measures of energy use and emissions is described in appendix 10B of the direct final rule TSD.

3. Net Present Value Analysis

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

As discussed in section IV.F.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

[68] For more information on NEMS, refer to *The National Energy Modeling System: An Overview 2009,* DOE/EIA–0581(2009), October 2009. Available at *www.eia.gov/forecasts/aeo/index.cfm* (last accessed July 13, 2023).

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 2059, which is the end date of the projection period for the Recommended TSL detailed in the Joint Agreement, the average single-speed compressor refrigerators, refrigerator-freezers, and freezers price is projected to drop 33-percent relative to 2030. DOE's projection of product prices is described in chapter 8 of the direct final rule 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 two product price 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 direct final rule TSD.

The energy cost savings are calculated using the estimated energy savings in each year and the projected price of the appropriate form of energy. To estimate energy prices in future years, DOE multiplied the average regional energy prices by the projection of annual national-average residential energy price changes in the Reference case from *AEO2023,* which has an end year of 2050. To estimate price trends after 2050, the 2046–2050 average was used for all years. As part of the NIA, DOE also analyzed scenarios that used inputs from variants of the *AEO2023* Reference case that have lower and higher economic growth. Those cases have lower and higher energy price trends compared to the Reference case. NIA results based on these cases are presented in appendix 10C of the direct final rule TSD.

In calculating the NPV, DOE multiplies the net savings in future years by a discount factor to determine their present value. For this direct final rule, 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.[69] The discount rates for the determination of NPV are in contrast to the discount rates used in the LCC analysis, which are designed to reflect a consumer's perspective. The 7-percent real value is an estimate of the average before-tax rate of return to private capital in the U.S. economy. The 3-percent real value represents the ''social rate of time preference,'' which is the rate at which society discounts future consumption flows to their present value.

*I. Consumer Subgroup Analysis*

In analyzing the potential impact of new or amended energy conservation standards on consumers, DOE evaluates the impact on identifiable subgroups of consumers that may be disproportionately affected by a new or amended national standard. The purpose of a subgroup analysis is to determine the extent of any such disproportional impacts. DOE evaluates impacts on particular subgroups of consumers by analyzing the LCC impacts and PBP for those particular consumers from alternative standard levels.

For this direct final rule, DOE analyzed the impacts of the considered standard levels on low-income households and, for PC 11A, on small businesses. For low-income households, the analysis used a subset of the RECS 2020 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 may not pay to have their refrigerator, refrigerator-freezer, or freezer replaced (that would be up to the landlord).

DOE notes that RECS 2020 indicates that a small fraction 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 2020 indicates that a small fraction 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 PCs 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 direct final rule TSD describes the consumer subgroup analysis.

In response to the February 2023 NOPR, AHAM commented that amended standards requiring more variable-speed compressors could lead to higher upfront costs, disproportionately impacting low-income consumers. (AHAM, No. 69 at p. 5) Whirlpool added that the proposed standards would raise the cost of entry-level models, which are the preferred models for low-income consumers. (Whirlpool, No. 70 at pp. 5–6) As noted previously, many low-income consumers are renters who are not expected to pay the incremental cost due to an amended standard. For low-income homeowners who are expected to bear that incremental cost, the analysis incorporates the higher incremental costs at each considered TSL. DOE notes that at the Recommended TSL (TSL 4), the estimated increase in installed cost relative to the baseline (EL 0) product across PCs 3, 7, and 9 is less than $20. Moreover, in the aggregate, DOE finds that low-income consumers have higher average LCC savings and lower payback periods relative to the general population (*see* the results in section

[69] United States Office of Management and Budget. *Circular A–4: Regulatory Analysis.* September 17, 2003. Section E. Available at *georgewbush-whitehouse.archives.gov/omb/memoranda/m03-21.html* (last accessed July 10, 2023).

V.B.1.b of this document). DOE also finds that, in the aggregate, only 8.6 percent of impacted low-income consumers would experience a net cost at TSL 4, meaning 91.4 percent would see no change or a net benefit.

AHAM also commented that DOE has not supported its split-incentive assumption for low-income renters (*i.e.,* renters will reap benefits of more efficient products through lower utility bills while landlords have little to no incentive to purchase more efficient products) nor has DOE considered the impact of amended standards on low-income homeowners. (AHAM, No. 69 at p. 10) AHAM provided consumer research results indicating that cost is the primary consideration for households when purchasing a new refrigerator, low-income households that make less than $25,000 per year would not be able to purchase a new refrigerator, and 78 percent of such households would not pay $100 extra for a more efficient refrigerator that saved $50-$150 in utility bills over 10 years. (AHAM, No. 69 at pp. 10–11) AHAM added that the proposed standards in the February 2023 NOPR will result in insignificant savings for consumers, which do not amount to a material benefit, especially for low-income consumers. (AHAM, No. 69 at p. 15) Whirlpool commented that DOE's assumption that landlords will absorb increased appliance costs and not pass them on to tenants is incorrect. (Whirlpool, No. 70 at p. 6)

The existence of a split-incentive across a substantial number of U.S. households, in which a tenant pays for the cost of electricity while the building owner furnishes appliances, has been identified through a number of studies of residential appliance and equipment use broadly. Building from early work including Jaffe and Stavins,[70] Murtishaw and Sathaye[71] discussed the presence of landlord–tenant split incentives (*i.e.,* the ''principal-agent problem''). While the study did not solely focus on the low-income households, they estimated that 33% of all residential refrigerator use is subject to the principal-agent problem, largely within rental housing. Spurlock and Fujita[72] showed that 87% of low-income individuals who rented their homes were found to pay the electricity bill resulting from their energy use, such that they were likely subject to a scenario in which their landlord purchased the appliance, but they paid the operating costs. DOE notes that there continues to be a lack of data to corroborate the notion that landlords pass on some, or all, of increased appliance costs to tenants. Without representative data to suggest otherwise, DOE has continued to analyze low-income renters under the assumption that they pay no upfront costs under an amended standard in this direct final rule. DOE further notes, that AHAM is a party to the Joint Agreement and is supportive of the recommended standard adopted in this direct final rule.

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

The quantitative part of the MIA primarily relies on the GRIM, an industry cash flow model with inputs specific to this rulemaking. The key GRIM inputs include data on the industry cost structure, unit production costs, product shipments, manufacturer markups, and investments in R&D and manufacturing capital required to produce compliant products. The key GRIM outputs are the INPV, which is the sum of industry annual cash flows over the analysis period, discounted using the industry weighted average cost of capital, and the impact to domestic manufacturing employment. The model uses standard accounting principles to estimate the impacts of more stringent energy conservation standards on a given industry by comparing changes in INPV and domestic manufacturing employment between a no-new-standards case and the various standards cases. 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 direct final rule TSD.

DOE conducted the MIA for this rulemaking in three phases. In Phase 1 of the MIA, DOE prepared a profile of the refrigerators, refrigerator-freezers, and freezers manufacturing industry based on the market and technology assessment and publicly available information. This included a top-down analysis of refrigerators, refrigerator-freezers, and freezers 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 refrigerators, refrigerator-freezers, and freezers manufacturing industry, including company filings of form 10–K from the SEC,[73] corporate annual reports, the U.S. Census Bureau's *Annual Survey of Manufactures* (''*ASM*''),[74] and reports from Dun & Bradstreet.[75]

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

[70] A.B. Jaffe and R.N. Stavins (1994). The energy-efficiency gap What does it mean? Energy Policy, 22 (10) 804–810, 10.1016/0301–4215(94)90138–4.

[71] Murtishaw, S., & Sathaye, J. (2006). Quantifying the Effect of the Principal-Agent Problem on US Residential Energy Use. Lawrence Berkeley National Laboratory. Retrieved from *https://escholarship.org/uc/item/6f14t11t.*

[72] Equity implications of market structure and appliance energy efficiency regulation, Energy Policy, 165(112943), *https://doi.org/10.1016/j.enpol.2022.112943.*

[73] U.S. Securities and Exchange Commission, Electronic Data Gathering, Analysis, and Retrieval (''EDGAR'') system. Available at *www.sec.gov/edgar/search/* (last accessed July 5, 2023).

[74] U.S. Census Bureau, *Annual Survey of Manufactures.* ''Summary Statistics for Industry Groups and Industries in the U.S (2021).'' Available at *www.census.gov/programs-surveys/asm/data.html* (last accessed July 5, 2023).

[75] The Dun & Bradstreet Hoovers login is available at: *app.dnbhoovers.com* (last accessed July 5, 2023).

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 subgroup impacts.

In Phase 3 of the MIA, DOE conducted structured, detailed interviews with representative manufacturers. During these interviews, DOE discussed engineering, manufacturing, procurement, and financial topics to validate assumptions used in the GRIM and to identify key issues or concerns. 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 chapter 12 of the direct final rule TSD. The domestic LVM subgroup is discussed in section V.B.2.d of this document and in chapter 12 of the direct final rule 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 change in costs, distribution of shipments, investments, and manufacturer margins that could result from an amended energy conservation standard. The GRIM spreadsheet uses the inputs to arrive at a series of annual cash flows, beginning in 2023 (the base year of the analysis) and continuing 30 years from the analyzed compliance year.[76] 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, results of the 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 direct final rule TSD.

a. Manufacturer Production Costs

Manufacturing more efficient products is typically more expensive than manufacturing baseline products due to the use of more complex components, which are typically more costly than baseline components. The changes in the MPCs of covered products can affect the revenues, gross margins, and cash flow of the industry. For a complete description of the MPCs, *see* chapter 5 of the direct final rule TSD.

b. Shipments Projections

The GRIM estimates manufacturer revenues based on total unit shipment projections and the distribution of those shipments by efficiency level. Changes in sales volumes and efficiency mix over time can significantly affect manufacturer finances. For this analysis, the GRIM uses the NIA's annual shipment projections derived from the shipments analysis from the base year (2023) to 30 years from the analyzed compliance date.[77] *See* chapter 9 of the direct final rule TSD for additional details.

c. Product and Capital Conversion Costs

Amended energy conservation standards could cause manufacturers to incur conversion costs to bring their production facilities and product designs into compliance. DOE evaluated the level of conversion-related expenditures that would be needed to comply with each considered efficiency level in each product class. For the MIA, DOE classified these conversion costs into two major groups: (1) 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 potentially necessitate 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

[76] For the no-new-standards case and all TSLs except for the Recommended TSL, the analysis period ranges from 2023–2056. For the Recommended TSL, the analysis period ranges from 2023–2058 for the product classes listed in Table I.1 and 2023–2059 for the product classes listed in Table I.2.

[77] *Id.*

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 direct final rule TSD for details on the mapping of analyzed product classes to non-represented product classes. *See* chapter 12 of the direct final rule 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 within 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. These investments are incorporated into the conversion costs estimated in the MIA for efficiency levels that would likely necessitate VIP technology. 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. DOE did not receive detailed information about the percent of VIPs that are punctured during the manufacturing process. Manufacturers noted the need to allocate special warehouse space 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. VIPs 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 is 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 direct final rule TSD for additional details on capital conversion costs.

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 model provides reasonable estimates of industry-level investments.

DOE adjusted the conversion cost estimates developed in support of the February 2023 NOPR to 2022$ for this analysis.

In general, DOE assumes all conversion-related investments occur between the year of publication of the direct final rule and the year by which manufacturers must comply with the new or amended 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 direct final rule 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'' 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.[78] Manufacturers tend to believe it is optimistic to assume that they would be able to maintain the same gross margin percentage as their production costs increase, particularly for minimally efficient products. Therefore, this scenario represents a high bound of industry profitability under an amended energy conservation standard.

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

For this direct final rule, DOE considered comments it had received regarding its MIA presented in the February 2023 NOPR. The approach used for this direct final rule is largely the same approach DOE had used for the February 2023 NOPR analysis.

In response to the February 2023 NOPR, AHAM stated that manufacturers may need to significantly redesign products in several classes to comply with the proposed DOE standards. In some high-volume product classes, AHAM asserted that there are no or very few shipments of products that meet the proposed standards. AHAM stated that this indicates that even when compliant models exist, they may not represent real-world shipments. AHAM commented that for other product classes, there is considerable variation in the availability of compliant models and shipments. AHAM added that in many instances, there are few compliant models and no reported shipments of compliant products, suggesting that substantial redesign efforts may be required across the market. (AHAM, No. 69 at pp. 2–3)

DOE relied on multiple sources, including feedback from confidential manufacturer interviews and the design paths analyzed in the engineering analysis, to estimate the likely levels of redesign and investment required to meet each analyzed efficiency level. As discussed in section IV.J.2.c of this document, meeting higher efficiency levels may require product redesigns, particularly for efficiency levels that necessitate changes to the cabinet structure (*i.e.,* changes to insulation such as increasing wall thickness or incorporating VIPs). Those costs are incorporated into the MIA. Regarding AHAM's concerns about low shipments at higher efficiency levels, DOE incorporated data from stakeholders into the shipments analysis for this direct final rule analysis. DOE used confidential aggregate historical shipments data from 2015–2022 provided by AHAM to calibrate the total shipments for standard-size refrigerator-freezers, compact refrigerators, upright freezers, chest freezers, and built-in refrigerator-freezers. For this direct final rule, DOE also used the AHAM-provided estimates for the efficiency distributions based on shipments for standard-size refrigerator-freezers and compact freezers. *See* section IV.G of this document for additional information on the shipments analysis.

In response to the February 2023 NOPR, Whirlpool commented that a large decrease in INPV would stifle innovation as manufacturers would be forced to invest product development resources to meet the amended standards and potentially lay off U.S. production employees. (Whirlpool, No. 70 at p. 5)

As discussed in section IV.J.2.c of this document, DOE's analysis shows that as efficiency levels increase, more manufacturers would need to dedicate more financial, engineering, laboratory, and marketing resources to updating products to meet more stringent standards. DOE accounts for those investments in the MIA (*see* section V.B.2.a of this document). However, DOE disagrees with the assertion that redesigning products to improve energy efficiency is in opposition to product innovation. As indicated by manufacturers' participation in the Environmental Protection Agency's (EPA) voluntary ENERGY STAR program and the estimated shipments that meet ENERGY STAR levels, manufacturers and consumers consider energy efficiency a product attribute. Of the 63 refrigerator, refrigerator-freezer, and freezer original equipment manufacturers (OEMs) identified, approximately 46 OEMs manufacture models that meet ENERGY STAR levels and certify those models with the ENERGY STAR program. Approximately 22 percent of refrigerator, refrigerator-freezer, and freezer shipments already meet ENERGY STAR levels. Regarding the potential for a reduction in direct employment as a result of amended standards, DOE provides a range of potential quantitative impacts to direct employment and a discussion of the potential qualitative impacts to direct employment in section V.B.2.b of this document. Most major manufacturers with U.S. production facilities currently produce a portion of their products outside of the United States (*e.g.,* Mexico). 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. *See* section V.B.2.b of this document for additional details on potential impacts to direct employment. DOE further notes, that Whirlpool is a party to the Joint Agreement and is supportive of the

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

recommended standard adopted in this direct final rule.

Whirlpool commented that adoption of the proposed standard levels could make it difficult for multi-brand companies like Whirlpool to differentiate their products and product lines from other manufacturers as models become more technologically complex and costly. Whirlpool added that this could lead to the elimination of certain product segments and result in lost energy savings as consumers switch to more energy-intensive product types. (Whirlpool, No. 70 at pp. 7–8)

DOE uses the GRIM, as described in section IV.J.2 of this document, to determine the quantitative impacts on the refrigerators, refrigerator-freezer, and freezer industry as a whole. DOE recognizes that the industry impacts do not apply evenly across manufacturers. Many manufacturers would need to update certain product designs to meet amended standard levels. However, DOE expects that manufacturers would still be able to differentiate their products and product lines by various factors (*e.g.,* price, technologies, consumer features, energy efficiency). At the adopted level, all analyzed product classes will be required to meet efficiency levels below max-tech levels. Thus, DOE does not expect manufacturers would need to implement all analyzed design options across their product portfolio to meet the adopted levels. Furthermore, in this direct final rule, DOE is adopting the Recommended TSL, which would require lower efficiency levels for high-volume product classes such as PC 5A and PC 7, as compared to the levels proposed in the February 2023 NOPR. Additionally, AHAM, a trade organization representing the interests of their members, including Whirlpool and other refrigerator, refrigerator-freezer, and freezer OEMs, is a signatory of the Joint Agreement. As discussed in section IV.A.1 of this document, DOE is adopting energy allowances for special door and multi-door designs for some product classes. Therefore, DOE expects that these types of features and others will remain prevalent in the market and could offer means for product differentiation. *See* section IV.A.1 of this document for additional information on the energy use allowances.

The California Investor-Owned Utilities (''CA IOUs'') noted the differences between PC 7 and PC 5A in DOE's proposed energy efficiency standards for refrigerators, refrigerator-freezers, and freezers. The CA IOUs commented that the main difference between the two classes is the cost of moving to the VIP side walls and doors at max-tech EL, with PC 7 having a substantially higher order of magnitude for capital conversion costs compared to PC 5A. The CA IOUs recommended revising the proposal to consider EL 5 for PC 7 instead of EL 4. The CA IOUs requested that DOE elaborate on the reason for the differences in cost. (CA IOUs, No. 72 at p. 5)

DOE relied on manufacturer feedback, among other sources, to derive the estimated product and capital conversion costs at each efficiency level for each directly analyzed product class. There are many reasons why the incremental industry conversion costs at each efficiency level could vary between product classes. These reasons include but are not limited to differences in analyzed design options, production volume, the number of models that would require redesign, the number of OEMs engaged in manufacturing each product class, the age of the product families and/or production equipment, and location of the production facilities. For PC 7, manufacturers could include less VIPs to meet the required efficiency level at EL 4 compared to EL 5. At EL 4, 75 percent of the maximum area could incorporate VIPs whereas EL 5 could incorporate VIPs for the maximum area on sidewalls and doors. As discussed in section IV.J.2.c of this document, incorporation of VIPs into designs requires significant upfront capital due to differences in the handling, storing, and manufacturing of VIPs as compared to typical polyurethane foams. DOE estimates the difference in capital conversion costs to be $117.9 million between EL 4 and EL 5. For product conversion costs, extensive use of VIPs would require redesign of the cabinet to maximize the benefits of VIPs. DOE estimated the difference to be $18.8 million between EL 4 and EL 5, which is attributed to design efforts required to meet 75 percent of maximum area of VIPs at EL 4 and the maximum area of VIPs at EL 5. Although manufacturers may incorporate some VIPs (on side walls and doors) for EL 2 for PC 5A, EL 2 may be achieved by component swaps rather than product redesign based on information gathered during manufacturer interviews. AHAM commented the cumulative regulatory burden is significant for home appliance manufacturers when redesigning products and product lines for consumer clothes dryers, residential clothes washers, conventional cooking products, refrigeration products, miscellaneous refrigeration products, and room air conditioners. (AHAM, No. 69 at p. 20) AHAM asserted that engineers will therefore need to spend all their time redesigning products to meet more stringent energy efficiency standards, pulling resources from other development efforts and business priorities. AHAM suggested that DOE could reduce cumulative regulatory burden by spacing out the timing of final rules, allowing more lead time by delaying the publication of final rules in the **Federal Register** after they have been issued, and reducing the stringency of standards such that fewer products would require redesign. (*Id.* At p. 21) AHAM urged DOE to fully review the cumulative impacts its rules will have on manufacturers (as well as consumers). AHAM suggested that this review should include examining the potential impact on the economy and inflation as a result of reducing INPV so significantly. (*Id.* At p. 22)

DOE analyzes cumulative regulatory burden in accordance with section 13(g) of the Process Rule. DOE details the rulemakings and expected conversion expenses of Federal energy conservation standards that could impact refrigerator, refrigerator-freezer, and freezer OEMs that take effect approximately 3 years before the 2029 compliance date and 3 years after the 2030 compliance date in section V.B.2.e of this document. As shown in Table V.29 in section V.B.2.e of this document, DOE considers the potential cumulative regulatory burden from other DOE energy conservation standards rulemakings for consumer clothes dryers, residential clothes washers, conventional cooking products, refrigeration products, miscellaneous refrigeration products, and room air conditioners in this direct final rule analysis. Regarding AHAM's suggestion about spacing out the timing of final rules for home appliance rulemakings, DOE has statutory requirements under EPCA on the timing of rulemakings. For refrigerators, refrigerator-freezers, and freezers, consumer conventional cooking products, residential clothes washers, consumer clothes dryers, room air conditioners, and dishwashers, amended standards apply to covered products manufactured 3 years after the date on which any new or amended standard is published. (42 U.S.C. 6295(m)(4)(A)(i)) For miscellaneous refrigeration products, amended standards apply 5 years after the date on which any new or amended standard is published. (42 U.S.C. 6295(l)(2)) However, the multi-product Joint Agreement recommends alternative compliance dates. As discussed in section of this document, the Joint

Agreement recommendations are in accordance with the statutory requirements of 42 U.S.C. 6295(p)(4) for the issuance of a direct final rule. Therefore, as compared to the EPCA-required lead time, manufacturers will have additional time to meet amended standards for refrigerators, refrigerator-freezers, and freezers in this direct final rule.

Regarding examining the cumulative impacts of energy conservation standards rulemakings on manufacturers and consumers, DOE must follow specific statutory criteria for prescribing new or amended standards for covered products, including refrigerators, refrigerator-freezers, and freezers. An amended standard must be designed to achieve the maximum improvement in energy efficiency that is determined to be technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A) and 42 U.S.C. 6295(o)(3)(B)) In its assessment of whether standards are economically justified, DOE considers the impact of the standard on manufacturers and consumers. DOE analyzes the impacts to manufacturers in accordance with section 13 of the Process Rule and the impacts to consumers in accordance with section 14 of the Process Rule. Although DOE does not analyze the cumulative burden on consumers, section V.B.1.a of this document discusses the economic impact of amended standards on individual consumers, which is the main impact consumers will face with a final amended energy conservation standard.

AHAM stated that it cannot comment on the accuracy of DOE's approach for including how manufacturers might or might not recover potential investments (*i.e.,* the accuracy of DOE's manufacturer markup scenarios) but that AHAM supports DOE's intent in the microwave ovens supplemental notice of proposed rulemaking (''SNOPR'') (''August 2022 SNOPR'') energy conservation standards rulemaking to include those costs and investments in the actual costs of products and retail prices. 87 FR 52282. AHAM urged DOE to apply the same conceptual approach used in the August 2022 SNOPR in this refrigerator/freezer and all future rulemakings (*i.e.,* to analyze a conversion-cost-recovery manufacturer markup scenario). (AHAM, No. 69 at p. 18)

As discussed in section IV.J.2.d of this document, DOE modeled two standards-case manufacturer markup scenarios to represent the uncertainty regarding the potential impacts on prices and profitability for manufacturers following the implementation of amended energy conservation standards. For the February 2023 NOPR, DOE applied the preservation-of-gross-margin-percentage scenario to reflect an upper bound of industry profitability and a preservation-of-operating-profit scenario to reflect a lower bound of industry profitability under amended standards. DOE used these scenarios to reflect the range of realistic profitability impacts under more stringent standards. Manufacturing more efficient refrigerators, refrigerator-freezers, and freezers is generally more expensive than manufacturing baseline refrigerators, refrigerator-freezers, and freezers, as reflected by the MPCs estimated in the engineering analysis. Under the preservation-of-gross-margin scenario for refrigerators, refrigerator-freezers, and freezers, incremental increases in MPCs at higher efficiency levels result in an increase in per-unit dollar profit per unit sold. In interviews, multiple manufacturers asserted that they would likely need to reduce manufacturer markups under more stringent standards to remain competitive in the marketplace. Therefore, the preservation of gross-margin-scenario represents the upper bound of industry profitability under amended standards. Applying the approach used in the microwave ovens rulemaking (*i.e.,* a conversion-cost-recovery scenario) would result in manufacturers increasing manufacturer markups under amended standards. Based on information gathered during confidential interviews in support of the February 2023 NOPR and a review of financial statements of companies engaged in manufacturing refrigerators, refrigerator-freezers, and freezers, DOE does not expect that the refrigerators, refrigerator-freezers, and freezers industry would increase manufacturer markups under an amended standard. Furthermore, in response to the February 2023 NOPR, DOE did not receive any public or confidential data indicating that industry would increase manufacturer markups in response to more stringent standards. Therefore, DOE maintained the two manufacturer markup scenarios from the February 2023 NOPR for this direct final rule analysis.

### *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 in 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 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 direct final rule TSD. The analysis presented in this notice uses projections from *AEO2023.* Power sector emissions of $CH_4$ and $N_2O$ from fuel combustion are estimated using Emission Factors for Greenhouse Gas Inventories published by the Environmental Protection Agency (EPA).[79]

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

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

#### 1. Air Quality Regulations Incorporated in DOE's Analysis

DOE's no-new-standards case for the electric power sector reflects the *AEO,* which incorporates the projected impacts of existing air quality regulations on emissions. *AEO2023* generally represents current legislation and environmental regulations, including recent government actions, that were in place at the time of preparation of *AEO2023,* including the emissions control programs discussed in the following paragraphs.[80]

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

[80] For further information, see the Assumptions to *AEO2023* report that sets forth the major assumptions used to generate the projections in the

$SO_2$ emissions from affected electric generating units (''EGUs'') are subject to nationwide and regional emissions cap-and-trade programs. Title IV of the Clean Air Act sets an annual emissions cap on $SO_2$ for affected EGUs in the 48 contiguous States and the District of Columbia (''DC''). (42 U.S.C. 7651 *et seq.*) $SO_2$ emissions from numerous States in the eastern half of the United States are also limited under the Cross-State Air Pollution Rule (''CSAPR''). 76 FR 48208 (Aug. 8, 2011). CSAPR requires these States to reduce certain emissions, including annual $SO_2$ emissions, and went into effect as of January 1, 2015.[81] *AEO2023* incorporates implementation of CSAPR, including the update to the CSAPR ozone season program emission budgets and target dates issued in 2016. 81 FR 74504 (Oct. 26, 2016). Compliance with CSAPR is flexible among EGUs and is enforced through the use of tradable emissions allowances. Under existing EPA regulations, for states subject to $SO_2$ emissions limits under CSAPR, any excess $SO_2$ emissions allowances resulting from the lower electricity demand caused by the adoption of an efficiency standard could be used to permit offsetting increases in $SO_2$ emissions by another regulated EGU.

However, beginning in 2016, $SO_2$ emissions began to fall as a result of the Mercury and Air Toxics Standards (''MATS'') for power plants. 77 FR 9304 (Feb. 16, 2012). The direct final rule establishes power plant emission standards for mercury, acid gases, and non-mercury metallic toxic pollutants. In order to continue operating, coal plants must have either flue gas desulfurization or dry sorbent injection systems installed. Both technologies, which are used to reduce acid gas emissions, also reduce $SO_2$ emissions. Because of the emissions reductions under the MATS, it is unlikely that excess $SO_2$ emissions allowances resulting from the lower electricity demand would be needed or used to permit offsetting increases in $SO_2$ emissions by another regulated EGU. Therefore, energy conservation standards that decrease electricity generation will generally reduce $SO_2$ emissions. DOE estimated $SO_2$ emissions reduction using emissions factors based on *AEO2023.*

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

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

### *L. Monetizing Emissions Impacts*

As part of the development of this direct final 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 direct final rule.

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

#### 1. Monetization of Greenhouse Gas Emissions

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

For this direct final rule, DOE considered comments it had received regarding its approach for monetizing greenhouse gas emissions in the February 2023 NOPR. The approach used for this direct final rule is largely the same approach DOE had used for the February 2023 NOPR analysis.

The attorneys general (AGs) of TN, AL, *et al.* commented that DOE's misguided use of the SC–GHG estimates is a significant problem with the proposed standards. The AGs of TN, AL, *et al.* attached as evidence their comment letter in response to DOE's proposed standards for consumer conventional cooking products, in which they expressed detailed concerns about the IWG estimates. The AGs of TN, AL, *et al.* noted that the reversal of the preliminary injunction that a coalition of States received in *Louisiana* v. *Biden,* 585 F. Supp. 3d 840 (W.D. La. 2022) does not change the criticisms in the aforementioned comment letter. (The AGs of TN, AL, *et al.,* No. 68 at pp. 1–2)

The IWG's SC–GHG estimates 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. A number of criticisms raised in the comment letter attached by the AGs of TN, AL, *et al.* were addressed by the IWG in its February 2021 SC–GHG TSD, and previous parts of this section summarized the IWG's conclusions on

Annual Energy Outlook. Available at *www.eia.gov/outlooks/aeo/assumptions/* (last accessed July 13, 2023).

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

key issues, including the question of discount rates cited by the Competitive Enterprise Institute (''CEI''). The IWG's 2016 TSD [82] and the 2017 National Academies report provide detailed discussions of the ways in which the modeling underlying the development of the SC–GHG estimates addressed quantified sources of uncertainty. In the February 2021 SC–GHG TSD, the IWG stated that the models used to produce the interim estimates do not include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature. For these same impacts, the science underlying their ''damage functions'' lags behind the most recent research. In the judgment of the IWG, these and other limitations suggest that the range of four interim SC–GHG estimates presented in the TSD likely underestimate societal damages from GHG emissions. The IWG is in the process of assessing how best to incorporate the latest peer-reviewed science and the recommendations of the National Academies to develop an updated set of SC–GHG estimates.

AHAM objected to DOE using the social cost of carbon and other monetization of emissions reductions benefits in its analysis of the factors EPCA requires DOE to balance in determining the appropriate standard. AHAM stated that while it may be acceptable for DOE to continue its current practice of examining the SCC and monetization of other emissions reductions benefits as informational so long as the underlying interagency analysis is transparent and vigorous, the monetization analysis should not impact the TSLs DOE selects as a new or amended standard. (AHAM, No. 69 at pp. 22–23) The AGs of TN, AL, *et al.* stated that even if it is important to take into account emissions reductions when considering the need for national energy conservation (as DOE has claimed), the IWG estimates are unlawful and poor methods for doing so. The AGs of TN, AL, *et al.* concluded that the IWG's SC–GHG estimates are fundamentally flawed and are an unreliable metric on which to base administrative action. (The AGs of TN, AL, *et al.,* No. 68 at pp. 1–2)

As stated in section III.F.1.f of this document, DOE accounts for the environmental and public health benefits associated with the more efficient use of energy, including those connected to global climate change, as they are important to take into account when considering the need for national energy conservation. (*See* 42 U.S.C. 6295(o)(2)(B)(i)(IV)) In addition, Executive Order 13563, which was re-affirmed on January 21, 2021, stated that each agency must, among other things: ''select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity).'' For these reasons, DOE includes the monetized value of emissions reductions in its evaluation of potential standard levels. While the benefits associated with reduction of GHG emissions inform DOE's evaluation of potential standards, the action of proposing or adopting specific standards is not ''based on'' the SC–GHG values, as DOE would reach the same conclusion regarding the economic justification of standards presented in this direct final rule without considering the social cost of greenhouse gases.

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

DOE estimated the global social benefits of $CO_2$, $CH_4$, and $N_2O$ reductions using SC–GHG values that were based on the interim values presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990,* published in February 2021 by the IWG. The SC–GHG 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, the SC–GHG 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–GHG therefore, reflects the societal value of reducing emissions of the gas in question by one metric ton. The SC–GHG 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–GHG 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.*[83] 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

[82] Interagency Working Group on Social Cost of Greenhouse Gases, United States Government. Technical Update on the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866. August 2016. Available at *www.epa.gov/sites/default/files/2016-12/documents/sc_co2_tsd_august_2016.pdf* (last accessed January 18, 2022).

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

review of the SC–$CO_2$ estimates to offer advice on how to approach future updates to ensure that the estimates continue to reflect the best available science and methodologies. In January 2017, the National Academies released their final report, ''Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide,'' and recommended specific criteria for future updates to the SC–$CO_2$ estimates, a modeling framework to satisfy the specified criteria, and both near-term updates and longer-term research needs pertaining to various components of the estimation process (National Academies, 2017).[84] Shortly thereafter, in March 2017, President Trump issued Executive Order 13783, which disbanded the IWG, withdrew the previous TSDs, and directed agencies to ensure SC–$CO_2$ estimates used in regulatory analyses are consistent with the guidance contained in OMB's Circular A–4, ''including with respect to the consideration of domestic versus international impacts and the consideration of appropriate discount rates'' (E.O. 13783, section 5I). Benefit-cost analyses following E.O. 13783 used SC–GHG estimates that attempted to focus on the U.S.-specific share of climate change damages as estimated by the models and were calculated using two discount rates recommended by Circular A–4, 3 percent and 7 percent. All other methodological decisions and model versions used in SC–GHG calculations remained the same as those used by the IWG in 2010 and 2013, respectively.

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

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

Second, the IWG found that the use of the social rate of return on capital (7 percent under current OMB Circular A–4 guidance) to discount the future benefits of reducing GHG emissions inappropriately underestimates the impacts of climate change for the purposes of estimating the SC–GHG. Consistent with the findings of the National Academies (2017) and the economic literature, the IWG continued to conclude that the consumption rate of interest is the theoretically appropriate discount rate in an intergenerational context,[85] 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

[84] 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.

[85] Interagency Working Group on Social Cost of Carbon, Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866 (2010) United States Government. Available at *www.epa.gov/sites/default/files/2016-12/documents/scc_tsd_2010.pdf* (last accessed Jan. 3, 2023); Interagency Working Group on Social Cost of Carbon. Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866 (2013). 78 FR 70586 (November 26, 2013). Available at *www.federalregister.gov/documents/2013/11/26/2013-28242/technical-support-document-technical-update-of-the-social-cost-of-carbon-for-regulatory-impact* (last accessed April 15, 2022); Interagency Working Group on Social Cost of Greenhouse Gases, United States Government. Technical Support Document: Technical Update on the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866 (August 2016). Available at *www.epa.gov/sites/default/files/2016-12/documents/sc_co2_tsd_august_2016.pdf* (last accessed Jan. 3, 2023); Interagency Working Group on Social Cost of Greenhouse Gases, United States Government. Addendum to Technical Support Document on Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866: Application of the Methodology to Estimate the Social Cost of Methane and the Social Cost of Nitrous Oxide (August 2016). Available at *www.epa.gov/sites/default/files/2016-12/documents/addendum_to_sc-ghg_tsd_august_2016.pdf* (last accessed Jan. 3, 2023).

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

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

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

There are a number of limitations and uncertainties associated with the SC–GHG estimates. First, the current scientific and economic understanding of discounting approaches suggests discount rates appropriate for intergenerational analysis in the context of climate change are likely to be less than 3 percent, near 2 percent or lower.[86] Second, the IAMs used to produce these interim estimates do not include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature and the science underlying their ''damage functions''—*i.e.,* the core parts of the IAMs that map global mean temperature changes and other physical impacts of climate change into economic (both market and nonmarket) damages—lags behind the most recent research. For example, limitations include the incomplete treatment of catastrophic and non-catastrophic impacts in the integrated assessment models, their incomplete treatment of adaptation and technological change, the incomplete way in which inter-regional and intersectoral linkages are modeled, uncertainty in the extrapolation of damages to high temperatures, and inadequate representation of the relationship between the discount rate and uncertainty in economic growth over long time horizons. Likewise, the socioeconomic and emissions scenarios used as inputs to the models do not reflect new information from the last decade of scenario generation or the full range of projections. The modeling limitations do not all work in the same direction in terms of their influence on the SC–$CO_2$ estimates. However, as discussed in the February 2021 SC–GHG TSD, the IWG has recommended that, taken together, the limitations suggest that the interim SC–GHG estimates used in this direct final rule likely underestimate the damages from GHG emissions. DOE concurs with this assessment.

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

a. Social Cost of Carbon

The SC–$CO_2$ values used for this direct final rule were based on the values developed for the IWG's February 2021 SC–GHG TSD. Table IV.13 shows the updated sets of SC–$CO_2$ estimates from the IWG's TSD in 5-year increments from 2020 to 2050. The full set of annual values that DOE used is presented in appendix 14–A of the direct final rule TSD.

[86] Interagency Working Group on Social Cost of Greenhouse Gases. 2021. Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990. February. United States Government. Available at *www.whitehouse.gov/briefing-room/blog/2021/02/26/a-return-to-science-evidence-based-estimates-of-the-benefits-of-reducing-climate-pollution/* (last accessed July 12, 2023).

For purposes of capturing the uncertainties involved in regulatory impact analysis, DOE has determined it is appropriate to include all four sets of SC–$CO_2$ values, as recommended by the IWG.[87]

TABLE IV.13—ANNUAL SC–$CO_2$ VALUES FROM 2021 INTERAGENCY UPDATE, 2020–2050

[2020$ per metric ton $CO_2$]

| Year | Discount rate and statistic | | | |
|---|---|---|---|---|
| | 5% Average | 3% Average | 2.5% Average | 3% 95th percentile |
| 2020 | 14 | 51 | 76 | 152 |
| 2025 | 17 | 56 | 83 | 169 |
| 2030 | 19 | 62 | 89 | 187 |
| 2035 | 22 | 67 | 96 | 206 |
| 2040 | 25 | 73 | 103 | 225 |
| 2045 | 28 | 79 | 110 | 242 |
| 2050 | 32 | 85 | 116 | 260 |

For 2051 to 2070, DOE used SC–$CO_2$ estimates published by EPA, adjusted to 2020$.[88] These estimates are based on methods, assumptions, and parameters identical to the 2020–2050 estimates published by the IWG (which were based on EPA modeling). DOE expects additional climate benefits to accrue for any longer-life refrigerators, refrigerator-freezers, and freezers after 2070, but a lack of available SC–$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 2022$ using the implicit price deflator for gross domestic product (''GDP'') from the Bureau of Economic Analysis. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the four cases using the specific discount rate that had been used to obtain the SC–$CO_2$ values in each case.

b. Social Cost of Methane and Nitrous Oxide

The SC–$CH_4$ and SC–$N_2O$ values used for this direct final rule were based on the values developed for the February 2021 SC–GHG TSD. Table IV.14 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 direct final rule 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.14—ANNUAL SC–$CH_4$ AND SC–$N_2O$ VALUES FROM 2021 INTERAGENCY UPDATE, 2020–2050

[2020$ per metric ton]

| Year | SC–$CH_4$ Discount rate and statistic | | | | SC–$N_2O$ Discount rate and statistic | | | |
|---|---|---|---|---|---|---|---|---|
| | 5% Average | 3% Average | 2.5% Average | 3% 95th percentile | 5% Average | 3% Average | 2.5% Average | 3% 95th percentile |
| 2020 | 670 | 1,500 | 2,000 | 3,900 | 5,800 | 18,000 | 27,000 | 48,000 |
| 2025 | 800 | 1,700 | 2,200 | 4,500 | 6,800 | 21,000 | 30,000 | 54,000 |
| 2030 | 940 | 2,000 | 2,500 | 5,200 | 7,800 | 23,000 | 33,000 | 60,000 |
| 2035 | 1,100 | 2,200 | 2,800 | 6,000 | 9,000 | 25,000 | 36,000 | 67,000 |
| 2040 | 1,300 | 2500 | 3,100 | 6,700 | 10,000 | 28,000 | 39,000 | 74,000 |
| 2045 | 1,500 | 2,800 | 3,500 | 7,500 | 12,000 | 30,000 | 42,000 | 81,000 |
| 2050 | 1,700 | 3,100 | 3,800 | 8,200 | 13,000 | 33,000 | 45,000 | 88,000 |

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 2022$ using the implicit price deflator for gross domestic product (''GDP'') from the Bureau of Economic Analysis. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the 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 direct final rule, DOE estimated the monetized value of $NO_X$ and $SO_2$ emissions reductions from electricity generation using benefit-per-ton estimates for that sector from the EPA's Benefits Mapping and Analysis Program.[89] DOE used EPA's values for $PM_{2.5}$-related benefits associated with $NO_X$ and $SO_2$ and for ozone-related benefits associated with $NO_X$ for 2025, 2030, and 2040, calculated with discount rates of 3 percent and 7 percent. DOE used linear interpolation

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

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

[89] Estimating the Benefit per Ton of Reducing $PM_{2.5}$ Precursors from 21 Sectors. Available at *www.epa.gov/benmap/estimating-benefit-ton-reducing-pm25-precursors-21-sectors* (last accessed July 19, 2023).

to define values for the years not given in the 2025 to 2040 period; for years beyond 2040, the values are held constant. DOE combined the EPA benefit-per-ton estimates with regional information on electricity consumption and emissions to define weighted-average national values for $NO_X$ and $SO_2$ as a function of sector (*see* appendix 14B of the NOPR TSD).

DOE 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 *AEO2023*. NEMS produces the *AEO* Reference case, as well as a number of side cases that estimate the economy-wide impacts of changes to energy supply and demand. For the current analysis, impacts are quantified by comparing the levels of electricity sector generation, installed capacity, fuel consumption and emissions in the *AEO2023* Reference case and various side cases. Details of the methodology are provided in the appendices to chapters 13 and 15 of the direct final rule 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 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. 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.[90] 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 direct final rule using an input/output model of the U.S. economy called Impact of Sector Energy Technologies version 4 (''ImSET'').[91] ImSET is a special-purpose version of the ''U.S. Benchmark National Input-Output'' (''I–O'') model, which was designed to estimate the national employment and income effects of energy-saving technologies. The ImSET software includes a computer-based I–O model having structural coefficients that characterize economic flows among 187 sectors most relevant to industrial, commercial, and residential building energy use.

DOE notes that ImSET is not a general equilibrium forecasting model, and that the uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Because ImSET does not incorporate price changes, the employment effects predicted by ImSET may over-estimate actual job impacts over the long run for this rule. Therefore, DOE used ImSET only to generate results for near-term timeframes (2029/30–2033/4), where these uncertainties are reduced. For more details on the employment impact analysis, *see* chapter 16 of the direct final rule TSD.

*O. Other Comments*

As discussed previously, DOE considered relevant comments, data, and information obtained during its own rulemaking process in determining whether the recommended standards from the Joint Agreement are in accordance with 42 U.S.C. 6295(o). And while some of those comments were directed at specific aspects of DOE's analysis of the Joint Agreement under 42 U.S.C. 6295(o), others were more generally applicable to DOE's energy conservation standards rulemaking program as a whole. The ensuing discussion focuses on these general comments concerning energy conservation standards issued under EPCA.

1. Commerce Clause

The AGs of TN, AL, *et al.* commented that DOE's approach to Congress's Commerce Clause is improper because precedent dictates that Congress can only regulate intrastate activity under the Commerce Clause when that activity ''substantially affects interstate commerce.'' (AGs of TN, AL, *et al.,* No. 0068 at pp. 3–5) The AGs of TN, AL, *et al.* commented that for the proposed standards to reach the intrastate market for refrigerators, refrigerator-freezers, and freezers, DOE must show that the intrastate activity covered by 42 U.S.C. 6291(17) and 6302(5) substantially affects the interstate market for those products and the proposed standards show no constitutional basis for applying the standards to intrastate commerce in refrigerators, refrigerator-freezers, and freezers. (*Id.*) The AGs of TN, AL, *et al.* added that if such an

[90] *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/sites/default/files/methodologies/RIMSII_User_Guide.pdf* (last accessed July 17, 2023).

[91] 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's Guide.* 2015. Pacific Northwest National Laboratory: Richland, WA. PNNL–24563.

analysis showed the intrastate market did not substantially affect the interstate market (and so was not properly the subject of Federal regulation), then DOE would be obligated to redo its cost-benefit analysis since the proposed standards would apply to a more limited set of products—those traveling interstate. (*Id.*) Finally, the AGs of TN, AL, *et al.* requested that even if DOE found that the intrastate market substantially affected interstate commerce, DOE should nevertheless exclude intrastate activities from the proposed standards to ''maintain a healthy balance of power between the States and the Federal Government.'' (*Id.* at 4–5)

DOE responds that it believes the scope of both the standard proposed in the NOPR and the amended standard adopted in this direct final rule properly includes all refrigerators, refrigerator-freezers, and freezers distributed in commerce for personal use or consumption because intrastate state activity regulated by 42 U.S.C. 6291(17) and 6302 is inseparable from and substantially affects interstate commerce. DOE has clear authority under EPCA to regulate the energy use of a variety of consumer products and certain commercial and industrial equipment, including the subject refrigerators, refrigerator-freezers, and freezers. *See* 42 U.S.C. 6295. Based on this statutory authority, DOE has a long-standing practice of issuing standards with the same scope as the standard in this direct final rule. For example, DOE has maintained a similar scope of products in the final rule that established the current standards for refrigerators, refrigerator-freezers, and freezers, which was published on September 15, 2011 (76 FR 57516), and in the final rule establishing the preceding set of standards for these products, published on April 28, 1997 (62 FR 23102). DOE disagrees with the AGs of TN, AL, *et al.*'s contention that the Commerce Clause, the Tenth Amendment, the Major Questions Doctrine, or any canons of statutory construction limit DOE's clear and long-standing authority under EPCA to adopt the standard, including its scope, in this direct final rule. A further discussion regarding the AGs of TN, AL, *et al.*'s federalism concerns can be found at section VI.E of this document.

2. National Academy of Sciences Report

The National Academies of Sciences, Engineering, and Medicine (''NAS'') periodically appoint a committee to peer review the assumptions, models, and methodologies that DOE uses in setting energy conservation standards for covered products and equipment. The most recent such peer review was conducted in a series of meetings in 2020, and NAS issued the report [92] in 2021 detailing its findings and recommendations on how DOE can improve its analyses and align them with best practices for cost-benefit analysis.

AHAM stated that despite previous requests from AHAM and others, DOE has failed to review and incorporate the recommendations of the NAS report, instead indicating that it will conduct a separate rulemaking process without such a process having been initiated. (AHAM, No. 69 at pp. 9–10) AHAM further stated that DOE seems to be ignoring the recommendations in the NAS Report and even conducting analysis that is opposite to the recommendations. AHAM commented that DOE cannot continue to perpetuate the errors in its analytical approach that have been pointed out by stakeholders and the NAS report as to do so will lead to arbitrary and capricious rules. (*Id.*)

As discussed, the rulemaking process for establishing new or amended standards for covered products and equipment are specified at appendix A to subpart C of 10 CFR part 430. DOE periodically examines and revises these provisions in separate rulemaking proceedings. The recommendations provided in the 2011 NAS report, which pertain to the processes by which DOE analyzes energy conservation standards, will be considered by DOE in a separate rulemaking process.

3. Family Well-Being

The AGs of TN, AL, *et al.* submitted a joint comment that DOE's proposed standards regulate an appliance that is commonly used in family kitchens, and the costs they impose affect every family's budget, forcing lower-income families to make difficult financial decisions. Therefore, the AGs of TN, AL, *et al.* requested that DOE provide the assessment required by section 654 of the Treasury and General Government Appropriations Act, 1999, which considers the impact of the Proposed Standards on family well-being. (The AGs of TN, AL, *et al.,* No. 68 at pp. 5–6)

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 proposed rule or policy that may affect family well-being. Although this direct final rule would not have any impact on the autonomy or integrity of the family as an institution as defined, this rule could impact a family's well-being. When developing a Family Policymaking Assessment, agencies must assess whether: (1) the action strengthens or erodes the stability or safety of the family and, particularly, the marital commitment; (2) the action strengthens or erodes the authority and rights of parents in the education, nurture, and supervision of their children; (3) the action helps the family perform its functions, or substitutes governmental activity for the function; (4) the action increases or decreases disposable income or poverty of families and children; (5) the proposed benefits of the action justify the financial impact on the family; (6) the action may be carried out by State or local government or by the family; and whether (7) the action establishes an implicit or explicit policy concerning the relationship between the behavior and personal responsibility of youth, and the norms of society.

DOE has considered how the proposed benefits of this rule compare to the possible financial impact on a family (the only factor listed that is relevant to this rule). As part of its rulemaking process, DOE must determine whether the energy conservation standards contained in this direct final rule are economically justified. As discussed in section V.C.1 of this document, DOE has determined that the standards are economically justified because the benefits to consumers far outweigh the costs to manufacturers. Families will also see LCC savings as a result of this rule. Moreover, as discussed further in section V.B.1 of this document, DOE has determined that for the for low-income households, average LCC savings and PBP at the considered efficiency levels are improved (*i.e.,* higher LCC savings and lower payback period) as compared to the average for all households. Further, the standards will also result in climate and health benefits for families. Numerous individuals commented against proposed standards. Comments cited cost increases on consumers, narrowing of consumer choice, and government overregulation. (Individual Commenters, No. 47–53, 56, 58, 59 at p. 1)

As discussed in section II.A of this document, DOE conducted numerous analyses in support of this direct final rule consistent with EPCA, which requires that DOE consider many factors, including those concerns raised

[92] National Academies of Sciences, Engineering, and Medicine. 2021. *Review of Methods Used by the U.S. Department of Energy in Setting Appliance and Equipment Standards.* Washington, DC: The National Academies Press. Available at *doi.org/10.17226/25992* (last accessed August 2, 2023).

by commenters. Analyses include the potential negative impacts on consumers and manufacturers and an assessment of the impact relative to the cost and energy savings resulting from amended standards, which are discussed in further detail in sections IV.F, IV.H, and IV.J of this document. DOE conducted its engineering analysis to determine standards that are applicable to reducing energy consumption while remaining technologically feasible. The engineering analysis is discussed in greater detail throughout section IV.C of this document. DOE notes that the comments on government overregulation lack the necessary specificity to properly address them in this context. However, as mentioned above, DOE conducted the analysis in this rulemaking consistent with the requirements in EPCA and those used in past rulemakings for this product.

## 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 adopting in this direct final rule. Additional details regarding DOE's analyses are contained in the direct final rule 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 direct final rule, 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. 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 percent across the product classes analyzed, consistent with ENERGY STAR requirements, except for PC 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 PCs 5, 5A, 7, 11A, and 18 and increases NES while keeping economic impacts on consumers relatively modest. TSL 4 is the Recommended TSL detailed in the Joint Agreement. TSL 4 increases the proposed standard level for PCs 3 and 9, as well as the expected NES, while average LCC savings are positive for every product class. TSL 4 also corresponds to different compliance years than the other TSLs. Rather than a compliance year of 2027, for TSL 4, 2029 is the compliance year for the product classes listed in Table I.1 and 2030 is the compliance year for the product classes listed in Table I.2. TSL 5 increases the proposed standard level for PC 5A and PC 7, decreases the proposed standard level for PC 9, and increases the expected overall 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 direct final rule 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 | PC5–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 2 | EL 3 | EL 2 | 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.
** Recommended TSL from the Joint Agreement. This TSL also includes different standard levels for the non-representative PCs 4–BI, 5A–BI, 7–BI, 9–BI, 9A–BI and 12. The compliance year varies by product class. See the Joint Agreement for details.

Section IV.C.3 shows the design options determined to be required for representative products of each analyzed class as a function of the TSLs.

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

Tables V.2 through V.21 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, the impacts are measured relative to the efficiency distribution in the 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.2—AVERAGE LCC AND PBP RESULTS FOR PRODUCT CLASS 3

| TSL * | Efficiency level | Average costs 2022$ | | | | Simple payback years | Average lifetime years |
|---|---|---|---|---|---|---|---|
| | | Installed cost | First year's operating cost | Lifetime operating cost | LCC | | |
| | Baseline | 830.22 | 68.31 | 937.19 | 1,767.41 | .................... | 14.5 |
| 1 | 1 | 834.70 | 65.19 | 902.11 | 1,736.81 | 1.4 | 14.5 |
| 2–3 | 2 | 857.14 | 61.93 | 868.69 | 1,725.83 | 4.2 | 14.5 |
| 4 | 3 | 838.61 | 58.22 | 835.33 | 1,673.94 | 4.8 | 14.5 |
| 5 | 3 | 882.91 | 58.32 | 831.71 | 1,714.63 | 5.3 | 14.5 |
| | 4 | 959.74 | 55.15 | 809.28 | 1,769.02 | 9.8 | 14.5 |
| 6 | 5 | 999.59 | 50.11 | 758.46 | 1,758.05 | 9.3 | 14.5 |

**Note:** The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.
* All TSLs except TSL 4 have a compliance year of 2027; TSL 4 has a compliance year of 2030.

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

| TSL ** | Efficiency level | Life-cycle cost savings | |
|---|---|---|---|
| | | Average LCC savings * 2022$ | Percent of consumers that experience net cost |
| 1 | 1 | 30.50 | 3.9 |
| 2–3 | 2 | 40.14 | 17.3 |
| 4 | 3 | 50.91 | 28.3 |
| 5 | 3 | 43.46 | 34.2 |
| | 4 | −10.94 | 70.7 |
| 6 | 5 | 0.03 | 67.1 |

* The savings represent the average LCC for affected consumers.
** All TSLs except TSL 4 have a compliance year of 2027; TSL 4 has a compliance year of 2030.

TABLE V.4—AVERAGE LCC AND PBP RESULTS FOR PRODUCT CLASS 5

| TSL * | Efficiency level | Average costs 2022$ | | | | Simple payback years | Average lifetime years |
|---|---|---|---|---|---|---|---|
| | | Installed cost | First year's operating cost | Lifetime operating cost | LCC | | |
| | Baseline | 1,312.92 | 103.02 | 1,441.88 | 2,754.80 | .................... | 14.5 |
| 1–2 | 1 | 1,343.59 | 95.86 | 1,364.05 | 2,707.64 | 4.3 | 14.5 |
| 3 | 2 | 1,382.17 | 91.75 | 1,323.25 | 2,705.42 | 6.1 | 14.5 |
| 4 | 2 | 1,313.51 | 91.73 | 1,329.76 | 2,643.28 | 5.6 | 14.5 |
| 5 | 2 | 1,382.17 | 91.75 | 1,323.25 | 2,705.42 | 6.1 | 14.5 |
| | 3 | 1,433.17 | 87.11 | 1,278.50 | 2,711.67 | 7.6 | 14.5 |
| 6 | 4 | 1,464.67 | 85.43 | 1,264.79 | 2,729.46 | 8.6 | 14.5 |

**Note:** The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.
* All TSLs except TSL 4 have a compliance year of 2027; TSL 4 has a compliance year of 2030.

TABLE V.5—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR PRODUCT CLASS 5

| TSL ** | Efficiency level | Life-cycle cost savings | |
|---|---|---|---|
| | | Average LCC savings * 2022$ | Percent of consumers that experience net cost |
| 1–2 | 1 | 46.90 | 18.2 |
| 3 | 2 | 45.47 | 39.4 |
| 4 | 2 | 55.23 | 33.6 |
| 5 | 2 | 45.47 | 39.4 |
| | 3 | 38.19 | 52.8 |
| 6 | 4 | 20.22 | 60.3 |

* The savings represent the average LCC for affected consumers.
** All TSLs except TSL 4 have a compliance year of 2027; TSL 4 has a compliance year of 2030.

TABLE V.6—AVERAGE LCC AND PBP RESULTS FOR PRODUCT CLASS 5BI

| TSL * | Efficiency level | Average costs 2022$ | | | | Simple payback years | Average lifetime years |
|---|---|---|---|---|---|---|---|
| | | Installed cost | First year's operating cost | Lifetime operating cost | LCC | | |
| | Baseline | 1,579.54 | 106.75 | 1,534.74 | 3,114.28 | .................... | 14.5 |
| 1–3 | 1 | 1,603.84 | 96.55 | 1,420.31 | 3,024.15 | 2.4 | 14.5 |
| 4 | 1 | 1,550.34 | 96.23 | 1,423.25 | 2,973.59 | 2.1 | 14.5 |
| 5 | 1 | 1,603.84 | 96.55 | 1,420.31 | 3,024.15 | 2.4 | 14.5 |
| | 2 | 1,659.01 | 91.45 | 1,371.03 | 3,030.04 | 5.2 | 14.5 |
| 6 | 3 | 1,714.16 | 90.43 | 1,369.31 | 3,083.47 | 8.2 | 14.5 |

**Note:** The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.
* All TSLs except TSL 4 have a compliance year of 2027; TSL 4 has a compliance year of 2029.

TABLE V.7—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR PRODUCT CLASS 5BI

| TSL ** | Efficiency level | Life-cycle cost savings | |
|---|---|---|---|
| | | Average LCC savings * 2022$ | Percent of consumers that experience net cost |
| 1–3 | 1 | 86.19 | 1.0 |
| 4 | 1 | 91.13 | 0.5 |
| 5 | 1 | 86.19 | 1.0 |
| | 2 | 22.77 | 44.8 |
| 6 | 3 | −30.73 | 61.0 |

* The savings represent the average LCC for affected consumers.
** All TSLs except TSL 4 have a compliance year of 2027; TSL 4 has a compliance year of 2029.

TABLE V.8—AVERAGE LCC AND PBP RESULTS FOR PRODUCT CLASS 5A

| TSL * | Efficiency level | Average costs 2022$ | | | | Simple payback years | Average lifetime years |
|---|---|---|---|---|---|---|---|
| | | Installed cost | First year's operating cost | Lifetime operating cost | LCC | | |
| | Baseline | 1,460.58 | 128.51 | 1,772.25 | 3,232.84 | .................... | 14.5 |
| 1–2 | 1 | 1,487.03 | 114.95 | 1,618.23 | 3,105.26 | 1.9 | 14.5 |
| 3 | 2 | 1,546.91 | 108.78 | 1,557.08 | 3,103.99 | 4.4 | 14.5 |
| 4 | 2 | 1,495.23 | 108.00 | 1,561.70 | 3,056.93 | 4.1 | 14.5 |
| 5–6 | 3 | 1,622.24 | 101.39 | 1,484.33 | 3,106.57 | 6.0 | 14.5 |

**Note:** The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.
* All TSLs except TSL 4 have a compliance year of 2027; TSL 4 has a compliance year of 2029.

TABLE V.9—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR PRODUCT CLASS 5A

| TSL ** | Efficiency level | Life-cycle cost savings | |
|---|---|---|---|
| | | Average LCC savings * 2022$ | Percent of consumers that experience net cost |
| 1–2 | 1 | 127.59 | 1.2 |
| 3 | 2 | 124.76 | 23.0 |
| 4 | 2 | 133.27 | 19.8 |
| 5–6 | 3 | 122.18 | 39.4 |

* The savings represent the average LCC for affected consumers.
** All TSLs except TSL 4 have a compliance year of 2027; TSL 4 has a compliance year of 2029.

TABLE V.10—AVERAGE LCC AND PBP RESULTS FOR PRODUCT CLASS 7

| TSL * | Efficiency level | Average costs 2022$ | | | | Simple payback years | Average lifetime years |
|---|---|---|---|---|---|---|---|
| | | Installed cost | First year's operating cost | Lifetime operating cost | LCC | | |
| | Baseline | 1,278.19 | 107.33 | 1,475.40 | 2,753.59 | .................... | 14.5 |
| 1 | 1 | 1,281.77 | 102.46 | 1,419.59 | 2,701.36 | 0.7 | 14.5 |

TABLE V.10—AVERAGE LCC AND PBP RESULTS FOR PRODUCT CLASS 7—Continued

| TSL * | Efficiency level | Average costs 2022$ | | | | Simple payback years | Average lifetime years |
|---|---|---|---|---|---|---|---|
| | | Installed cost | First year's operating cost | Lifetime operating cost | LCC | | |
| 2 | 2 | 1,305.88 | 97.68 | 1,368.72 | 2,674.59 | 2.9 | 14.5 |
| 3 | 3 | 1,307.20 | 92.09 | 1,304.25 | 2,611.45 | 1.9 | 14.5 |
| 4 | 3 | 1,242.09 | 91.60 | 1,310.33 | 2,552.41 | 1.6 | 14.5 |
| 5 | 4 | 1,399.77 | 87.83 | 1,271.83 | 2,671.59 | 6.2 | 14.5 |
| 6 | 5 | 1,431.19 | 84.98 | 1,244.65 | 2,675.84 | 6.8 | 14.5 |

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

* All TSLs except TSL 4 have a compliance year of 2027; TSL 4 has a compliance year of 2030.

TABLE V.11—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR PRODUCT CLASS 7

| TSL ** | Efficiency level | Life-cycle cost savings | |
|---|---|---|---|
| | | Average LCC savings * 2022$ | Percent of consumers that experience net cost |
| 1 | 1 | 52.10 | 0.0 |
| 2 | 2 | 70.96 | 9.6 |
| 3 | 3 | 134.10 | 1.2 |
| 4 | 3 | 142.56 | 0.5 |
| 5 | 4 | 73.96 | 42.6 |
| 6 | 5 | 69.71 | 48.3 |

* The savings represent the average LCC for affected consumers.

** All TSLs except TSL 4 have a compliance year of 2027; TSL 4 has a compliance year of 2030.

TABLE V.12—AVERAGE LCC AND PBP RESULTS FOR PRODUCT CLASS 9

| TSL * | Efficiency level | Average costs 2022$ | | | | Simple payback years | Average lifetime years |
|---|---|---|---|---|---|---|---|
| | | Installed cost | First year's operating cost | Lifetime operating cost | LCC | | |
| | Baseline | 1,023.63 | 70.01 | 1,072.00 | 2,095.63 | .................... | 18.5 |
| 1–3 | 1 | 1,050.17 | 63.46 | 983.71 | 2,033.88 | 4.1 | 18.5 |
| 4 | 2 | 1,039.42 | 60.04 | 950.64 | 1,990.06 | 6.6 | 18.5 |
| 5 | 1 | 1,050.17 | 63.46 | 983.71 | 2,033.88 | 4.1 | 18.5 |
| | 3 | 1,141.15 | 56.64 | 897.84 | 2,039.00 | 8.8 | 18.5 |
| 6 | 4 | 1,201.08 | 53.36 | 858.25 | 2,059.33 | 10.7 | 18.5 |

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

* All TSLs except TSL 4 have a compliance year of 2027; TSL 4 has a compliance year of 2030.

TABLE V.13—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR PRODUCT CLASS 9

| TSL ** | Efficiency level | Life-cycle cost savings | |
|---|---|---|---|
| | | Average LCC savings * 2022$ | Percent of consumers that experience net cost |
| 1–3 | 1 | 62.02 | 12.2 |
| 4 | 2 | 56.17 | 39.1 |
| 5 | 1 | 62.02 | 12.2 |
| | 3 | 46.62 | 52.2 |
| 6 | 4 | 26.33 | 61.0 |

* The savings represent the average LCC for affected consumers.

** All TSLs except TSL 4 have a compliance year of 2027; TSL 4 has a compliance year of 2030.

TABLE V.14—AVERAGE LCC AND PBP RESULTS FOR PRODUCT CLASS 10

| TSL * | Efficiency level | Average costs 2022$ | | | | Simple payback years | Average lifetime years |
|---|---|---|---|---|---|---|---|
| | | Installed cost | First year's operating cost | Lifetime operating cost | LCC | | |
| 1 | 1 | 1,037.56 | 38.90 | 638.00 | 1,675.56 | 11.2 | 18.5 |
| 2–3 | Baseline | 994.99 | 42.72 | 686.42 | 1,681.41 | .................... | 18.5 |
| 4 | Baseline | 963.19 | 42.36 | 688.01 | 1,651.20 | .................... | 18.5 |
| 5 | Baseline | 994.99 | 42.72 | 686.42 | 1,681.41 | .................... | 18.5 |
| | 2 | 1,075.74 | 36.64 | 610.58 | 1,686.33 | 13.3 | 18.5 |
| | 3 | 1,078.80 | 34.66 | 583.52 | 1,662.32 | 10.4 | 18.5 |
| 6 | 4 | 1,115.72 | 33.71 | 574.13 | 1,689.85 | 13.4 | 18.5 |

**Note:** The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.
* All TSLs except TSL 4 have a compliance year of 2027; TSL 4 has a compliance year of 2029.

TABLE V.15—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR PRODUCT CLASS 10

| TSL ** | Efficiency level | Life-cycle cost savings | |
|---|---|---|---|
| | | Average LCC savings * 2022$ | Percent of consumers that experience net cost |
| 1 | 1 | 5.94 | 57.5 |
| | 2 | −5.13 | 69.8 |
| | 3 | 18.87 | 57.4 |
| 6 | 4 | −8.65 | 70.0 |

* The savings represent the average LCC for affected consumers.
** All results in this table assume a compliance year of 2027.

TABLE V.16—AVERAGE LCC AND PBP RESULTS FOR PRODUCT CLASS 11A

| TSL * | Efficiency level | Average costs 2022$ | | | | Simple payback years | Average lifetime years |
|---|---|---|---|---|---|---|---|
| | | Installed cost | First year's operating cost | Lifetime operating cost | LCC | | |
| Residential: | | | | | | | |
| | Baseline | 298.57 | 35.44 | 288.26 | 586.83 | .................... | 8.9 |
| 1–2 | 1 | 305.89 | 32.01 | 262.49 | 568.38 | 2.1 | 8.9 |
| 3 | 2 | 308.97 | 30.52 | 251.30 | 560.27 | 2.1 | 8.9 |
| 4 | 2 | 299.10 | 30.33 | 253.30 | 552.40 | 2.1 | 8.9 |
| 5 | 2 | 308.97 | 30.52 | 251.30 | 560.27 | 2.1 | 8.9 |
| | 3 | 344.16 | 28.67 | 239.20 | 583.36 | 6.7 | 8.9 |
| 6 | 4 | 362.81 | 24.73 | 210.23 | 573.04 | 6.0 | 8.9 |
| Commercial: | | | | | | | |
| | Baseline | 299.37 | 25.22 | 179.75 | 479.12 | .................... | 8.9 |
| 1–2 | 1 | 306.71 | 22.99 | 165.59 | 472.30 | 3.3 | 8.9 |
| 3 | 2 | 309.79 | 22.03 | 159.45 | 469.24 | 3.3 | 8.9 |
| 4 | 2 | 299.89 | 21.52 | 158.91 | 458.81 | 3.2 | 8.9 |
| 5 | 2 | 309.79 | 22.03 | 159.45 | 469.24 | 3.3 | 8.9 |
| | 3 | 345.08 | 20.82 | 153.37 | 498.45 | 10.4 | 8.9 |
| 6 | 4 | 363.77 | 18.27 | 137.64 | 501.41 | 9.3 | 8.9 |

**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.
* All TSLs except TSL 4 have a compliance year of 2027; TSL 4 has a compliance year of 2029.

TABLE V.17—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR PRODUCT CLASS 11A

| TSL ** | Efficiency level | Life-cycle cost savings | |
|---|---|---|---|
| | | Average LCC savings * 2022$ | Percent of consumers that experience net cost |
| Residential: | | | |
| 1–2 | 1 | 0.00 | 0.0 |
| 3 | 2 | 8.11 | 8.4 |
| 4 | 2 | 8.35 | 8.0 |
| 5 | 2 | 8.11 | 8.4 |
| | 3 | −14.97 | 84.8 |
| 6 | 4 | −4.66 | 61.7 |

TABLE V.17—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR PRODUCT CLASS 11A—Continued

| TSL ** | Efficiency level | Life-cycle cost savings | |
|---|---|---|---|
| | | Average LCC savings * 2022$ | Percent of consumers that experience net cost |
| Commercial: | | | |
| 1–2 | 1 | 0.00 | 0.0 |
| 3 | 2 | 3.06 | 16.1 |
| 4 | 2 | 3.16 | 15.7 |
| 5 | 2 | 3.06 | 16.1 |
| | 3 | −26.15 | 99.3 |
| 6 | 4 | −29.11 | 92.7 |

* The savings represent the average LCC for affected consumers.
** All TSLs except TSL 4 have a compliance year of 2027; TSL 4 has a compliance year of 2029.

TABLE V.18—AVERAGE LCC AND PBP RESULTS FOR PRODUCT CLASS 17

| TSL * | Efficiency level | Average costs 2022$ | | | | Simple payback years | Average lifetime years |
|---|---|---|---|---|---|---|---|
| | | Installed cost | First year's operating cost | Lifetime operating cost | LCC | | |
| | Baseline | 514.48 | 73.65 | 739.82 | 1,254.30 | .................... | 11.5 |
| 1–3 | 1 | 548.82 | 66.16 | 670.81 | 1,219.62 | 4.6 | 11.5 |
| 4 | 1 | 529.02 | 65.85 | 677.65 | 1,206.67 | 4.1 | 11.5 |
| 5 | 1 | 548.82 | 66.16 | 670.81 | 1,219.62 | 4.6 | 11.5 |
| | 2 | 585.96 | 62.52 | 638.75 | 1,224.71 | 6.4 | 11.5 |
| 6 | 3 | 623.09 | 58.56 | 603.65 | 1,226.75 | 7.2 | 11.5 |

**Note:** The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.
* All TSLs except TSL 4 have a compliance year of 2027; TSL 4 has a compliance year of 2029.

TABLE V.19—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR PRODUCT CLASS 17

| TSL ** | Efficiency level | Life-cycle cost savings | |
|---|---|---|---|
| | | Average LCC savings * 2022$ | Percent of consumers that experience net cost |
| 1–3 | 1 | 32.29 | 5.6 |
| 4 | 1 | 36.86 | 4.5 |
| 5 | 1 | 32.29 | 5.6 |
| | 2 | 2.62 | 52.0 |
| 6 | 3 | 0.26 | 61.5 |

* The savings represent the average LCC for affected consumers.
** All TSLs except TSL 4 have a compliance year of 2027; TSL 4 has a compliance year of 2029.

TABLE V.20—AVERAGE LCC AND PBP RESULTS FOR PRODUCT CLASS 18

| TSL * | Efficiency level | Average costs 2022$ | | | | Simple payback years | Average lifetime years |
|---|---|---|---|---|---|---|---|
| | | Installed cost | First year's operating cost | Lifetime operating cost | LCC | | |
| | Baseline | 487.72 | 31.07 | 329.24 | 816.96 | .................... | 11.5 |
| 1–2 | 1 | 491.75 | 28.09 | 301.39 | 793.14 | 1.4 | 11.5 |
| 3 | 2 | 506.37 | 26.58 | 288.10 | 794.47 | 4.2 | 11.5 |
| 4 | 2 | 490.19 | 26.33 | 289.27 | 779.46 | 4.1 | 11.5 |
| 5 | 2 | 506.37 | 26.58 | 288.10 | 794.47 | 4.2 | 11.5 |
| | 3 | 527.04 | 25.26 | 277.15 | 804.19 | 6.8 | 11.5 |
| 6 | 4 | 569.15 | 22.39 | 253.14 | 822.29 | 9.4 | 11.5 |

**Note:** The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.
* All TSLs except TSL 4 have a compliance year of 2027; TSL 4 has a compliance year of 2029.

TABLE V.21—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR PRODUCT CLASS 18

| TSL ** | Efficiency level | Life-cycle cost savings | |
|---|---|---|---|
| | | Average LCC savings * 2022$ | Percent of consumers that experience net cost |
| 1–2 | 1 | 23.82 | 0.8 |
| 3 | 2 | 22.49 | 18.9 |
| 4 | 2 | 23.55 | 17.6 |
| 5 | 2 | 22.49 | 18.9 |
| | 3 | 12.77 | 45.6 |
| 6 | 4 | −5.34 | 68.5 |

* The savings represent the average LCC for affected consumers.
** All TSLs except TSL 4 have a compliance year of 2027; TSL 4 has a compliance year of 2029.

b. Consumer Subgroup Analysis

In the consumer subgroup analysis, DOE estimated the impact of the considered TSLs on low-income households and small businesses. Table V.22 compares the average LCC savings and PBP at each efficiency level for the low-income consumer subgroup with similar metrics for the entire consumer sample for PCs 3, 7, 9, and 10 (*see* section IV.I for an explanation of why other product classes are excluded). Table V.23 provides a similar comparison for PC 11A for the small business subgroup. In all 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 PC 11A are similar to those for all businesses. Chapter 11 of the direct final rule TSD presents the complete LCC and PBP results for the subgroups.

TABLE V.22—COMPARISON OF LCC SAVINGS AND PBP FOR LOW-INCOME CONSUMER SUBGROUP AND ALL CONSUMERS

| TSL ** | Average LCC savings * 2022$ | | Simple payback period years | |
|---|---|---|---|---|
| | Low-income households | All households | Low-income households | All households |
| Product Class 3: | | | | |
| 1 | 32.24 | 30.50 | 0.4 | 1.4 |
| 2–3 | 58.01 | 40.14 | 1.3 | 4.2 |
| 4 | 80.07 | 50.91 | 1.4 | 4.8 |
| 5 | 76.69 | 43.46 | 1.6 | 5.3 |
| 6 | 123.04 | 0.03 | 2.8 | 9.3 |
| Product Class 7: | | | | |
| 1 | 56.76 | 52.10 | 0.5 | 0.7 |
| 2 | 87.29 | 70.96 | 1.8 | 2.9 |
| 3 | 154.61 | 134.10 | 1.2 | 1.9 |
| 4 | 161.87 | 142.56 | 1.0 | 1.6 |
| 5 | 132.77 | 73.96 | 3.9 | 6.2 |
| 6 | 142.45 | 69.71 | 4.2 | 6.8 |
| Product Class 9: | | | | |
| 1–3 | 65.99 | 62.02 | 2.8 | 4.1 |
| 4 | 69.62 | 56.17 | 4.6 | 6.6 |
| 5 | 65.99 | 62.02 | 2.8 | 4.1 |
| 6 | 72.77 | 26.33 | 7.4 | 10.7 |
| Product Class 10: | | | | |
| 1 | 22.75 | 5.94 | 6.4 | 11.2 |
| 2–5 | N/A | N/A | N/A | N/A |
| 6 | 39.03 | −8.65 | 7.6 | 13.4 |

* The savings represent the average LCC for affected consumers.
** The compliance year for TSLs 1–3 and 5–6 is 2027; the compliance year for TSL 4 varies by product class: 2029: PC 10; 2030: PCs 3, 7, and 9.

TABLE V.23—COMPARISON OF LCC SAVINGS AND PBP FOR SMALL BUSINESS CONSUMER SUBGROUP AND ALL BUSINESSES

| TSL ** | Average LCC savings * 2022$ | | Simple payback period years | |
|---|---|---|---|---|
| | Small businesses | All businesses | Small businesses | All businesses |
| Product Class 11A: | | | | |
| 1–2 | 0.00 | 0.00 | 3.3 | 3.3 |

TABLE V.23—COMPARISON OF LCC SAVINGS AND PBP FOR SMALL BUSINESS CONSUMER SUBGROUP AND ALL BUSINESSES—Continued

| TSL ** | Average LCC savings * 2022$ | | Simple payback period years | |
|---|---|---|---|---|
| | Small businesses | All businesses | Small businesses | All businesses |
| 3 | 2.54 | 3.06 | 3.2 | 3.3 |
| 4 | 2.64 | 3.16 | 3.2 | 3.2 |
| 5 | 2.54 | 3.06 | 3.2 | 3.3 |
| 6 | −31.43 | −29.11 | 9.2 | 9.3 |

* The savings represent the average LCC for affected consumers.
** The compliance year for TSLs 1–3 and 5–6 is 2027; the compliance year for TSL 4 is 2029.

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 procedures 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.24 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 this rule 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.24—REBUTTABLE-PRESUMPTION PAYBACK PERIODS

| TSL * | PC 3 | PC 5 | PC 5BI | PC 5A | PC 7 | PC 9 | PC 10 | PC 11A | | PC 17 | PC 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Res. | Com. | | |
| 1 | 1.5 | 4.5 | 2.5 | 2.0 | 0.7 | 3.7 | 10.2 | 1.9 | 2.8 | 3.9 | 1.2 |
| 2 | 4.3 | 4.5 | 2.5 | 2.0 | 2.9 | 3.7 | ............... | 1.9 | 2.8 | 3.9 | 1.2 |
| 3 | 4.3 | 6.4 | 2.5 | 4.5 | 1.9 | 3.7 | ............... | 1.9 | 2.8 | 3.9 | 3.7 |
| 4 | 4.9 | 5.8 | 2.2 | 4.2 | 1.6 | 6.0 | ............... | 1.8 | 2.7 | 3.5 | 3.6 |
| 5 | 5.4 | 6.4 | 2.5 | 6.1 | 6.3 | 3.7 | ............... | 1.9 | 2.8 | 3.9 | 3.7 |
| 6 | 9.6 | 9.0 | 8.6 | 6.1 | 6.9 | 9.7 | 12.2 | 5.3 | 7.9 | 6.2 | 8.3 |

* The compliance year for TSLs 1–3 and 5–6 is 2027; the compliance year for TSL 4 varies by product class: 2029: PCs 5BI, 5A, 10, 11A, 17, and 18; 2030: PCs 3, 5, 7, and 9.

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 next section describes the expected impacts on manufacturers at each considered TSL. Chapter 12 of the direct final rule 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.[93] 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 or 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 (30 years from the analyzed compliance

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

year).[94] The ''change in INPV'' results refer to the difference in industry value between the no-new-standards case and standards case at each TSL. To provide perspective on the short-run cash flow impact, DOE includes a comparison of free cash flow between the no-new-standards case and the standards case at each TSL in the year before amended standards would take effect. This figure provides an understanding of the magnitude of the required conversion costs relative to the cash flow generated by the industry in the no-new-standards case.

Conversion costs are one-time investments for manufacturers to bring their manufacturing facilities and product designs into compliance with potential amended standards. As described in section IV.J.2.c of this document, conversion cost investments occur between the year of publication of the direct 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 of the industry and generally result in lower free cash flow in the period between the publication of the direct 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.25—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 | *2022$ Million* | 4,905.8 | 4,841.5 to 4,891.4 | 4,798.5 to 4,870.1 | 4,387.6 to 4,514.7 | 4,401.3 to 4,522.3 | 3,839.9 to 4,061.6 | 3,080.1 to 3,604.0 |
| Change in INPV * | *%* | | (1.3) to (0.3) | (2.2) to (0.7) | (10.6) to (8.0) | (10.3) to (7.8) | (21.7) to (17.2) | (37.2) to (26.5) |
| Free Cash Flow (2026) ** | *2022$ Million* | *** 414.5 | 385.3 | 363.3 | 137.8 | 195.3 | (166.2) | (581.0) |
| Change in Free Cash Flow (2026) **. | *%* | | (7.0) | (12.4) | (66.7) | (51.7) | (140.1) | (240.2) |
| Capital Conversion Costs | *2022$ Million* | | 10.8 | 22.3 | 378.1 | 471.8 | 945.3 | 1,677.2 |
| Product Conversion Costs | *2022$ Million* | | 71.7 | 121.7 | 314.7 | 358.5 | 458.7 | 711.4 |
| Total Conversion Costs | *2022$ Million* | | 82.5 | 144.0 | 692.8 | 830.3 | 1,404.0 | 2,388.6 |

* Parentheses denote negative (−) values.
** TSL 4 (*i.e.,* the Recommended TSL) represents the change in free cash flow in 2029.
*** In 2029, the no-new-standards case free cash flow is $413.1 million.

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 Tables IV.5 through 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 −1.3 to −0.3 percent. At this level, free cash flow is estimated to decrease by 7.0 percent compared to the no-new-standards case value of $414.5 million in the year 2026, the year before the 2027 standards year. Currently, approximately 24 percent of domestic refrigerator, refrigerator-freezer, and freezer shipments meet the efficiencies required at TSL 1. *See* Table V.27 for the percentage of 2023 shipments that meet each TSL by product class.

The design options DOE analyzed primarily included implementing more efficient single-speed compressors. For PC 5,[95] PC 5A, PC 5–BI, PC 10, and PC 17, the design options analyzed included implementing higher-efficiency variable-speed compressors. DOE also analyzed implementing BLDC fan motors and variable defrost for some product classes. DOE expects manufacturers would likely need to increase wall thickness for some of PC 11A models to meet TSL 1 efficiencies. 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 $10.8 million and product conversion costs of $71.7 million. Conversion costs total $82.5 million.

At TSL 1, the shipment-weighted average MPC for all refrigerators, refrigerator-freezers, and freezers is expected to increase by 1.6 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 $82.5 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 2027 compliance year. This reduction in the manufacturer markup and the $82.5 million in conversion costs incurred by manufacturers cause a slightly negative change in INPV at TSL 1 under the preservation-of-operating-profit scenario. *See* section IV.J.2.d of this document for details on the manufacturer markup scenarios.

At TSL 2, the standard represents an increase in efficiency of approximately 10 percent across all analyzed product classes, consistent with ENERGY STAR requirements, except for PC 10. The change in INPV is expected to range from −2.2 to −0.7 percent. At this level, free cash flow is estimated to decrease by 12.4 percent compared to the no-new-standards case value of $414.5 million in the year 2026, the year before the 2027 standards year. Currently, approximately 26 percent of domestic refrigerator, refrigerator-

[94] The analysis period ranges from 2023–2056 for the no-new-standards case and all TSLs, except for TSL 4 (the Recommended TSL). The analysis period for the Recommended TSL ranges from 2023–2058 for the product classes listed in Table I.1 and 2023–2059 for the product classes listed in Table I.2.

[95] The engineering analysis modeled PC 5 (23.0 AV) as requiring a higher-efficiency single-speed compressor to meet TSL 1 efficiencies and modeled PC 5 (30.0 AV) as requiring a variable-speed compressor system to meet TSL 1 efficiencies.

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, BLDC fans, and variable defrost. For PC 3, the design options included implementing incrementally more efficient single-speed compressors and variable defrost. For PC 7, the design options analyzed included implementing variable-speed compressors. For PC 3 and PC 7, TSL 2 corresponds to EL 2. For PC 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 PC 3 and PC 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 $22.3 million and product conversion costs of $121.7 million. Conversion costs total $144.0 million.

At TSL 2, the shipment-weighted average MPC for all refrigerators, refrigerator-freezers, and freezers is expected to increase by 2.3 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 $144.0 million in conversion costs, causing a slightly negative change in INPV at TSL 2 under this scenario. Under the preservation-of-operating-profit scenario, the manufacturer markup decreases in 2028. This reduction in the manufacturer markup and the $144.0 million in conversion costs incurred by manufacturers cause a slightly negative change in INPV at TSL 2 under the preservation-of-operating-profit scenario.

At TSL 3, the standard represents an increased stringency for PC 5, PC 5A, PC 7, PC 11A, and PC 18 and increased NES while keeping economic impacts on consumers modest. The change in INPV is expected to range from −10.6 to −8.0 percent. At this level, free cash flow is estimated to decrease by 66.7 percent compared to the no-new-standards case value of $414.5 million in the year 2026, the year before the 2027 standards year. Currently, approximately 18 percent of domestic refrigerator, refrigerator-freezer, and freezer shipments meet the efficiencies required at TSL 3.

In addition to the design options DOE analyzed at TSL 2, the design options analyzed for PC 5 include implementing higher-efficiency variable-speed compressors and incorporating partial VIP for larger capacity (*i.e.,* adjusted volume) products. DOE expects that PC 5A products would likely also need to incorporate some partial VIP. For PC 7, the deign options analyzed included implementing more efficient variable-speed compressors. Additionally, for the compact-size PC 18, DOE expects manufacturers may need to increase cabinet wall thickness. For PC 5, PC 5A, PC 11A, and PC 18, TSL 3 corresponds to EL 2. For PC 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 PC 5 and PC 5A due to their large market share (together, these product classes account for approximately 30 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. For PC 5 and PC 5A, DOE understands the two product classes often share the same production lines, with shared cabinet architecture and tooling. DOE expects manufacturers would likely need to incorporate some VIPs into PC 5A designs, but not to the extent required at TSL 5 and TSL 6. Thus, for the 10 OEMs that manufacture both PC 5 and PC 5A, DOE expects manufacturers could implement similar cabinet upgrades (*i.e.,* partial VIP) for PC 5 and PC 5A designs to achieve the efficiencies required at this level. 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 $378.1 million and product conversion costs of $314.7 million. Conversion costs total $629.8 million.

At TSL 3, the shipment-weighted average MPC for all refrigerators, refrigerator-freezers, and freezers is expected to increase by 4.0 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 $692.8 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. This reduction in the manufacturer markup and the $692.8 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 (*i.e.,* the Recommended TSL), the standard represents an increased stringency for PC 3 and PC 9, 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 −10.3 to −7.8 percent. At this level, free cash flow is estimated to decrease by 51.7 percent compared to the no-new-standards case value of $413.1 million in the year 2029, the year before the 2030 standards year.[96] Currently, approximately 14 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 PC 3 products include implementing the highest-EER single-speed compressors or variable-speed compressors. For PC 9, the design options analyzed included the highest-EER variable-speed compressors. For PC 3, TSL 4 corresponds to EL 3. For PC 9, TSL 4 corresponds to EL 2. For the remaining directly analyzed 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 PC 3 and PC 9, which together account for approximately 33 percent of current industry shipments. Many manufacturers of these product classes would need to update their platforms to integrate variable-speed compressors. For PC 5 and PC 5A, DOE understands the two product classes often share the same production lines, with shared cabinet architecture and tooling. DOE expects industry to incur

[96] For the Recommended TSL, the compliance year varies by product class. For the product classes listed in Table I.1, the analyzed compliance year is 2029. For the product classes listed in Table I.2, the analyzed compliance year is 2030. The product classes associated with the 2030 compliance year account for approximately 68 percent of total shipments.

more re-flooring costs compared to TSL 3. DOE estimates capital conversion costs of $471.8 million and product conversion costs of $358.5 million. Conversion costs total $830.3 million.

At TSL 4, the shipment-weighted average MPC for all refrigerator, refrigerator-freezers, and freezers is expected to increase by 4.8 percent relative to the no-new-standards case shipment-weighted average MPC for all refrigerators, refrigerator-freezers, and freezers in 2030. In the preservation-of-gross-margin-percentage scenario, the increase in cashflow from the higher MSP is outweighed by the $830.3 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 2031, the year after the analyzed 2030 compliance year.[97] This reduction in the manufacturer markup and the $830.3 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 −21.7 to −17.2 percent. At this level, free cash flow is estimated to decrease by 140.1 percent compared to the no-new-standards case value of $414.5 million in the year 2026, the year before the 2027 standards year. Currently, approximately 14 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 PC 5A includes implementing VIPs on all of the cabinet surface (side walls and doors) and for PC 7 includes implementing VIPs on roughly 75 percent of the cabinet surface. For PC 5A, TSL 5 corresponds to EL 3. For PC 7, TSL 5 corresponds to EL 4. For PC 9, TSL 5 corresponds to EL 1, the same efficiency level required for TSL 3. 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 PC 5A and PC 7, which likely necessitates incorporating some VIPs. In interviews, some manufacturers stated that their existing PC 5A and PC 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 $945.3 million and product conversion costs of $458.7 million. Conversion costs total $1.40 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 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 7.0 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 $1.40 billion in conversion costs, causing a moderately negative change in INPV at TSL 5 under this scenario. Under the preservation-of-operating-profit scenario, the manufacturer markup decreases in 2028. This reduction in the manufacturer markup and the $1.40 billion in conversion costs incurred by manufacturers cause a large 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 −37.2 to −26.5 percent. At this level, free cash flow is estimated to decrease by 240.2 percent compared to the no-new-standards case value of $414.5 million in the year 2026, the year before the 2027 standards year. Currently, approximately 0.9 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 the best-available-efficiency VSC, 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). Manufacturers would also likely incorporate VIP doors for PC 10 and PC 18 and VIPs for roughly half the cabinet surface (typically side walls and doors for an upright cabinet) for all other classes. 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 seven out of 22 OEMs currently offer 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 to the more stringent standard. DOE estimates capital conversion costs of $1.68 billion and product conversion costs of $711.4 million. Conversion costs total $2.39 billion.

At TSL 6, the large conversion costs result in a free cash flow dropping below zero in the years before the 2027 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 16.8 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 $2.39 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. This reduction in the manufacturer markup and the $2.39 billion in conversion costs incurred by manufacturers causes a significant decrease in INPV at TSL 6 under the preservation-of-operating-profit scenario.

[97] The compliance year for the Recommended TSL varies by product class. For PC 1, PC 1A, PC 2, PC 3, PC 3A, PC 4, PC 5, PC 6, PC 7, and PC 9, the compliance year is 2030. For the remaining product classes, the compliance year is 2029.

TABLE V.26—PERCENTAGES OF 2023 SHIPMENTS THAT MEET EACH TSL BY PRODUCT CLASS

| Directly analyzed equipment class | TSL 1 (%) | TSL 2 (%) | TSL 3 (%) | TSL 4 (%) | TSL 5 (%) | TSL 6 (%) |
|---|---|---|---|---|---|---|
| PC 3 | 23.0 | 19.0 | 19.0 | 0.0 | 0.0 | 0.0 |
| PC 5 | 10.0 | 10.0 | 3.0 | 3.0 | 3.0 | 0.5 |
| PC 5A | 3.0 | 3.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| PC 7 | 14.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| PC 5 BI | 73.0 | 73.0 | 73.0 | 73.0 | 73.0 | 21.6 |
| PC 9 | 17.0 | 17.0 | 17.0 | 1.0 | 17.0 | 1.0 |
| PC 10 | 4.7 | 100.0 | 100.0 | 100.0 | 100.0 | 0.0 |
| PC 11A | 100.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| PC 17 | 80.6 | 80.6 | 80.6 | 80.6 | 80.6 | 9.0 |
| PC 18 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Overall Industry * | 24.4 | 26.4 | 18.5 | 14.1 | 13.6 | 0.9 |

* Reflects the percent of industry shipments for all product classes that meet each TSL, including the product classes that were not directly analyzed (*i.e.,* non-representative classes).

b. Direct Impacts on Employment

To quantitatively assess the potential impacts of amended energy conservation standards on direct employment in the refrigerators, refrigerator-freezers, and freezers 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. For the direct final rule, DOE used the most up-to-date information available. DOE calculated these values using statistical data from the 2021 *ASM,*[98] BLS employee compensation data,[99] results of the engineering analysis, and manufacturer interviews conducted in support of the February 2023 NOPR.

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. Consistent with the February 2023 NOPR, 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 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.[100] 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 6,366 domestic production and non-production 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.

[98] U.S. Census Bureau, *Annual Survey of Manufactures.* ''Summary Statistics for Industry Groups and Industries in the U.S (2021).'' Available at *www.census.gov/programs-surveys/asm/data.html* (last accessed July 5, 2023).

[99] U.S. Bureau of Labor Statistics. *Employer Costs for Employee Compensation—March 2023.* June 16, 2023. Available at *www.bls.gov/news.release/pdf/ecec.pdf* (last accessed July 5, 2023).

[100] The comprehensive description of production and non-production workers is available at ''Definitions and Instructions for the Annual Survey of Manufactures, MA–10000'' (pp. 13–14) *www2.census.gov/programs-surveys/asm/technical-documentation/questionnaire/2021/instructions/MA_10000_Instructions.pdf* (last accessed September 9, 2023).

TABLE V.27—DOMESTIC DIRECT EMPLOYMENT IMPACTS FOR REFRIGERATOR, REFRIGERATOR-FREEZER, AND FREEZER MANUFACTURERS IN THE ANALYZED COMPLIANCE YEAR

| | No-new-standards case | TSL 1 | TSL 2 | TSL 3 | TSL 4 | TSL 5 | TSL 6 |
|---|---|---|---|---|---|---|---|
| Direct Employment in 2027 * (Production Workers + Non-Production Workers) | 6,366 | 6,403 | 6,405 | 6,526 | 6,494 | 6,740 | 7,571 |
| Potential Changes in Direct Employment Workers ** | | (5,683) to 37 | (5,683) to 39 | (5,683) to 160 | (5,683) to 166 | (5,683) to 374 | (5,683) to 1,205 |

* For TSL 4 (the Recommended TSL), the direct employment values reflect 2030 estimates.
** 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 direct final rule. 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. At the Recommended TSL (TSL 4), DOE expects some manufacturers would need to implement insulation changes (*e.g.,* VIPs and/or increasing wall thickness) into certain product classes, which could require additional labor content and capital investment. For the high-volume product classes, DOE expects that PC 5A and some PC 5 models [101] would likely require implementing partial VIPs to meet TSL 4 efficiencies. DOE estimates the products that would likely require some VIPs to meet TSL 4 efficiencies collectively account for approximately 24 percent of industry shipments. Based on information gathered during confidential manufacturer interviews and public sources, DOE understands that a portion of PC 5 and PC 5A products are currently manufactured in the United States. Although it is possible that amended standards in this rulemaking and other DOE rulemakings could factor into production siting locations due to the level of investment and additional labor content required. However, based on information gathered during confidential manufacturer interviews, DOE does not expect most manufacturers would shift domestic production outside of the United States solely as a result of this direct final rule.

Additional detail on the analysis of direct employment can be found in chapter 12 of the direct final rule 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 direct final rule 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.,* PC 3, PC 5, PC 5A, and PC 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 with through-the-door ice service (TSL 5), bottom-mount without through-the-door ice service (TSL 6), and side-by-side (TSL 6) standard-size refrigerator-freezers, and stated that the 3-year period between the announcement of the direct 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. In this direct final rule, DOE adopts TSL 4 (the Recommended TSL). At the adopted level, the max-tech efficiencies are not required for any of the analyzed product classes, including the high-volume product classes manufacturers expressed concerns about during confidential interviews. Furthermore, compliance with amended standards would not be required until 2030 for freestanding top-mount product classes (*i.e.,* PC 1, PC 1A, PC 2, PC 3, PC 3A, PC 6), freestanding side-by-side product classes (*i.e.,* PC 4, PC 7), and freestanding bottom-mount without through-the-door ice service product class (*i.e.,* PC 5), and 2029 for the remaining product classes. Compared to TSLs with a 2027 compliance date, manufacturers would have additional time to update production facilities and redesign products to meet amended standards. The Recommended TSL's compliance dates would provide manufacturers the opportunity to spread capital requirements, engineering resources, and conversion activities over a longer period of time.

In response to the February 2023 NOPR, AHAM, Whirlpool, GEA, and Sub Zero expressed concerns that the supply of high-efficiency components such as VIPs and VSCs would not be able to ramp up in the 3-year compliance period to meet the expected consumer demand for refrigerators, refrigerator-freezers, and freezers. (AHAM, No. 69 at p. 5; Whirlpool, No. 70 at p. 5; GEA, No. 75 at p. 2; and Sub Zero, No. 77 at p. 2) Conversely, Samsung commented that the industry has a significant amount of VSCs available for purchase, and that the 3-year compliance period is acceptable for manufacturers and suppliers to establish sufficient availability of VSCs. (Samsung, No. 78 at p. 3)

In support of this analysis, DOE conducted research and interviewed

[101] The design path analyzed in DOE's engineering analysis for PC 5 with a 3-door configuration (adjusted volume of 30 $ft^3$) would likely require some VIPs at TSL 4 (EL 2). *See* section IV.C.2 of this document for the analyzed design options at each efficiency level for the directly analyzed product classes.

VSC and VIP component suppliers to gather additional information on the global market capacity for these high-efficiency components. Based on the information gathered, DOE expects that VIP production lines can be quickly scaled up to meet demand of future amended standards (within 1 to 2 years depending on the specific VIP design). For VSCs, based on supplier information on the global refrigerator VSC production capacity, supply constraints, and ramp-up time, DOE determined that the industry can meet the increased demand of VSCs that may result due to the adoption of more stringent standards within the necessary compliance period, with an estimated 8 to 12 month VSC production ramp-up, as needed.

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 for the standards proposed in the NOPR published elsewhere in this issue of the **Federal Register** and in chapter 12 of the direct final rule TSD. In summary, the Small Business Administration (''SBA'') defines a ''small business'' as having 1,500 employees or less for NAICS 335220, ''Major Household Appliance Manufacturing.'' 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* chapter 12 of the direct final rule 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 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 miscellaneous refrigeration products, 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 estimated 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 * (2022$ millions) | Refrigerator, refrigerator-freezer, and freezer product offerings |
| --- | --- | --- |
| Domestic LVMs | $186 to $4,030 | High-end, built-in or fully integrated ''undercounter'' or standard-size refrigeration products (*e.g.,* PC 5–BI, PC 13A, PC 14). |
| Large Appliance Manufacturers | $15,730 to $164,030 | Wide range of freestanding, standard-size refrigerator-freezers and freezers. (*e.g.,* PC 3, PC 5, PC 5A, PC 7, PC 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 amended 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 adopted amendments may be beneficial for domestic LVMs. As discussed in section IV.A.1 of this document, DOE is proposing to incorporate certain energy use allowances for products with special 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 of this document for additional details on energy use allowances for products with special doors and multi-door designs.

e. Cumulative Regulatory Burden

One aspect of assessing manufacturer burden involves looking at the cumulative impact of multiple DOE standards and the regulatory actions of other Federal agencies and States 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. Multiple regulations affecting the same manufacturer can strain profits and lead companies to abandon product lines or markets with lower expected future returns than competing products. For these reasons, DOE conducts an analysis of cumulative regulatory burden as part of its rulemakings pertaining to appliance efficiency.

For the cumulative regulatory burden analysis, DOE examines Federal, product-specific regulations that could affect refrigerator, refrigerator-freezer, and freezer manufacturers that take effect approximately 3 years before the 2029 compliance date and 3 years after the after the 2030 compliance date (2026 to 2033). This information is presented in Table V.29.

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 by this rule ** | Approximate standards compliance year | Industry conversion costs (Millions) | Industry conversion costs/ equipment revenue *** |
|---|---|---|---|---|---|
| Portable Air Conditioners; 85 FR 1378 (January 10, 2020) | 9 | 2 | 2025 | $320.9 (2015$) | 6.7 |
| Consumer Conventional Cooking Products; 88 FR 6818 † (February 1, 2023) | 34 | 12 | 2027 | 183.4 (2021$) | 1.2 |
| Residential Clothes Washers; † 88 FR 13520 (March 3, 2023) | 19 | 14 | 2027 | 690.8 (2021$) | 5.2 |
| Consumer Clothes Dryers; † 87 FR 51734 (August 23, 2022) | 15 | 11 | 2027 | 149.7 (2020$) | 1.8 |
| Miscellaneous Refrigeration Products; † 88 FR 19382 (March 31, 2023) | 38 | 23 | 2029 | 126.9 (2021$) | 3.1 |
| Automatic Commercial Ice Makers; † 88 FR 30508 (May 11, 2023) | 23 | 6 | 2027 | 15.9 (2022$) | 0.6 |
| Dishwashers; † 88 FR 32514 (May 19, 2023) | 21 | 16 | 2027 | 125.6 (2021$) | 2.1 |
| Refrigerated Bottled or Canned Beverage Vending Machines; † 88 FR 33968 (May 25, 2023) | 5 | 1 | 2028 | 1.5 (2022$) | 0.2 |
| Room Air Conditioners; 88 FR 34298 (May 26, 2023) | 8 | 4 | 2026 | 24.8 (2021$) | 0.4 |
| Microwave Ovens; 88 FR 39912 (June 20, 2023) | 18 | 12 | 2026 | 46.1 (2021$) | 0.7 |
| Walk-in Coolers and Freezers; † 88 FR 60746 (September 5, 2023) | 79 | 1 | 2027 | 89.0 (2022$) | 0.8 |
| Commercial Water Heating Equipment; 88 FR 69686 (October 6, 2023) | 15 | 1 | 2026 | 42.7 (2022$) | 3.8 |
| Consumer Water Heaters; † 88 FR 49058 (July 27, 2023) | 22 | 3 | 2030 | 228.1 (2022$) | 1.1 |
| Consumer Boilers; † 88 FR 55128 (August 14, 2023) | 24 | 1 | 2030 | 98.0 (2022$) | 3.6 |
| Commercial Refrigerators, Refrigerator-Freezers, and Freezers; † 88 FR 70196 (October 10, 2023) | 83 | 10 | 2028 | 226.4 (2022$) | 1.6 |
| Dehumidifiers; † 88 FR 76510 (November 6, 2023) | 20 | 4 | 2028 | 6.9 (2022$) | 0.4 |
| Consumer Furnaces ‡ | 15 | 1 | 2029 | 162.0 (2022$) | 1.8 |

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

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

† These rulemakings are at the NOPR stage, and all values are subject to change until finalized through publication of a final rule.

‡ At the time of issuance of this refrigerator, refrigerator-freezer, and freezer direct final rule, the consumer furnace final rule has been issued and is pending publication in the FEDERAL REGISTER. Once published, the final rule pertaining to gas-fired consumer furnaces will be available at: *www.regulations.gov/docket/EERE-2014-BT-STD-0031/document.*

As shown in Table V.29, the ongoing rulemakings with the largest overlap of refrigerator, refrigerator-freezer, and freezer OEMs include miscellaneous refrigeration products, consumer conventional cooking products, residential clothes washers, consumer clothes dryers, and dishwashers, which are all part of the multi-product Joint Agreement submitted by interested parties. As detailed in the multi-product Joint Agreement, the signatories indicated that their recommendations should be considered a "complete package." The signatories further stated that "each part of this agreement is contingent upon the other parts being implemented." (Joint Agreement, No. 103 at p. 3)

The multi-product Joint Agreement states the "jointly recommended compliance dates will achieve the overall energy and economic benefits of this agreement while allowing necessary lead-times for manufacturers to redesign products and retool manufacturing plants to meet the recommended standards across product categories.'' (Joint Agreement, No. 103 at p. 2) The staggered compliance dates help mitigate manufacturers' concerns about their ability to allocate sufficient resources to comply with multiple concurrent amended standards and about the need to align compliance dates for products that are typically designed or sold as matched pairs (such as RCWs and consumer clothes dryers). *See* section IV.J.3 of this document for stakeholder comments about cumulative regulatory burden. *See* Table V.30 for a comparison of the estimated compliance dates based on EPCA-specified timelines and the compliance dates detailed in the Joint Agreement.

TABLE V.30—EXPECTED COMPLIANCE DATES FOR MULTI-PRODUCT JOINT AGREEMENT

| Rulemaking | Estimated compliance year based on EPCA requirements | Compliance year in the joint agreement |
|---|---|---|
| Consumer Clothes Dryers | 2027 | 2028 |
| RCWs | 2027 | 2028 |
| Consumer Conventional Cooking Products | 2027 | 2028 |
| Dishwashers | 2027 | 2027 * |
| Refrigerators, Refrigerator-Freezers, and Freezers | 2027 | 2029 or 2030 depending on the product class |
| Miscellaneous Refrigeration Products | 2029 | 2029 |

* Estimated compliance year. The Joint Agreement states, ''3 years after the publication of a final rule in the FEDERAL REGISTER.'' (Joint Agreement, No. 103 at p. 2).

3. National Impact Analysis

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

a. Significance of Energy Savings

To estimate the energy savings attributable to potential amended standards for 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 for all TSLs other than TSL 4; for TSL 4, 2029–2058 for the product classes listed in Table I.1 and 2030–2059 for the product classes listed in Table I.2). Tables V.30 and V.31 present DOE's projections of the national energy savings for each TSL considered for refrigerators, refrigerator-freezers, and freezers. The savings were calculated using the approach described in section IV.H.2 of this document.

TABLE V.31—CUMULATIVE NATIONAL ENERGY SAVINGS FOR FREESTANDING REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS; 30 YEARS OF SHIPMENTS *

| | 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 | 0.352 | 0.756 | 0.682 | 0.326 | 0.327 | 0.151 | 0.022 | 0.064 | 2.680 |
| | 2 | 0.738 | 0.756 | 0.682 | 0.699 | 0.316 | 0.000 | 0.022 | 0.064 | 3.278 |
| | 3 | 0.738 | 1.223 | 1.002 | 1.136 | 0.316 | 0.000 | 0.062 | 0.094 | 4.571 |
| | 4 | 1.310 | 1.263 | 1.023 | 1.173 | 0.512 | 0.000 | 0.049 | 0.096 | 5.427 |
| | 5 | 1.269 | 1.223 | 1.383 | 1.469 | 0.316 | 0.000 | 0.062 | 0.094 | 5.816 |
| | 6 | 2.442 | 1.950 | 1.383 | 1.687 | 0.916 | 0.365 | 0.310 | 0.195 | 9.248 |
| FFC | 1 | 0.361 | 0.777 | 0.701 | 0.335 | 0.336 | 0.155 | 0.023 | 0.065 | 2.753 |
| | 2 | 0.758 | 0.777 | 0.701 | 0.718 | 0.324 | 0.000 | 0.023 | 0.065 | 3.367 |
| | 3 | 0.758 | 1.257 | 1.029 | 1.167 | 0.324 | 0.000 | 0.063 | 0.097 | 4.696 |
| | 4 | 1.346 | 1.298 | 1.051 | 1.205 | 0.526 | 0.000 | 0.050 | 0.099 | 5.574 |
| | 5 | 1.303 | 1.257 | 1.421 | 1.509 | 0.324 | 0.000 | 0.063 | 0.097 | 5.974 |
| | 6 | 2.508 | 2.003 | 1.421 | 1.733 | 0.940 | 0.375 | 0.318 | 0.200 | 9.500 |

* 2027–2056 for all TSLs except TSL 4; for TSL 4, 2029–2058 for the product classes listed in Table I.1 and 2030–2059 for the product classes listed in Table I.2.

TABLE V.32—CUMULATIVE NATIONAL ENERGY SAVINGS FOR BUILT-IN REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS; 30 YEARS OF SHIPMENTS *

| | 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) | | | | |

TABLE V.32—CUMULATIVE NATIONAL ENERGY SAVINGS FOR BUILT-IN REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS; 30 YEARS OF SHIPMENTS *—Continued

| | 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 | |
| Primary Energy | 1 | 0.000 | 0.007 | 0.000 | 0.000 | 0.007 |
| | 2 | 0.005 | 0.007 | 0.005 | 0.000 | 0.017 |
| | 3 | 0.005 | 0.007 | 0.012 | 0.000 | 0.024 |
| | 4 | 0.011 | 0.007 | 0.017 | 0.000 | 0.036 |
| | 5 | 0.011 | 0.007 | 0.017 | 0.000 | 0.035 |
| | 6 | 0.028 | 0.018 | 0.021 | 0.001 | 0.067 |
| FFC | 1 | 0.000 | 0.007 | 0.000 | 0.000 | 0.007 |
| | 2 | 0.005 | 0.007 | 0.005 | 0.000 | 0.017 |
| | 3 | 0.005 | 0.007 | 0.012 | 0.000 | 0.024 |
| | 4 | 0.012 | 0.007 | 0.018 | 0.000 | 0.037 |
| | 5 | 0.011 | 0.007 | 0.017 | 0.000 | 0.036 |
| | 6 | 0.028 | 0.018 | 0.021 | 0.001 | 0.069 |

* 2027–2056 for all TSLs except TSL 4; for TSL 4, 2029–2058 for the product classes listed in Table I.1 and 2030–2059 for the product classes listed in Table I.2.

OMB Circular A–4 [102] requires agencies to present analytical results, including separate schedules of the monetized benefits and costs that show the type and timing of benefits and costs. Circular A–4 also directs agencies to consider the variability of key elements underlying the estimates of benefits and costs. For this rulemaking, DOE undertook a sensitivity analysis using 9 years, rather than 30 years, of product shipments. The choice of a 9-year period is a proxy for the timeline in EPCA for the review of certain energy conservation standards and potential revision of and compliance with such revised standards.[103] The review timeframe established in EPCA is generally not synchronized with the product lifetime, product manufacturing cycles, or other factors specific to 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 Tables V.32 and V.33. The impacts are counted over the lifetime of refrigerators, refrigerator-freezers, and freezers purchased 2027–2035 for all TSLs except TSL 4; for TSL 4, 2029–2037 for the product classes listed in Table I.1 and 2030–2038 for the product classes listed in Table I.2.

TABLE V.33—CUMULATIVE NATIONAL ENERGY SAVINGS FOR FREESTANDING REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS; 9 YEARS OF SHIPMENTS *

| | 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 | 0.094 | 0.202 | 0.182 | 0.087 | 0.089 | 0.041 | 0.006 | 0.017 | 0.718 |
| | 2 | 0.197 | 0.202 | 0.182 | 0.187 | 0.086 | 0.000 | 0.006 | 0.017 | 0.876 |
| | 3 | 0.197 | 0.326 | 0.267 | 0.303 | 0.086 | 0.000 | 0.015 | 0.025 | 1.220 |
| | 4 | 0.351 | 0.338 | 0.274 | 0.314 | 0.141 | 0.000 | 0.012 | 0.025 | 1.454 |
| | 5 | 0.338 | 0.326 | 0.369 | 0.391 | 0.086 | 0.000 | 0.015 | 0.025 | 1.551 |
| | 6 | 0.647 | 0.519 | 0.369 | 0.449 | 0.249 | 0.100 | 0.077 | 0.051 | 2.460 |
| FFC | 1 | 0.097 | 0.208 | 0.187 | 0.089 | 0.092 | 0.042 | 0.006 | 0.017 | 0.738 |
| | 2 | 0.203 | 0.208 | 0.187 | 0.192 | 0.089 | 0.000 | 0.006 | 0.017 | 0.901 |
| | 3 | 0.203 | 0.335 | 0.275 | 0.312 | 0.089 | 0.000 | 0.016 | 0.025 | 1.255 |
| | 4 | 0.360 | 0.347 | 0.281 | 0.323 | 0.145 | 0.000 | 0.013 | 0.026 | 1.494 |
| | 5 | 0.348 | 0.335 | 0.379 | 0.402 | 0.089 | 0.000 | 0.016 | 0.025 | 1.595 |
| | 6 | 0.666 | 0.533 | 0.379 | 0.462 | 0.256 | 0.103 | 0.079 | 0.052 | 2.530 |

* 2027–2035 for all TSLs except TSL 4; for TSL 4, 2029–2037 for the product classes listed in Table I.1 and 2030–2038 for the product classes listed in Table I.2.

[102] U.S. Office of Management and Budget. *Circular A–4: Regulatory Analysis.* Available at *https://www.whitehouse.gov/omb/information-for-agencies/circulars/* (last accessed July 13, 2023). DOE used the prior version of Circular A–4 (2003) as a result of the effective date of the new version.

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

TABLE V.34—CUMULATIVE NATIONAL ENERGY SAVINGS FOR BUILT-IN REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS; 9 YEARS OF SHIPMENTS *

| | 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 | 0.003 | 0.002 | 0.005 | 0.000 | 0.010 |
| | 5 | 0.003 | 0.002 | 0.005 | 0.000 | 0.009 |
| | 6 | 0.007 | 0.005 | 0.005 | 0.000 | 0.018 |
| FFC | 1 | 0.000 | 0.002 | 0.000 | 0.000 | 0.002 |
| | 2 | 0.001 | 0.002 | 0.001 | 0.000 | 0.005 |
| | 3 | 0.001 | 0.002 | 0.003 | 0.000 | 0.006 |
| | 4 | 0.003 | 0.002 | 0.005 | 0.000 | 0.010 |
| | 5 | 0.003 | 0.002 | 0.005 | 0.000 | 0.010 |
| | 6 | 0.008 | 0.005 | 0.006 | 0.000 | 0.018 |

* 2027–2035 for all TSLs except TSL 4; for TSL 4, 2029–2037 for the product classes listed in Table I.1 and 2030–2038 for the product classes listed in Table I.2

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,[104] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. Tables V.34 and V.35 show the consumer NPV results with impacts counted over the lifetime of products purchased in 2027–2056 for all TSLs except TSL 4; for TSL 4, 2029–2058 for the product classes listed in Table I.1 and 2030–2059 for the product classes listed in Table I.2.

TABLE V.35—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR FREESTANDING REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS; 30 YEARS OF SHIPMENTS *

| | 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 $2022) | | | | | | | | |
| 3 percent | 1 | 2.46 | 4.45 | 4.70 | 2.24 | 1.63 | 0.44 | 0.06 | 0.42 | 16.41 |
| | 2 | 3.87 | 4.45 | 4.70 | 4.24 | 1.59 | 0.00 | 0.06 | 0.42 | 19.33 |
| | 3 | 3.87 | 5.65 | 5.28 | 7.37 | 1.59 | 0.00 | 0.28 | 0.47 | 24.51 |
| | 4 | 6.20 | 5.69 | 5.21 | 7.12 | 1.96 | 0.00 | 0.20 | 0.46 | 26.84 |
| | 5 | 6.26 | 5.65 | 5.87 | 5.54 | 1.59 | 0.00 | 0.28 | 0.47 | 25.66 |
| | 6 | 5.27 | 5.48 | 5.87 | 5.71 | 2.18 | 0.54 | −0.20 | 0.48 | 25.33 |
| 7 percent | 1 | 1.01 | 1.68 | 1.92 | 0.94 | 0.58 | 0.09 | 0.02 | 0.18 | 6.42 |
| | 2 | 1.43 | 1.68 | 1.92 | 1.68 | 0.57 | 0.00 | 0.02 | 0.18 | 7.47 |
| | 3 | 1.43 | 1.87 | 1.95 | 3.01 | 0.57 | 0.00 | 0.11 | 0.18 | 9.12 |
| | 4 | 2.01 | 1.76 | 1.81 | 2.63 | 0.55 | 0.00 | 0.07 | 0.17 | 9.00 |
| | 5 | 2.20 | 1.87 | 1.93 | 1.73 | 0.57 | 0.00 | 0.11 | 0.18 | 8.59 |
| | 6 | 0.58 | 1.09 | 1.93 | 1.64 | 0.28 | −0.06 | −0.33 | 0.09 | 5.24 |

* 2027–2056 for all TSLs except TSL 4; for TSL 4, 2029–2058 for the product classes listed in Table I.1 and 2030–2059 for the product classes listed in Table I.2.

TABLE V.36—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR BUILT-IN REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS; 30 YEARS OF SHIPMENTS *

| | 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 $2022) | | | | |
| 3 percent | 1 | 0.00 | 0.05 | 0.00 | 0.00 | 0.05 |
| | 2 | 0.01 | 0.05 | 0.02 | 0.00 | 0.09 |

[104] U.S. Office of Management and Budget. *Circular A–4: Regulatory Analysis.* September 17, 2003. *obamawhitehouse.archives.gov/omb/circulars_a004_a-4* (last accessed July 1, 2021).

TABLE V.36—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR BUILT-IN REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS; 30 YEARS OF SHIPMENTS *—Continued

| | TSL | Built-in: All refrigerator PC 3A–BI | Built-in: Bottom-mount refrigerator PC 5–BI, 5I–BI | Built-in: Side-by-side refrigerator-freezers PC 4–BI, 4I–BI, and 7–BI | Built-in: Upright freezers PC 9–BI | Total |
|---|---|---|---|---|---|---|
| | 3 | 0.01 | 0.05 | 0.07 | 0.00 | 0.13 |
| | 4 | 0.04 | 0.05 | 0.05 | 0.00 | 0.14 |
| | 5 | 0.04 | 0.05 | 0.05 | 0.00 | 0.14 |
| | 6 | 0.03 | 0.01 | 0.06 | 0.00 | 0.10 |
| 7 percent | 1 | 0.00 | 0.02 | 0.00 | 0.00 | 0.02 |
| | 2 | 0.00 | 0.02 | 0.01 | 0.00 | 0.03 |
| | 3 | 0.00 | 0.02 | 0.03 | 0.00 | 0.05 |
| | 4 | 0.01 | 0.02 | 0.01 | 0.00 | 0.04 |
| | 5 | 0.01 | 0.02 | 0.01 | 0.00 | 0.04 |
| | 6 | −0.01 | −0.01 | 0.01 | 0.00 | −0.01 |

* 2027–2056 for all TSLs except TSL 4; for TSL 4, 2029–2058 for the product classes listed in Table I.1 and 2030–2059 for the product classes listed in Table I.2.

The NPV results based on the aforementioned 9-year analytical period are presented in Tables V.36 and V.37. The impacts are counted over the lifetime of products purchased in 2027–2035 for all TSLs except TSL 4; for TSL 4, 2029–2037 for the product classes listed in Table I.1 and 2030–2038 for the product classes listed in Table I.2. 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.37—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR CONSUMER BENEFITS FOR FREESTANDING REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS; 9 YEARS OF SHIPMENTS *

| Discount rate | TSL | Standard size refrigerator-freezers: Top mount PC 1, 1A, 2, 3, 3A, 3I, and 6 | Bottom mount PC 5 and 5I | Bottom mount with TTD PC 5A | Side-by-side PC 4, 4I, and 7 | Standard size freezers: Upright PC 8 and 9 | Chest PC 10 and 10A | Compact: Refrigerators PC 11, 11A, 12, 13, 13A, 14, and 15 | Freezers PC 16, 17, and 18 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | | (Billion $2022) | | | | | | | | |
| 3 percent | 1 | 0.85 | 1.40 | 1.56 | 0.78 | 0.56 | 0.10 | 0.01 | 0.14 | 5.40 |
| | 2 | 1.26 | 1.40 | 1.56 | 1.36 | 0.55 | 0.00 | 0.01 | 0.14 | 6.28 |
| | 3 | 1.26 | 1.64 | 1.68 | 2.46 | 0.55 | 0.00 | 0.08 | 0.15 | 7.81 |
| | 4 | 1.96 | 1.74 | 1.69 | 2.43 | 0.62 | 0.00 | 0.05 | 0.15 | 8.64 |
| | 5 | 1.89 | 1.64 | 1.76 | 1.60 | 0.55 | 0.00 | 0.08 | 0.15 | 7.67 |
| | 6 | 1.00 | 1.28 | 1.76 | 1.59 | 0.54 | 0.07 | −0.21 | 0.09 | 6.13 |
| 7 percent | 1 | 0.47 | 0.70 | 0.87 | 0.45 | 0.26 | 0.01 | 0.00 | 0.08 | 2.84 |
| | 2 | 0.62 | 0.70 | 0.87 | 0.73 | 0.26 | 0.00 | 0.00 | 0.08 | 3.26 |
| | 3 | 0.62 | 0.69 | 0.83 | 1.36 | 0.26 | 0.00 | 0.04 | 0.08 | 3.88 |
| | 4 | 0.84 | 0.70 | 0.79 | 1.21 | 0.22 | 0.00 | 0.03 | 0.07 | 3.86 |
| | 5 | 0.87 | 0.69 | 0.75 | 0.63 | 0.26 | 0.00 | 0.04 | 0.08 | 3.31 |
| | 6 | −0.21 | 0.15 | 0.75 | 0.54 | −0.01 | −0.10 | −0.23 | 0.00 | 0.88 |

* 2027–2035 for all TSLs except TSL 4; for TSL 4, 2029–2037 for the product classes listed in Table I.1 and 2030–2038 for the product classes listed in Table I.2.

TABLE V.38—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR CONSUMER BENEFITS FOR BUILT-IN REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS; 9 YEARS OF SHIPMENTS *

| | TSL | Built-in: All refrigerator PC 3A–BI | Built-in: Bottom-mount refrigerator PC 5–BI, 5I–BI | Built-in: Side-by-side refrigerator-freezers PC 4–BI, 4I–BI, and 7–BI | Built-in: Upright freezers PC 9–BI | Total |
|---|---|---|---|---|---|---|
| | | (Billion $2022) | | | | |
| 3 percent | 1 | 0.00 | 0.02 | 0.00 | 0.00 | 0.02 |
| | 2 | 0.00 | 0.02 | 0.01 | 0.00 | 0.03 |
| | 3 | 0.00 | 0.02 | 0.02 | 0.00 | 0.04 |
| | 4 | 0.01 | 0.02 | 0.01 | 0.00 | 0.04 |
| | 5 | 0.01 | 0.02 | 0.01 | 0.00 | 0.04 |
| | 6 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 |
| 7 percent | 1 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 |
| | 2 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 |
| | 3 | 0.00 | 0.01 | 0.01 | 0.00 | 0.02 |
| | 4 | 0.00 | 0.01 | 0.00 | 0.00 | 0.02 |
| | 5 | 0.00 | 0.01 | 0.00 | 0.00 | 0.02 |

TABLE V.38—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR CONSUMER BENEFITS FOR BUILT-IN REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS; 9 YEARS OF SHIPMENTS *—Continued

| | 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 | |
| | 6 | −0.01 | −0.01 | 0.00 | 0.00 | −0.02 |

* 2027–2035 for all TSLs except TSL 4; for TSL 4, 2029–2037 for the product classes listed in Table I.1 and 2030–2038 for the product classes listed in Table I.2.

The previous results reflect the use of a default trend to estimate the change in price for 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 direct final rule 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

DOE estimates that amended energy conservation standards for refrigerators, refrigerator-freezers, and freezers will 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 (2029/30–2033/34), where these uncertainties are reduced.

The results suggest that the adopted standards are 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 direct final rule TSD presents detailed results regarding anticipated indirect employment impacts.

4. Impact on Utility or Performance of Products

As discussed in section III.F.1.d of this document, DOE has concluded that the standards adopted in this direct final rule will 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 adopted standards.

5. Impact of Any Lessening of Competition

DOE considered any lessening of competition that would be likely to result from new or amended standards. As discussed in section III.F.1.e, EPCA directs the Attorney General of the United States (''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 in writing 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. To assist the Attorney General in making this determination, DOE is providing DOJ with copies of this direct final rule and the TSD for review.

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 direct final rule TSD presents the estimated impacts on electricity generating capacity, relative to the no-new-standards case, for the TSLs that DOE considered in this rulemaking.

Energy conservation resulting from potential energy conservation standards for 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. DOE reports annual emissions reductions for each TSL in chapter 13 of the direct final rule TSD.

TABLE V.39—CUMULATIVE EMISSIONS REDUCTION FOR REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS; 30 YEARS OF SHIPMENTS *

| | Trial standard level | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **Power Sector Emissions** | | | | | | |
| $CO_2$ (*million metric tons*) | 46.21 | 56.73 | 79.15 | 91.53 | 100.79 | 160.31 |
| $CH_4$ (*thousand tons*) | 3.48 | 4.28 | 5.97 | 6.80 | 7.60 | 12.08 |
| $N_2O$ (*thousand tons*) | 0.48 | 0.60 | 0.83 | 0.95 | 1.06 | 1.68 |
| $NO_X$ (*thousand tons*) | 21.81 | 26.81 | 37.42 | 42.15 | 47.66 | 75.73 |
| $SO_2$ (*thousand tons*) | 15.72 | 19.30 | 26.93 | 31.03 | 34.29 | 54.53 |

TABLE V.39—CUMULATIVE EMISSIONS REDUCTION FOR REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS; 30 YEARS OF SHIPMENTS *—Continued

| | Trial standard level | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| Hg (*tons*) | 0.11 | 0.13 | 0.19 | 0.22 | 0.24 | 0.38 |
| **Upstream Emissions** | | | | | | |
| $CO_2$ (*million metric tons*) | 4.58 | 5.62 | 7.83 | 9.22 | 9.98 | 15.88 |
| $CH_4$ (*thousand tons*) | 416.14 | 510.42 | 711.93 | 839.67 | 906.55 | 1443.16 |
| $N_2O$ (*thousand tons*) | 0.02 | 0.03 | 0.03 | 0.04 | 0.04 | 0.07 |
| $NO_X$ (*thousand tons*) | 71.35 | 87.52 | 122.07 | 143.96 | 155.44 | 247.45 |
| $SO_2$ (*thousand tons*) | 0.27 | 0.34 | 0.47 | 0.54 | 0.60 | 0.95 |
| Hg (*tons*) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total FFC Emissions** | | | | | | |
| $CO_2$ (*million metric tons*) | 50.79 | 62.34 | 86.98 | 100.76 | 110.76 | 176.19 |
| $CH_4$ (*thousand tons*) | 419.63 | 514.70 | 717.90 | 846.48 | 914.15 | 1455.24 |
| $N_2O$ (*thousand tons*) | 0.50 | 0.62 | 0.87 | 0.99 | 1.10 | 1.75 |
| $NO_X$ (*thousand tons*) | 93.17 | 114.33 | 159.50 | 186.11 | 203.10 | 323.18 |
| $SO_2$ (*thousand tons*) | 16.00 | 19.64 | 27.40 | 31.57 | 34.89 | 55.49 |
| Hg (*tons*) | 0.11 | 0.13 | 0.19 | 0.22 | 0.24 | 0.38 |

* 2027–2056 for all TSLs except TSL 4; for TSL 4, 2029–2058 for the product classes listed in Table I.1 and 2030–2059 for the product classes listed in Table I.2.

As part of the analysis for this 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 estimated 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 selected TSL in chapter 14 of the direct final rule TSD.

TABLE V.40—PRESENT MONETIZED VALUE OF $CO_2$ EMISSIONS REDUCTION FOR REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS; 30 YEARS OF SHIPMENTS *

| TSL | SC–$CO_2$ Case<br>Discount rate and statistics | | | |
|---|---|---|---|---|
| | 5%<br>Average | 3%<br>Average | 2.5%<br>Average | 3%<br>95th percentile |
| | (Billion 2022$) | | | |
| 1 | 0.49 | 2.11 | 3.30 | 6.39 |
| 2 | 0.60 | 2.60 | 4.07 | 7.89 |
| 3 | 0.85 | 3.64 | 5.69 | 11.03 |
| 4 | 0.89 | 3.93 | 6.21 | 11.92 |
| 5 | 1.08 | 4.63 | 7.25 | 14.06 |
| 6 | 1.70 | 7.34 | 11.49 | 22.26 |

* 2027–2056 for all TSLs except TSL 4; for TSL 4, 2029–2058 for the product classes listed in Table I.1 and 2030–2059 for the product classes listed in Table I.2.

As discussed in section IV.L.2, DOE estimated the climate benefits likely to result from the reduced emissions of methane and $N_2O$ that DOE estimated for each of the considered TSLs for 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 selected TSL in chapter 14 of the direct final rule TSD.

TABLE V.41—PRESENT MONETIZED VALUE OF METHANE EMISSIONS REDUCTION FOR REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS; 30 YEARS OF SHIPMENTS *

| TSL | SC–$CH_4$ Case<br>Discount rate and statistics | | | |
|---|---|---|---|---|
| | 5%<br>Average | 3%<br>Average | 2.5%<br>Average | 3%<br>95th percentile |
| | (Billion 2022$) | | | |

TABLE V.41—PRESENT MONETIZED VALUE OF METHANE EMISSIONS REDUCTION FOR REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS; 30 YEARS OF SHIPMENTS *—Continued

| TSL | SC–$CH_4$ Case Discount rate and statistics | | | |
|---|---|---|---|---|
| | 5% Average | 3% Average | 2.5% Average | 3% 95th percentile |
| 1 | 0.18 | 0.56 | 0.78 | 1.47 |
| 2 | 0.23 | 0.68 | 0.96 | 1.81 |
| 3 | 0.32 | 0.96 | 1.34 | 2.53 |
| 4 | 0.34 | 1.07 | 1.51 | 2.84 |
| 5 | 0.40 | 1.22 | 1.70 | 3.22 |
| 6 | 0.64 | 1.93 | 2.70 | 5.11 |

* 2027–2056 for all TSLs except TSL 4; for TSL 4, 2029–2058 for the product classes listed in Table I.1 and 2030–2059 for the product classes listed in Table I.2.

TABLE V.42—PRESENT MONETIZED VALUE OF NITROUS OXIDE EMISSIONS REDUCTION FOR REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS; 30 YEARS OF SHIPMENTS *

| TSL | SC–$N_2O$ Case Discount rate and statistics | | | |
|---|---|---|---|---|
| | 5% Average | 3% Average | 2.5% Average | 3% 95th percentile |
| | (Billion 2022$) | | | |
| 1 | 0.00 | 0.01 | 0.01 | 0.02 |
| 2 | 0.00 | 0.01 | 0.01 | 0.02 |
| 3 | 0.00 | 0.01 | 0.02 | 0.03 |
| 4 | 0.00 | 0.01 | 0.02 | 0.04 |
| 5 | 0.00 | 0.02 | 0.03 | 0.04 |
| 6 | 0.01 | 0.03 | 0.04 | 0.07 |

* 2027–2056 for all TSLs except TSL 4; for TSL 4, 2029–2058 for the product classes listed in Table I.1 and 2030–2059 for the product classes listed in Table I.2.

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, however, that the adopted standards would be economically justified even without inclusion of monetized benefits of reduced GHG emissions.

DOE also estimated the monetary value of the economic benefits associated with $NO_X$ 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 selected TSL in chapter 14 of the direct final rule TSD.

TABLE V.43—PRESENT MONETIZED VALUE OF $NO_X$ EMISSIONS REDUCTION FOR REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS; 30 YEARS OF SHIPMENTS *

| TSL | 3% Discount rate | 7% Discount rate |
|---|---|---|
| | (million 2022$) | |
| 1 | 4,225.06 | 1,638.96 |
| 2 | 5,207.05 | 2,026.87 |
| 3 | 7,278.46 | 2,837.92 |
| 4 | 7,910.68 | 2,778.25 |
| 5 | 9,271.74 | 3,615.51 |
| 6 | 14,703.70 | 5,718.41 |

* 2027–2056 for all TSLs except TSL 4; for TSL 4, 2029–2058 for the product classes listed in Table I.1 and 2030–2059 for the product classes listed in Table I.2.

TABLE V.44—PRESENT MONETIZED VALUE OF $SO_2$ EMISSIONS REDUCTION FOR REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS; 30 YEARS OF SHIPMENTS *

| TSL | 3% Discount rate | 7% Discount rate |
|---|---|---|
| | (million 2022$) | |
| 1 | 1,017.36 | 401.52 |
| 2 | 1,254.07 | 496.67 |
| 3 | 1,752.92 | 695.41 |
| 4 | 1,886.57 | 670.36 |
| 5 | 2,233.05 | 885.97 |
| 6 | 3,539.43 | 1,400.46 |

* 2027–2056 for all TSLs except TSL 4; for TSL 4, 2029–2058 for the product classes listed in Table I.1 and 2030–2059 for the product classes listed in Table I.2.

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

7. Other Factors

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

8. Summary of Economic Impacts

Table V.44 presents the NPV values that result from adding the estimates of the economic benefits resulting from reduced GHG and $NO_X$ and $SO_2$ emissions to the NPV of consumer benefits calculated for each TSL considered in this rulemaking. The consumer benefits are domestic U.S. monetary savings that occur as a result of purchasing the covered refrigerators, refrigerator-freezers, and freezers, and are measured for the lifetime of products shipped in 2027–2056 for all TSLs except TSL 4; for TSL 4, 2029–2058 for the product classes listed in Table I.1 and 2030–2059 for the product classes listed in Table I.2.

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 during the period 2027–2056 for all TSLs except TSL 4; for TSL 4, 2029–2058 for the product classes listed in Table I.1 and 2030–2059 for the product classes listed in Table I.2.

TABLE V.45—CONSUMER NPV COMBINED WITH PRESENT VALUE OF CLIMATE BENEFITS AND HEALTH BENEFITS

| Category | TSL 1 | TSL 2 | TSL 3 | TSL 4 | TSL 5 | TSL 6 |
|---|---|---|---|---|---|---|
| **Using 3% discount rate for Consumer NPV and Health Benefits (billion 2022$)** | | | | | | |
| 5% Average SC–GHG case | 22.37 | 26.71 | 34.85 | 38.01 | 38.79 | 46.02 |
| 3% Average SC–GHG case | 24.37 | 29.17 | 38.29 | 41.80 | 43.17 | 52.96 |
| 2.5% Average SC–GHG case | 25.78 | 30.92 | 40.73 | 44.52 | 46.28 | 57.89 |
| 3% 95th percentile SC–GHG case | 29.58 | 35.60 | 47.28 | 51.57 | 54.63 | 71.11 |
| **Using 7% discount rate for Consumer NPV and Health Benefits (billion 2022$)** | | | | | | |
| 5% Average SC–GHG case | 9.15 | 10.86 | 13.87 | 13.72 | 14.63 | 14.70 |
| 3% Average SC–GHG case | 11.15 | 13.32 | 17.31 | 17.51 | 19.01 | 21.64 |
| 2.5% Average SC–GHG case | 12.56 | 15.06 | 19.75 | 20.23 | 22.12 | 26.57 |
| 3% 95th percentile SC–GHG case | 16.36 | 19.75 | 26.30 | 27.28 | 30.46 | 39.79 |

*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 direct final rule, 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. There is evidence that consumers undervalue future energy savings as a result of (1) a lack of information; (2) a lack of sufficient salience of the long-term or aggregate benefits; (3) a lack of sufficient savings to warrant delaying or altering purchases; (4) excessive focus on the short term, in the form of inconsistent weighting of future energy cost savings relative to available returns on other investments; (5) computational or other difficulties associated with the evaluation of relevant tradeoffs; and (6) a divergence in incentives (for example, between renters and owners, or builders and purchasers). Having less than perfect foresight and a high degree of uncertainty about the future, consumers may trade off these types of investments at a higher-than-expected rate between current consumption and uncertain future energy cost savings.

In DOE's current regulatory analysis, potential changes in the benefits and costs of a regulation due to changes in consumer purchase decisions are included in two ways. First, if consumers forego the purchase of a product in the standards case, this decreases sales for product manufacturers, and the impact on manufacturers attributed to lost revenue is included in the MIA. Second, DOE accounts for energy savings attributable only to products actually used by consumers in the standards case; if a standard decreases the number of products purchased by consumers, this decreases the potential energy savings from an energy conservation standard. DOE provides estimates of shipments and changes in the volume of product purchases in chapter 9 of the direct final rule 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.[105]

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

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

Tables V.46 and V.47 summarize the quantitative impacts estimated for each TSL for refrigerators, refrigerator-freezers, and freezers. 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 for all TSLs except TSL 4; for TSL 4, 2029–2058 for the product classes listed in Table I.1 and 2030–2059 for the product classes listed in Table I.2). The energy savings, emissions reductions, and value of emissions reductions refer to full-fuel-cycle results. DOE is presenting monetized benefits of GHG emissions reductions in accordance with the applicable Executive orders and DOE would reach the same conclusion presented in this direct final rule in the absence of the social cost of greenhouse gases, including the Interim Estimates presented by the Interagency Working Group. The efficiency levels contained in each TSL are described in section V.A of this document.

TABLE V.46—SUMMARY OF ANALYTICAL RESULTS FOR REFRIGERATOR, REFRIGERATOR-FREEZER, AND FREEZER TSLS: NATIONAL IMPACTS

| Category | TSL 1 | TSL 2 | TSL 3 | TSL 4 | TSL 5 | TSL 6 |
|---|---|---|---|---|---|---|
| **Cumulative FFC National Energy Savings** | | | | | | |
| Quads | 2.76 | 3.38 | 4.72 | 5.61 | 6.01 | 9.57 |
| **Cumulative FFC Emissions Reduction** | | | | | | |
| $CO_2$ (*million metric tons*) | 50.79 | 62.34 | 86.98 | 100.76 | 110.76 | 176.19 |
| $CH_4$ (*thousand tons*) | 419.63 | 514.70 | 717.90 | 846.48 | 914.15 | 1455.24 |
| $N_2O$ (*thousand tons*) | 0.50 | 0.62 | 0.87 | 0.99 | 1.10 | 1.75 |
| $SO_2$ (*thousand tons*) | 16.00 | 19.64 | 27.40 | 31.57 | 34.89 | 55.49 |
| $NO_X$ (*thousand tons*) | 93.17 | 114.33 | 159.50 | 186.11 | 203.10 | 323.18 |
| Hg (*tons*) | 0.11 | 0.13 | 0.19 | 0.22 | 0.24 | 0.38 |
| **Present Value of Benefits and Costs (*3% discount rate, billion 2022$*)** | | | | | | |
| Consumer Operating Cost Savings | 19.68 | 24.06 | 33.21 | 36.36 | 41.23 | 63.08 |
| Climate Benefits * | 2.67 | 3.29 | 4.60 | 5.02 | 5.87 | 9.29 |
| Health Benefits ** | 5.24 | 6.46 | 9.03 | 9.80 | 11.50 | 18.24 |
| Total Benefits † | 27.60 | 33.81 | 46.85 | 51.18 | 58.60 | 90.61 |
| Consumer Incremental Product Costs ‡ | 3.23 | 4.64 | 8.56 | 9.38 | 15.43 | 37.66 |

[105] 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.*

[106] Sanstad, A.H. *Notes on the Economics of Household Energy Consumption and Technology Choice.* 2010. Lawrence Berkeley National Laboratory. Available at *www1.eere.energy.gov/buildings/appliance_standards/pdfs/consumer_ee_theory.pdf* (last accessed July 1, 2021).

TABLE V.46—SUMMARY OF ANALYTICAL RESULTS FOR REFRIGERATOR, REFRIGERATOR-FREEZER, AND FREEZER TSLS: NATIONAL IMPACTS—Continued

| Category | TSL 1 | TSL 2 | TSL 3 | TSL 4 | TSL 5 | TSL 6 |
|---|---|---|---|---|---|---|
| Consumer Net Benefits | 16.45 | 19.42 | 24.65 | 26.98 | 25.80 | 25.42 |
| Total Net Benefits | 24.37 | 29.17 | 38.29 | 41.80 | 43.17 | 52.96 |
| **Present Value of Benefits and Costs (*7% discount rate, billion 2022$*)** | | | | | | |
| Consumer Operating Cost Savings | 8.36 | 10.25 | 14.17 | 14.00 | 17.60 | 26.88 |
| Climate Benefits * | 2.67 | 3.29 | 4.60 | 5.02 | 5.87 | 9.29 |
| Health Benefits ** | 2.04 | 2.52 | 3.53 | 3.45 | 4.50 | 7.12 |
| Total Benefits † | 13.07 | 16.06 | 22.31 | 22.47 | 27.97 | 43.29 |
| Consumer Incremental Product Costs ‡ | 1.92 | 2.75 | 5.00 | 4.96 | 8.96 | 21.65 |
| Consumer Net Benefits | 6.44 | 7.50 | 9.17 | 9.04 | 8.64 | 5.23 |
| Total Net Benefits | 11.15 | 13.32 | 17.31 | 17.51 | 19.01 | 21.64 |

**Note:** This table presents the costs and benefits associated with consumer refrigerators, refrigerator-freezers, and freezers shipped in 2027–2056 for all TSLs except TSL 4; for TSL 4, 2029–2058 for the product classes listed in Table I.1 and 2030–2059 for the product classes listed in Table I.2. These results include benefits to consumers which accrue after 2056 from the products shipped in 2027–2056 for all TSLs except TSL 4; for TSL 4, 2029–2058 for the product classes listed in Table I.1 and 2030–2059 for the product classes listed in Table I.2.

* 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; however, DOE emphasizes the importance and value of considering the benefits calculated using all four sets of SC–GHG estimates. To monetize the benefits of reducing GHG emissions, this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990* published in February 2021 by the IWG.

** Health benefits are calculated using benefit-per-ton values for $NO_X$ and $SO_2$. DOE is currently only monetizing (for $NO_X$ and $SO_2$) $PM_{2.5}$ precursor health benefits and (for $NO_X$) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. The health benefits are presented at real discount rates of 3 and 7 percent. *See* section IV.L of this document for more details.

† Total and net benefits include consumer, climate, and health benefits. For presentation purposes, total and net benefits for both the 3-percent and 7-percent cases are presented using the average SC–GHG with 3-percent discount rate.

TABLE V.47—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 2022$) (No-new-standards case INPV = 4,905.8) | 4,841.5 to 4,891.4 | 4,798.5 to 4,870.1 | 4,387.6 to 4,514.7 | 4,401.3 to 4,522.3 | 3,839.9 to 4,061.6 | 3,080.1 to 3,604.0 |
| Industry NPV (% change) | (1.3) to (0.3) | (2.2) to (0.7) | (10.6) to (8.0) | (10.3) to (7.8) | (21.7) to (17.2) | (37.2) to (26.5) |
| *Consumer Average LCC Savings (2022$):* | | | | | | |
| PC 3 | 30.50 | 40.14 | 40.14 | 50.91 | 43.46 | 0.03 |
| PC 5 | 46.90 | 46.90 | 45.47 | 55.23 | 45.47 | 20.22 |
| PC 5BI | 86.19 | 86.19 | 86.19 | 91.13 | 86.19 | (30.73) |
| PC 5A | 127.59 | 127.59 | 124.76 | 133.27 | 122.18 | 122.18 |
| PC 7 | 52.10 | 70.96 | 134.10 | 142.56 | 73.96 | 69.71 |
| PC 9 | 62.02 | 62.02 | 62.02 | 56.17 | 62.02 | 26.33 |
| PC 10 | 5.94 | N/A | N/A | N/A | N/A | (8.65) |
| PC 11A (residential) | 0.00 | 0.00 | 8.11 | 8.35 | 8.11 | (4.66) |
| PC 11A (commercial) | 0.00 | 0.00 | 3.06 | 3.16 | 3.06 | (29.11) |
| PC 17 | 32.29 | 32.29 | 32.29 | 36.86 | 32.29 | 0.26 |
| PC 18 | 23.82 | 23.82 | 22.49 | 23.55 | 22.49 | (5.34) |
| Shipment-Weighted Average * | 47.08 | 55.22 | 63.46 | 70.88 | 55.93 | 27.51 |
| *Consumer Simple PBP (years):* | | | | | | |
| PC 3 | 1.4 | 4.2 | 4.2 | 4.8 | 5.3 | 9.3 |
| PC 5 | 4.3 | 4.3 | 6.1 | 5.6 | 6.1 | 8.6 |
| PC 5BI | 2.4 | 2.4 | 2.4 | 2.1 | 2.4 | 8.2 |
| PC 5A | 1.9 | 1.9 | 4.4 | 4.1 | 6.0 | 6.0 |
| PC 7 | 0.7 | 2.9 | 1.9 | 1.6 | 6.2 | 6.8 |
| PC 9 | 4.1 | 4.1 | 4.1 | 6.6 | 4.1 | 10.7 |
| PC 10 | 11.2 | N/A | N/A | N/A | N/A | 13.4 |
| PC 11A (residential) | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 6.0 |
| PC 11A (commercial) | 3.3 | 3.3 | 3.3 | 3.2 | 3.3 | 9.3 |
| PC 17 | 4.6 | 4.6 | 4.6 | 4.1 | 4.6 | 7.2 |
| PC 18 | 1.4 | 1.4 | 4.2 | 4.1 | 4.2 | 9.4 |
| Shipment-Weighted Average * | 3.0 | 3.6 | 4.3 | 4.5 | 5.4 | 8.7 |
| *Percent of Consumers that Experience a Net Cost:* | | | | | | |
| PC 3 | 3.9 | 17.3 | 17.3 | 28.3 | 34.2 | 67.1 |
| PC 5 | 18.2 | 18.2 | 39.4 | 33.6 | 39.4 | 60.3 |
| PC 5BI | 1.0 | 1.0 | 1.0 | 0.5 | 1.0 | 61.0 |
| PC 5A | 1.2 | 1.2 | 23.0 | 19.8 | 39.4 | 39.4 |
| PC 7 | 0.0 | 9.6 | 1.2 | 0.5 | 42.6 | 48.3 |
| PC 9 | 12.2 | 12.2 | 12.2 | 39.1 | 12.2 | 61.0 |

TABLE V.47—SUMMARY OF ANALYTICAL RESULTS FOR REFRIGERATOR, REFRIGERATOR-FREEZER, AND FREEZER TSLS: MANUFACTURER AND CONSUMER IMPACTS—Continued

| Category | TSL 1 | TSL 2 | TSL 3 | TSL 4 | TSL 5 | TSL 6 |
|---|---|---|---|---|---|---|
| PC 10 | 57.5 | N/A | N/A | N/A | N/A | 70.0 |
| PC 11A (residential) | 0.0 | 0.0 | 8.4 | 8.0 | 8.4 | 61.7 |
| PC 11A (commercial) | 0.0 | 0.0 | 16.1 | 15.7 | 16.1 | 92.7 |
| PC 17 | 5.6 | 5.6 | 5.6 | 4.5 | 5.6 | 61.5 |
| PC 18 | 0.8 | 0.8 | 18.9 | 17.6 | 18.9 | 68.5 |
| Shipment-Weighted Average * | 10.2 | 12.7 | 20.5 | 24.4 | 33.2 | 60.0 |

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 for all TSLs except TSL 4; for TSL 4, 2029 for PCs 5BI, 5A, 10, 11A, 17, and 18, and 2030 for PCs 3, 5, 7, and 9.

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 less than 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 9.57 quads of energy, an amount DOE considers significant. Under TSL 6, the NPV of consumer benefit would be $5.23 billion using a discount rate of 7 percent, and $25.42 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 6 are 176 Mt of $CO_2$, 55.5 thousand tons of $SO_2$, 323 thousand tons of $NO_X$, 0.38 tons of Hg, 1,455 thousand tons of $CH_4$, and 1.75 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 $9.29 billion. The estimated monetary value of the health benefits from reduced $SO_2$ and $NO_X$ emissions at TSL 6 is $7.12 billion using a 7-percent discount rate and $18.24 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 $21.64 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 6 is $52.96 billion. The estimated total NPV is provided for additional information, however DOE primarily relies upon the NPV of consumer benefits when determining whether a 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 76 percent of annual shipments, there is a life-cycle cost savings of $0.03, $20.22, $122.18, and $69.71 and a payback period of 9.3 years, 8.6 years, 6.0 years and 6.8 years, respectively. However, for these product classes, the fraction of customers experiencing a net LCC cost is 67.1 percent, 60.3 percent, 39.4 percent and 48.3 percent with increases in first cost of $169.37, $151.75, $161.65, and $153.01, respectively. Overall, a majority of refrigerators, refrigerator-freezers, and freezers consumers (60 percent) would experience a net cost and the average LCC savings would be negative for PC 5BI, PC 10, PC 11A, and PC 18. Additionally, 35 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 $1.83 billion to a decrease of $1.30 billion, which corresponds to decreases of 37.2 percent and 26.5 percent, respectively. Industry conversion costs could reach $2.39 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 less than 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 seven out of 22 OEMs currently offer products that meet the efficiency level required. For PC 7, which accounts for approximately 11 percent of annual shipments, only one out of 11 OEMs currently offers products that meet the efficiency level required.

At max-tech, manufacturers would likely need to implement all 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 17.0 million annual shipments of refrigerators, refrigerator-freezers, and freezers.[107]

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 likely 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.

[107] Current shipments calculations relied on shipments in the year 2023.

The Secretary 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 consumers (60 percent) would experience a net cost and the average LCC savings would be negative for PC 5BI, PC 10, PC 11A, 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 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 options as max-tech, but generally incorporates the use of high-efficiency compressors (single speed compressors or VSCs) 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 6.01 quads of energy, an amount DOE considers significant. Under TSL 5, the NPV of consumer benefit would be $8.64 billion using a discount rate of 7 percent, and $25.80 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 5 are 111 Mt of $CO_2$, 34.9 thousand tons of $SO_2$, 203 thousand tons of $NO_X$, 0.24 tons of Hg, 914 thousand tons of $CH_4$, and 1.10 thousand tons of $N_2O$. The estimated monetary value of the climate benefits from reduced GHG emissions (associated with the average SC–GHG at a 3-percent discount rate) at TSL 5 is $5.87 billion. The estimated monetary value of the health benefits from reduced $SO_2$ and $NO_X$ emissions at TSL 5 is $4.50 billion using a 7-percent discount rate and $11.50 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 $19.01 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 5 is $43.17 billion. The estimated total NPV is provided for additional information, however DOE primarily relies upon the NPV of consumer benefits when determining whether a 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 $43.46, $45.47, $122.18, and $73.96 and a payback period of 5.3 years, 6.1 years, 6.0 years and 6.2 years, respectively. For these product classes, the fraction of customers experiencing a net LCC cost is 34.2 percent, 39.4 percent, 39.4 percent and 42.6 percent with increases in first cost of $52.69, $69.25, $161.65, and $121.58, respectively. Overall, 33 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 16 percent of all low-income households experience a net cost, including 11 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 32 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). More than half of low-income PC 7 consumers with a net cost experience a net cost of at least $40 and while low-income PC 7 consumers experience an average LCC savings of $132.77 at TSL 5, there are larger average LCC savings at TSL 4 ($161.87) and substantially fewer low-income PC 7 consumers would experience a net cost (0.6 percent) at that TSL. Further, the incremental increase in purchase price at TSL 5 for PC 7 is $121.58, which may be difficult for low-income homeowners to afford.

At TSL 5, the projected change in INPV ranges from a decrease of $1.07 billion to a decrease of $844.2 million, which corresponds to decreases of 21.7 percent and 17.2 percent, respectively. DOE estimates that industry must invest $1.40 billion to comply with standards set at TSL 5.

DOE estimates that approximately 14 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 1 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 22 OEMs offering PC 3 products, three OEMs offer models that meet the efficiency level required. Of the 22 OEMs offering PC 5 products, 14 OEMs offer models that meet the efficiency level required. Of the 11 OEMs offering PC 7 products, only one OEM 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 could require the use of VIPs. DOE expects manufacturers would likely need to incorporate some VIPs into PC 5 and PC 7 designs, but not to the extent required at max-tech. However, DOE expects manufacturers would need to incorporate the max-tech design options for PC 5A, which includes the use of VIPs for roughly half the cabinet surface (side walls and doors) to meet TSL 5 efficiencies. 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 1 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 $1.40 billion because the majority of product platforms in the industry would require redesign and investment.

The Secretary concludes that at TSL 5 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 consumers, particularly low-income consumers of side-by-side refrigerator-freezers, and the impacts on manufacturers, including the large potential reduction in INPV and the lack of manufacturers currently offering standard-size refrigerator-freezer products meeting the efficiency levels required at this TSL. Specifically, only one OEM currently offers any PC 7 models that meet the TSL 5 efficiencies. At TSL 5, 32 percent of low-income PC 7 consumers would experience a net cost and the incremental increase in purchase price of $121.58 may be difficult for low-income homeowners to afford. Consequently, the Secretary has concluded that TSL 5 is not economically justified.

DOE then considered the Recommended TSL (*i.e.,* TSL 4). For representative product classes other than PC 5A, PC 7, and PC 9, this TSL represents the same efficiency levels as TSL 5.[108] Thus, the Recommended TSL represents similar design options as TSL 5, except for PC 5A, PC 7, and PC 9. For PC 7, DOE expects manufacturers would not require the use of VIPs to meet the required efficiency level. For PC 5A, DOE expects manufacturers would require less VIP surface area to meet the required efficiency level. For PC 9, DOE expects manufacturers to implement variable speed compressor systems to meet required standards. DOE estimates that approximately 14 percent of annual shipments across all refrigerator, refrigerator-freezer, and freezer product classes currently meet the efficiencies required. For the Recommended TSL, DOE's analysis utilized the January 31, 2029 (or January 31, 2030, for some product classes) compliance dates specified in the Joint Agreement. The Recommended TSL would save an estimated 5.61 quads of energy, an amount DOE considers significant. Under the Recommended TSL, the NPV of consumer benefit would be $9.04 billion using a discount rate of 7 percent, and $26.98 billion using a discount rate of 3 percent.

The cumulative emissions reductions at the Recommended TSL are 101 Mt of $CO_2$, 31.6 thousand tons of $SO_2$, 186 thousand tons of $NO_X$, 0.22 tons of Hg, 846.5 thousand tons of $CH_4$, and 0.99 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 the Recommended TSL is $5.02 billion. The estimated monetary value of the health benefits from reduced $SO_2$ and $NO_X$ emissions at the Recommended TSL is $3.45 billion using a 7-percent discount rate and $9.80 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 the Recommended TSL is $17.51 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at the Recommended TSL is $41.80 billion. The estimated total NPV is provided for additional information, however DOE primarily relies upon the NPV of consumer benefits when determining whether a standard level is economically justified.

At the Recommended TSL, for the largest product classes, which are 3, 5, 5A, and 7, there is a life-cycle cost savings of $50.91, $55.23, $133.27, and $142.56 and a payback period of 4.8 years, 5.6 years, 4.1 years, and 1.6 years, respectively. For these product classes, the fraction of customers experiencing a net LCC cost is 28.3 percent, 33.6 percent, 19.8 percent, and 0.5 percent with increases in first cost of $47.67, $62.72, $81.32, and $24.39, respectively. Overall, 24.4 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 the Recommended TSL, 9 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 0.6 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) experience a net cost. Additionally, the incremental increase in purchase price is $24.39 for low-income PC 7 homeowners at the Recommended TSL, substantially lower than the incremental increase in purchase price of $121.58 at TSL 5.

At the Recommended TSL, the projected change in INPV ranges from a decrease of $504.4 million to a decrease of $383.5 million, which correspond to decreases of 10.3 percent and 7.8 percent, respectively. DOE estimates that industry must invest $830.3 million comply with standards set at the Recommended TSL. DOE estimates that approximately 14 percent of refrigerator, refrigerator-freezer, and freezer annual shipments meet the Recommended TSL efficiencies.

Compared to TSL 5, more manufacturers offer standard-size refrigerator freezer products that meet the required efficiencies since PC 7 has a lower required efficiency level at the Recommended TSL. For PC 7, which accounts for 11 percent of shipments, three OEMs offer products that meet the efficiency level required. Furthermore, DOE does not expect manufacturers would need to incorporate VIPs into PC 7 designs to meet the efficiencies required at the Recommended TSL. For PC 5 and PC 5A, DOE understands the two product classes often share the same production lines, with shared cabinet architecture and tooling. DOE expects manufacturers would likely need to incorporate some VIPs into PC 5A designs, but not to the extent required at TSL 5 and TSL 6. Thus, for the 10 OEMs that manufacture both PC 5 and PC 5A, DOE expects manufacturers could implement similar cabinet upgrades (*i.e.,* partial VIP) for PC 5 and PC 5A designs to achieve the efficiencies required at this level.

For all TSLs considered in this direct final rule—except for the Recommended TSL—DOE is bound by the 3-year lead time requirements in EPCA when determining compliance dates (*i.e.,* compliance with amended standards required in 2027). For the Recommended TSL, DOE's analysis utilized the January 31, 2029 (or January 31, 2030, for some product classes) compliance dates specified in the Joint Agreement as they were an integral part of the multi-product joint recommendation. These compliance dates provide manufacturers the flexibility to spread capital requirements, engineering resources, and other conversion activities over a longer period of time depending on the individual needs of each manufacturer. Furthermore, these delayed compliance dates provide additional lead time and certainty for suppliers of components that improve efficiency. The Recommended TSL mitigates risks raised by AHAM and multiple manufacturers in response to the February 2023 NOPR regarding the ability for VSC and VIP component suppliers to increase supply of these key components in the 3-year lead time required by EPCA.

After considering the analysis and weighing the benefits and burdens, the Secretary has concluded that a standard set at the Recommended TSL for refrigerators, refrigerator-freezers, and freezers is economically justified. At this TSL, the average LCC savings are positive for all product classes for

[108] For all TSLs except the Recommended TSL, the efficiency levels required for non-representative product classes are the same as the efficiency levels required for the associated directly analyzed product classes. However, as noted in section V.A of this document, the Recommended TSL from the Joint Agreement includes standard levels for some non-representative product classes that differ from their associated representative product class. Thus, in addition to the representative PC 5A, PC 7, and PC 9, the efficiency levels required for non-representative PC 9A–BI and PC 12 at the Recommended TSL also differ from the efficiency levels required at TSL 5.

which an amended standard is considered. An estimated 24.4 percent of all refrigerator, refrigerator-freezer, and freezer consumers experience a net cost. An estimated 9 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 0.6 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), experience a net cost, which is a significantly lower percentage than under TSL 5. DOE notes that for low-income PC 7 consumers, as well as across all PC 7 consumers, the Recommended TSL represents the largest average LCC savings of any TSL. The FFC national energy savings are significant and the NPV of consumer benefits is positive at the Recommended TSL using both a 3-percent and 7-percent discount rate. Notably, the benefits to consumers vastly outweigh the cost to manufacturers. At the Recommended TSL, the NPV of consumer benefits, even measured at the more conservative discount rate of 7 percent is over 17 times higher than the maximum estimated manufacturers' loss in INPV. The standard levels at the Recommended TSL are economically justified even without weighing the estimated monetary value of emissions reductions. When those emissions reductions are included—representing $5.02 billion in climate benefits (associated with the average SC–GHG at a 3-percent discount rate), and $9.80 billion (using a 3-percent discount rate) or $3.45 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. DOE notes 72 percent of low-income households have a top-mount refrigerator-freezer (represented by PC 3) and that an estimated 9 percent of low-income PC 3 households experience a net cost at the Recommended TSL, whereas an estimated 6 percent of low-income households with a top-mount refrigerator-freezer experience a net cost at TSL 3. However, the average LCC savings for low-income PC 3 consumers are $22.05 higher at the Recommended TSL than at TSL 3. Further, compared to TSL 3, it is estimated that the Recommended TSL would result in additional FFC national energy savings of 0.9 quads. These additional savings and benefits at the Recommended TSL are significant. DOE considers the impacts to be, as a whole, economically justified at the Recommended TSL.

Although DOE considered 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. In general, the standard level represents the maximum energy savings that does not result in a large percentage of consumers experiencing a net LCC cost. For example, for PC 5, more than half of consumers experience a net cost at EL 3. In the case of PC 7, for which DOE found that a relatively higher percentage of low-income consumers may experience net costs at higher efficiency levels, at the standard level chosen, 0.6 percent of low-income households with side-by-side refrigerator-freezers will experience a potential burden. The ELs at the 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 concluded they are economically justified, as discussed for the Recommended TSL in the preceding paragraphs.

Therefore, based on the previous considerations, DOE adopts the energy conservation standards for refrigerators, refrigerator-freezers, and freezers at the Recommended TSL.

While DOE considered each potential TSL under the criteria laid out in 42 U.S.C. 6295(o) as discussed above, DOE notes that the Recommended TSL for refrigerators, refrigerator-freezers, and freezers adopted in this direct final rule is part of a multi-product Joint Agreement covering six rulemakings (refrigerators, refrigerator-freezers, and freezers; miscellaneous refrigeration products; conventional cooking products; residential clothes washers; consumer clothes dryers; and dishwashers). The signatories indicate that the Joint Agreement for the six rulemakings should be considered as a joint statement of recommended standards, to be adopted in its entirety. As discussed in section V.B.2.e of this document, many refrigerator, refrigerator-freezer, and freezer OEMs also manufacture miscellaneous refrigeration products, conventional cooking products, residential clothes washers, consumer clothes dryers, and dishwashers. Rather than requiring compliance with five amended standards in a single year (2027),[109] the negotiated multi-product Joint Agreement staggers the compliance dates for the five amended standards over a 4-year period (2027–2030). In response to the February 2023 NOPR, AHAM and individual manufacturers expressed concerns about the timing of ongoing home appliance rulemakings. Specifically, AHAM commented that the combination of the stringency of DOE's proposals, the short lead-in time required under EPCA to comply with standards, and the overlapping timeframe of multiple standards affecting the same manufacturers represents significant cumulative regulatory burden for the home appliance industry. (AHAM, No. 69 at pp. 20–21) AHAM has submitted similar comments to other ongoing consumer product rulemakings.[110] As AHAM is a key signatory of the Joint Agreement, DOE understands that the compliance dates recommended in the Joint Agreement would help reduce cumulative regulatory burden. These compliance dates help relieve concern on the part of some manufacturers about their ability to allocate sufficient resources to comply with multiple concurrent amended standards, about the need to align compliance dates for products that are typically designed or sold as matched pairs, and about the ability of their suppliers to ramp up production of key components. The Joint Agreement also provides additional years of regulatory certainty for manufacturers and their suppliers while still achieving the maximum improvement in energy efficiency that is technologically feasible and economically justified.

The amended energy conservation standards for refrigerators, refrigerator-freezers, and freezers, which are

[109] The refrigerators, refrigerator-freezers, and freezers (88 FR 12452); consumer conventional cooking products (88 FR 6818); residential clothes washers (88 FR 13520); consumer clothes dryers (87 FR 51734); and dishwashers (88 FR 32514) utilized a 2027 compliance year for analysis at the proposed rule stage. Miscellaneous refrigeration products (88 FR 12452) utilized a 2029 compliance year for the NOPR analysis.

[110] AHAM has submitted written comments regarding cumulative regulatory burden for the other five rulemakings included in the multi-product Joint Agreement. AHAM's written comments on cumulative regulatory burden are available at: *www.regulations.gov/comment/EERE-2020-BT-STD-0039-0031* (pp. 12–15) for miscellaneous refrigeration products; *www.regulations.gov/comment/EERE-2014-BT-STD-0005-2285* (pp. 44–27) for consumer conventional cooking products; *www.regulations.gov/comment/EERE-2017-BT-STD-0014-0464* (pp. 40–44) for residential clothes washers; *www.regulations.gov/comment/EERE-2014-BT-STD-0058-0046* (pp. 12–13) for consumer clothes dryers; and *www.regulations.gov/comment/EERE-2019-BT-STD-0039-0051* (pp. 21–24) for dishwashers.

expressed as kWh/yr, are shown in Table V.48.

TABLE V.48—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)*K4 + 28I | (0.243av + 241.2)*K4 + 28I. |
| 4–BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer. | (8.79AV + 307.4)*K4BI + 28I | (0.310av + 307.4)*K4BI + 28I. |
| 5. Refrigerator-freezers—automatic defrost with bottom-mounted freezer | (7.79AV + 279.0)*K5 + 28I | (0.275av + 279.0)*K5 + 28I. |
| 5–BI. Built-In Refrigerator-freezers—automatic defrost with bottom-mounted freezer. | (8.46AV + 303.2)*K5BI + 28I | (0.299av + 303.2)*K5BI + 28I. |
| 5A. Refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service. | (7.22AV + 327.1)*K5A | (0.255av + 327.1)*K5A. |
| 5A–BI. Built-in refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service. | (8.16AV + 368.4)*K5ABI | (0.288av + 368.4)*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)*K9 + 28I | (0.274av + 205.5)*K9 + 28I. |
| 9–BI. Built-In Upright freezers with automatic defrost | (9.37AV + 247.9)*K9BI + 28I | (0.331av + 247.9)*K9BI + 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 | 5.02AV + 285.4 | 0.177av + 285.4. |
| 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 | (7.79AV + 220.4)*K13A | (0.275av + 220.4)*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.

| 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 | 1.0 | 1.0 | 1 + 0.02 * ($N_d$ − 1). |
| K3A | 1.10 | 1.0 | 1.0. |
| K3ABI | 1.10 | 1.0 | 1.0. |
| K4 | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 2). |
| K4BI | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 2). |
| K5 | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 2). |
| K5BI | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 2). |
| K5A | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 3). |
| K5ABI | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 3). |
| K7 | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 2). |
| K7BI | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 2). |
| K9 | 1.0 | 1.0 | 1 + 0.02 * ($N_d$ − 1). |

| 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 |
|---|---|---|---|
| K9BI | 1.0 | 1.0 | 1 + 0.02 * ($N_d$ − 1). |
| K12 | 1.0 | 1.0 | 1 + 0.02 * ($N_d$ − 1). |
| K13A | 1.10 | 1.0 | 1.0. |

**Notes:**
[1] $N_d$ is the number of external doors.
[2] The maximum $N_d$ values are 2 for K2 and K12, 3 for K9BI, and 5 for all other K values.

2. Annualized Benefits and Costs of the Adopted Standards

The benefits and costs of the adopted standards can also be expressed in terms of annualized values. The annualized net benefit is (1) the annualized national economic value (expressed in 2022$) of the benefits from operating products that meet the adopted 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.

Table V.49 shows the annualized values for consumer refrigerator, refrigerator-freezers, and freezers under the Recommended TSL expressed in 2022$. The results under the primary estimate are as follows.

Using a 7-percent discount rate for consumer benefits and costs and health benefits from reduced $NO_X$ and $SO_2$ emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the standards adopted in this rule is $590.5 million per year in increased equipment costs, while the estimated annual monetized benefits are $1.7 billion in reduced equipment operating costs, $303.8 million in climate benefits, and $410.6 million in health benefits. In this case, the net benefit would amount to $1.8 billion per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the standards is $567.5 million per year in increased equipment costs, while the estimated annual monetized benefits are $2.2 billion in reduced operating costs, $303.8 million in climate benefits, and $592.9 million in health benefits. In this case, the net benefit would amount to $2.5 billion per year.

TABLE V.49—ANNUALIZED BENEFITS AND COSTS OF ADOPTED STANDARDS (THE RECOMMENDED TSL) FOR CONSUMER REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS

| | Million 2022$/year | | |
|---|---|---|---|
| | Primary estimate | Low-net-benefits estimate | High-net-benefits estimate |
| *3% discount rate:* | | | |
| Consumer Operating Cost Savings | 2,200.5 | 2,023.9 | 2,326.6 |
| Climate Benefits * | 303.8 | 291.8 | 307.9 |
| Health Benefits ** | 592.9 | 569.7 | 600.7 |
| Total Benefits † | 3,097.2 | 2,885.4 | 3,235.2 |
| Consumer Incremental Product Costs ‡ | 567.5 | 666.6 | 547.8 |
| Net Benefits | 2,529.6 | 2,218.8 | 2,687.4 |
| Change in Producer Cashflow (INPV ‡‡) | (49) to (37) | (49) to (37) | (49) to (37) |
| *7% discount rate:* | | | |
| Consumer Operating Cost Savings | 1,667.0 | 1,541.9 | 1,758.5 |
| Climate Benefits * (3% discount rate) | 303.8 | 291.8 | 307.9 |
| Health Benefits ** | 410.6 | 395.8 | 415.7 |
| Total Benefits † | 2,381.4 | 2,229.5 | 2,482.0 |
| Consumer Incremental Product Costs ‡ | 590.5 | 677.9 | 569.6 |
| Net Benefits | 1,790.9 | 1,551.6 | 1,912.5 |
| Change in Producer Cashflow (INPV ‡‡) | (49) to (37) | (49) to (37) | (49) to (37) |

**Note:** This table presents present value (in 2022$) of the costs and benefits associated with refrigerators, refrigerator-freezers, and freezers shipped in 2029–2058 for the product classes listed in Table I.1 and shipped in 2030–2059 for the product classes listed in Table I.2. These results include benefits which accrue after 2056 from the products shipped in 2029–2058 for the product classes listed in Table I.1 and shipped in 2030–2059 for the product classes listed in Table I.2. The Primary, Low Net Benefits, and High Net Benefits Estimates utilize projections of energy prices from the *AEO2023* Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental equipment costs reflect a medium decline rate in the Primary Estimate, a low decline rate in the Low Net Benefits Estimate, and a high decline rate in the High Net Benefits Estimate. The methods used to derive projected price trends are explained in 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; however, DOE emphasizes the importance and value of considering the benefits calculated using all four sets of SC–GHG estimates. To monetize the benefits of reducing GHG emissions, this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane.*

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

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

‡‡ Operating Cost Savings are calculated based on the life-cycle costs analysis and national impact analysis as discussed in detail below. *See* sections IV.F and IV.H of this document. DOE's NIA includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the product and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (the MIA). *See* section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. The annualized change in INPV is calculated using the industry weighted average cost of capital value of 9.1 percent that is estimated in the manufacturer impact analysis (*see* chapter 12 of the direct final rule TSD for a complete description of the industry weighted average cost of capital). For refrigerators, refrigerator-freezers, and freezers, those values are −$48.7 million to −$37.0 million. DOE accounts for that range of likely impacts in analyzing whether a TSL is economically justified. *See* section V.C of this document. DOE is presenting the range of impacts to the INPV under two manufacturer markup scenarios: the Preservation of Gross Margin scenario, which is the manufacturer markup scenario used in the calculation of Consumer Operating Cost Savings in this table, and the Preservation of Operating Profit Markup scenario, where DOE assumed manufacturers would not be able to increase per-unit operating profit in proportion to increases in manufacturer production costs. DOE includes the range of estimated annualized change in INPV in the above table, drawing on the MIA explained further in section IV.J of this document, to provide additional context for assessing the estimated impacts of this direct final rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A–4 and E.O. 12866. If DOE were to include the INPV into the annualized net benefit calculation for this direct final rule, the annualized net benefits would range from $2,480.9 million to $2,492.6 million at 3-percent discount rate and would range from $1,742.2 million to $1,753.9 million at 7-percent discount rate. Parentheses ( ) indicate negative values.

## VI. Procedural Issues and Regulatory Review

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

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), and amended by E.O. 14094, ''Modernizing Regulatory Review,'' 88 FR 21879 (April 11, 2023), requires agencies, to the extent permitted by law, to (1) propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify); (2) tailor regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations; (3) select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity); (4) to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt; and (5) identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public. DOE emphasizes as well that E.O. 13563 requires agencies to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible. In its guidance, the Office of Information and Regulatory Affairs (''OIRA'') in the Office of Management and Budget (''OMB'') has emphasized that such techniques may include identifying changing future compliance costs that might result from technological innovation or anticipated behavioral changes. For the reasons stated in the preamble, this 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 final regulatory action constitutes a ''significant regulatory action'' within the scope of section 3(f)(1) of E.O. 12866. Accordingly, pursuant to section 6(a)(3)(C) of E.O. 12866, DOE has provided to OIRA an assessment, including the underlying analysis, of benefits and costs anticipated from the final regulatory action, together with, to the extent feasible, a quantification of those costs; and an assessment, including the underlying analysis, of costs and benefits of potentially effective and reasonably feasible alternatives to the planned regulation, and an explanation why the planned regulatory action is preferable to the identified potential alternatives. These assessments are summarized in this preamble and further detail can be found in the technical support document for this rulemaking.

### *B. Review Under the Regulatory Flexibility Act*

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

DOE is not obligated to prepare a regulatory flexibility analysis for this rulemaking because there is not a requirement to publish a general notice of proposed rulemaking under the Administrative Procedure Act. See 5 U.S.C. 601(2), 603(a). As discussed previously, DOE has determined that the Joint Agreement meets the necessary requirements under EPCA to issue this direct final rule for energy conservation standards for refrigerators, refrigerator-freezers, and freezers under the procedures in 42 U.S.C. 6295(p)(4). DOE notes that the NOPR for energy conservation standards for refrigerators, refrigerator-freezers, and freezers published elsewhere in the **Federal Register** contains an IRFA.

### *C. Review Under the Paperwork Reduction Act*

Manufacturers of consumer 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 consumer 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 consumer refrigerators, refrigerator-freezers, and freezers. (*See* *generally* 10 CFR part 429) The collection-of-information requirement for the certification and recordkeeping is subject to review and approval by OMB under the Paperwork Reduction Act (''PRA''). This requirement has been approved by OMB under OMB control number 1910–1400. Public reporting burden for the certification is estimated to average 35 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

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

*D. Review Under the National Environmental Policy Act of 1969*

Pursuant to the National Environmental Policy Act of 1969 (''NEPA''), DOE has analyzed this rule in accordance with NEPA and DOE's NEPA implementing regulations (10 CFR part 1021). DOE has determined that this rule qualifies for categorical exclusion under 10 CFR part 1021, subpart D, appendix B, B5.1, because it is a rulemaking that establishes energy conservation standards for consumer products or industrial equipment, none of the exceptions identified in B5.1(b) apply, no extraordinary circumstances exist that require further environmental analysis, and it meets the requirements for application of a categorical exclusion. *See* 10 CFR 1021.410. Therefore, DOE has determined that promulgation of this rule is not a major Federal action significantly affecting the quality of the human environment within the meaning of NEPA, and does not require an environmental assessment or an environmental impact statement.

*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.

In the February 2023 NOPR, DOE tentatively determined that the proposed rule 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. 88 FR 13616. Furthermore, DOE stated that EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of this proposed rule and that States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. *Id.* (*citing* 42 U.S.C. 6297). Accordingly, DOE concluded that no further action was required by E.O. 13132.

The AGs of TN, AL, *et al.* submitted a joint comment that DOE's analysis is woefully deficient. The AGs of TN, AL, *et al.* commented that this determination is incorrect because, in their view, the Proposed Standards have significant federalism implications within the meaning of Executive Order 13132. The AGs of TN, AL, *et al.* go on to state that if the Proposed Standards are promulgated, ''[a]ny State regulation which sets forth procurement standards'' relating to refrigerators, refrigerator-freezers, or freezers, is ''superseded'' unless those ''standards are more stringent than the corresponding Federal energy conservation standards. The AGs of TN, AL, et al. argue that preempting—even in part—State procurement rules is plainly a direct effect on the States and alters the federal-state relationship by directly regulating the States. See Exec. Order No. 13132 § 6(c).'' (The AGs of TN, AL, *et al.,* No. 68 at p. 3) Further, the AGs of TN, *et al.,* argue that section 6(b) of E.O. 13132 applies because states are purchasers of refrigerators, refrigerator-freezers, and freezers; therefore, reliance interests are implicated and subject the states to substantial direct compliance costs. (*Id.* at 2–3)

DOE reiterates that this direct final rule does not have significant federalism implications. DOE has examined this rule and has 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 expressly prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of this direct final 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.

Even if DOE were to find otherwise, with regards to the AGs of TN, AL *et al.'s* arguments regarding section 6(c) of E.O. 13132, DOE notes that the AGs of TN, AL *et al.* do not provide any examples of a state procurement rule that conflicts with the standards adopted in this rulemaking and DOE is not aware of any such conflicts. While it is possible that a State may have to revise its procurement standards to reflect the new standards, States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. Absent such information, DOE concludes that no further action would be required by E.O. 13132 even if the Executive order were applicable here. Moreover, assuming the hypothetical preemption alleged by the AGs of TN, AL *et al.* were to present itself, DOE notes that, like all interested parties, states were presented with an opportunity to engage in the rulemaking process early in the development of the proposed rule. Prior to publishing the proposed rulemaking, on November 15, 2019, DOE published and sought public comment on 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''). DOE then published a notice of public meeting and availability of the preliminary TSD on October 15, 2021, and sought public comment again. (''October 2021 Preliminary Analysis''). 86 FR 57378. DOE then held a public meeting on December 1, 2021, to discuss and receive comments on the preliminary TSD, which was open to the public, including state agencies. As such, states were provided the opportunity for meaningful and substantial input as envisioned by the Executive order.

With regards to the AGs of TN, AL *et al.'s* arguments regarding section 6(b) of E.O. 13132, the potential effect alleged by the AGs of TN, AL, *et al.* is the same effect experienced by all refrigerator consumers—models manufactured after a specific date must meet revised efficiency standards. This impact does not constitute a ''substantial'' impact as required by the Executive order. Further, contrary to the assertions of the AGs of TN *et al.,* the direct final rule is required by law. As noted previously, where DOE determines that a proposed amended standard is designed to achieve the maximum improvement in energy efficiency and is both technologically feasible and economically justified, it must adopt it. Therefore, section 6(b) is inapplicable. E.O. 13132, section6(b) (applicable to regulation ''that is not required by statute'').

*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 E.O. 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 direct final rule meets the relevant standards of E.O. 12988.

*G. Review Under the Unfunded Mandates Reform Act of 1995*

Title II of the Unfunded Mandates Reform Act of 1995 (''UMRA'') requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Public Law 104–4, sec. 201 (codified at 2 U.S.C. 1531). For a 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 ''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.*

DOE has concluded that this direct final rule may require expenditures of $100 million or more in any one year by the private sector. Such expenditures may include (1) investment in research and development and in capital expenditures by consumer refrigerators, refrigerator-freezers, and freezers manufacturers in the years between the direct final rule and the compliance date for the new standards and (2) incremental additional expenditures by consumers to purchase higher-efficiency consumer 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 direct final 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 document and the TSD for this direct final rule respond to those requirements.

Under section 205 of UMRA, DOE 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 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 direct final rule establishes amended energy conservation standards for consumer 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 sections 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 direct final rule.

*H. Review Under Executive Order 12630*

Pursuant to E.O. 12630, ''Governmental Actions and Interference with Constitutionally Protected Property Rights,'' 53 FR 8859 (March 18, 1988), DOE has determined that this rule would not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution.

*I. 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 direct final rule under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

*J. 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 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 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 concluded that this regulatory action, which sets forth amended energy conservation standards for consumer refrigerators, refrigerator-freezers, and freezers, is not a significant energy action because the 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 direct final rule.

*K. 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 prepared a report describing that peer review.[111] 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 DOE's analyses. DOE is in the process of evaluating the resulting report.[112]

*L. Congressional Notification*

As required by 5 U.S.C. 801, DOE will report to Congress on the promulgation of this rule prior to its effective date. The report will state that the Office of Information and Regulatory Affairs has determined that this action meets the criteria set forth in 5 U.S.C. 804(2).

*M. Materials Incorporated by Reference*

The following standards appear in the amendatory text of this document and were previously approved for the locations in which they appear: AS/NZS 4474.1:2007; HRF–1–2019.

## VII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this direct final rule.

### List of Subjects in 10 CFR Part 430

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, Imports, Incorporation by reference, Intergovernmental relations, Reporting and recordkeeping requirements, Small businesses.

### Signing Authority

This document of the Department of Energy was signed on December 28, 2023, by Jeffrey Marootian, Principal Deputy 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 December 29, 2023.

**Treena V. Garrett,**

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

For the reasons set forth in the preamble, DOE amends 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 1:

■ i. In paragraph (b)(i), removing the text ''5.3(e)'' and adding in its place the text ''5.5''; and

■ ii. Removing the undesignated paragraph immediately following paragraph (b)(ii);

■ b. In section 3, adding in alphabetical order definitions for ''Door-in-door'' and ''Transparent door'';

■ c. In section 5.3:

■ i. Removing paragraphs (a) and (f); and

■ ii. Redesignating paragraphs (b) through (e) as paragraphs (a) through (d); and

■ d. Adding 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

[111] 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 2, 2023).

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

compartment to which the door-in-door provides access.

* * * * *

*Transparent door* means an external fresh food compartment door which meets the following criteria:

(a) The area of the transparent portion of the door is at least 40 percent of the area of the door.

(b) The area of the door is at least 50 percent of the sum of the areas of all the external doors providing access to the fresh food compartments and cooler compartments.

(c) For the purposes of this evaluation, the area of a door is determined as the product of the maximum height and maximum width dimensions of the door, not considering potential extension of flaps used to provide a seal to adjacent doors.

* * * * *

5. * * *

5.4. *Icemaker Energy Use*

(a) For refrigerators and refrigerator-freezers: To demonstrate compliance with the energy conservation standards at § 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.

(b) For miscellaneous refrigeration products: To demonstrate compliance with the energy conservation standards at § 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 section 5.4.

The addition reads as follows:

## Appendix B to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Freezers

* * * * *

5. * * *

5.4. *Icemaker Energy Use*

For freezers: To demonstrate compliance with the energy conservation standards at § 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:

■ a. Redesignating table 3 to paragraph (b) and table 4 to paragraph (b)(2) as table 6 to paragraph (b)(1) and table 7 to paragraph (b)(2); and

■ b. Revising paragraph (a).

The revision reads as follows:

### § 430.32 Energy and water conservation standards and their compliance dates.

* * * * *

(a) *Refrigerators/refrigerator-freezers/freezers.* The standards in this paragraph (a) 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.

(1) The following standards apply to products manufactured on or before September 15, 2014, and before the 2029/2030 compliance dates depending on product class (see paragraphs (a)(2) and (3) of this section).

TABLE 1 TO PARAGRAPH (a)(1)

| 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. |

TABLE 1 TO PARAGRAPH (a)(1)—Continued

| Product class | Equations for maximum energy use (kWh/yr) | |
|---|---|---|
| | Based on AV ($ft^3$) | Based on av (L) |
| 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 to subpart B of this part.
av = Total adjusted volume, expressed in Liters.

(2) The following standards apply to products manufactured on or after January 31, 2029.

TABLE 2 TO PARAGRAPH (a)(2)

| Product class | Equations for maximum energy use (kWh/yr) | |
|---|---|---|
| | Based on AV ($ft^3$) | Based on av (L) |
| 3–BI. Built-in refrigerator-freezer—automatic defrost with top-mounted freezer | 8.24AV + 238.4 + 28I | 0.291av + 238.4 + 28I. |
| 3A–BI. Built-in All-refrigerators—automatic defrost | (7.22AV + 205.7)*K3ABI | (0.255av + 205.7)*K3ABI. |
| 4–BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer. | (8.79AV + 307.4)*K4BI + 28I | (0.310av + 307.4)*K4BI + 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. |

TABLE 2 TO PARAGRAPH (a)(2)—Continued

| Product class | Equations for maximum energy use (kWh/yr) | |
|---|---|---|
| | Based on AV ($ft^3$) | Based on av (L) |
| 5A. Refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service. | (7.76AV + 351.9)*K5A | (0.274av + 351.9)*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. |
| 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–BI. Built-In Upright freezers with automatic defrost | (9.37AV + 247.9)*K9BI + 28I | (0.331av + 247.9)*K9BI + 28I. |
| 9A–BI. Built-In Upright freezers with automatic defrost with through-the-door ice service. | 9.86AV + 288.9 | 0.348av + 288.9. |
| 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. | 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 | (5.32AV + 302.2)*K12 | (0.188av + 302.2)*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 to 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.,* K3ABI) are as defined in the following table.

TABLE 3 TO PARAGRAPH (a)(2)

| 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 |
|---|---|---|---|
| K3ABI | 1.10 | 1.0 | 1.0. |
| K4BI | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 2). |
| K5BI | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 2). |
| K5A | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 3). |
| K5ABI | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 3). |
| K7BI | 1.10 | 1.06 | 1 + 0.02 * ($N_d$ − 2). |
| K9BI | 1.0 | 1.0 | 1 + 0.02 * ($N_d$ − 1). |
| K12 | 1.0 | 1.0 | 1 + 0.02 * ($N_d$ − 1). |
| K13A | 1.10 | 1.0 | 1.0 |

**Notes:**
[1] $N_d$ is the number of external doors.
[2] The maximum $N_d$ values are 2 for K12, 3 for K9BI, and 5 for all other K values.

(3) The following standards apply to products manufactured on or after January 31, 2030.

TABLE 4 TO PARAGRAPH (a)(3)

| 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. |

TABLE 4 TO PARAGRAPH (a)(3)—Continued

| Product class | Equations for maximum energy use (kWh/yr) | |
|---|---|---|
| | Based on AV ($ft^3$) | Based on av (L) |
| 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. |
| 3A. All-refrigerators—automatic defrost | (6.01AV + 171.4)*K3A | (0.212av + 171.4)*K3A. |
| 4. Refrigerator-freezers—automatic defrost with side-mounted freezer | (7.28AV + 254.9)*K4 + 28I | (0.257av + 254.9)*K4 + 28I. |
| 5. Refrigerator-freezers—automatic defrost with bottom-mounted freezer | (7.61AV + 272.6)*K5 + 28I | (0.269av + 272.6)*K5 + 28I. |
| 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. | (7.31AV + 322.5)*K7 | (0.258av + 322.5)*K7. |
| 9. Upright freezers with automatic defrost | (7.33AV + 194.1)*K9 + 28I | (0.259av + 194.1)*K9 + 28I. |

AV = Total adjusted volume, expressed in $ft^3$, as determined in appendices A and B to subpart B of this part.
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 following table.

TABLE 5 TO PARAGRAPH (a)(3)

| 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 | 1.0 | 1.0 | $1 + 0.02 * (N_d - 1)$. |
| K3A | 1.10 | 1.0 | 1.0. |
| K4 | 1.10 | 1.06 | $1 + 0.02 * (N_d - 2)$. |
| K5 | 1.10 | 1.06 | $1 + 0.02 * (N_d - 2)$. |
| K7 | 1.10 | 1.06 | $1 + 0.02 * (N_d - 2)$. |
| K9 | 1.0 | 1.0 | $1 + 0.02 * (N_d - 1)$. |

**Notes:**
[1] $N_d$ is the number of external doors.
[2] The maximum $N_d$ values are 2 for K2, and 5 for all other K values.

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