DEPARTMENT OF ENERGY

10 CFR Part 430

[EERE–2021–BT–STD–0035]

RIN 1904–AF46

Energy Conservation Program: Energy Conservation Standards for Air Cleaners; Final Rule

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''), authorizes the Secretary of Energy to classify additional types of consumer products as covered products upon determining that: classifying the product as a covered product is necessary for the purposes of EPCA; and the average annual per-household energy use by products of such type is likely to exceed 100 kilowatt-hours per year (''kWh/yr''). In a final determination published on July 15, 2022, DOE determined that classifying air cleaners as a covered product is necessary or appropriate to carry out the purposes of EPCA, and that the average U.S. household energy use for air cleaners is likely to exceed 100 kWh/yr. In this direct final rule, DOE is establishing energy conservation standards for air cleaners. DOE has determined that energy conservation standards for these products will result in significant conservation of energy, and are technologically feasible and economically justified.

DATES: The effective date of this rule is August 9, 2023, unless adverse comment is received by July 31, 2023. If adverse comments are received that DOE determines may provide a reasonable basis for withdrawal of the direct final rule, a timely withdrawal of this rule will be published in the **Federal Register**. If no such adverse comments are received, compliance with the standards established for air cleaners in this direct final rule is required on and after December 31, 2023.

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-2021-BT-STD-0035.* 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.*

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SUPPLEMENTARY INFORMATION:

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I. Synopsis of the Direct Final Rule

On July 15, 2022, DOE published a final determination (''July 2022 Final Determination'') in which it determined that air cleaners qualify as a ''covered product'' under the Energy Policy and Conservation Act, as amended (''EPCA'').[1] 87 FR 42297. DOE determined in the July 2022 Final Determination that coverage of air cleaners is necessary or appropriate to carry out the purposes of EPCA, and that the average U.S. household energy use for air cleaners is likely to exceed 100 kWh/yr. *Id.* Currently, no energy conservation standards are prescribed by DOE for air cleaners.

Pursuant to EPCA, any new or amended energy conservation standard must be designed to achieve the maximum improvement in energy efficiency that DOE determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) Furthermore, the new or amended standard must result in significant conservation of energy. (42 U.S.C. 6295(o)(3)(B))

As previously mentioned, and under the authority provided by 42 U.S.C. 6295(p)(4), DOE is issuing this direct final rule establishing energy conservation standards for air cleaners. These standard levels were submitted jointly to DOE on August 23, 2022, by groups representing manufacturers, energy and environmental advocates, and consumer groups, hereinafter referred to as ''the Joint Stakeholders.''[2] This collective set of comments, titled ''Joint Statement of Joint Stakeholder Proposal On Recommended Energy Conservation Standards And Test Procedure For Consumer Room Air Cleaners'' (the ''Joint Proposal''),[3] recommends specific energy conservation standards for air cleaners that, in the commenters' view, would satisfy the EPCA requirements in 42 U.S.C. 6295(o). See sections II.B.3 and II.B.2 of this document for a detailed discussion of the Joint Proposal and history of the current rulemaking, respectively.

After carefully considering the Joint Proposal, DOE determined that the recommendations contained therein are compliant with 42 U.S.C. 6295(o), as required by 42 U.S.C. 6295(p)(4)(A)(i) for the issuance of a direct final rule. As required by 42 U.S.C. 6295(p)(4)(A)(i), DOE is simultaneously publishing, elsewhere in this issue of the **Federal Register**, a notice of proposed rulemaking (''NOPR'') proposing that the identical standard levels contained in this direct final rule be adopted. 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), DOE will 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.

This direct final rule documents DOE's analyses to objectively and independently evaluate the energy savings potential, technological feasibility, and economic justification of the standard levels recommended in the Joint Proposal, as per the requirements of 42 U.S.C. 6295(o).

Ultimately, DOE found that the standard levels recommended in the Joint Proposal would result in significant energy savings and are technologically feasible and economically justified. Table I.1 documents the standards for air cleaners. The standards correspond to the recommended trial standard level (''TSL'') 3 (as described in section V.A of this document) and are expressed as an integrated energy factor (''IEF'') in terms of $PM_{2.5}$[4] clean air delivery rate per watt (''$PM_{2.5}$ CADR/W''), based on the product's $PM_{2.5}$ CADR. The standards are the same as those recommended by the Joint Stakeholders, which consist of two-tiered (Tier 1 and Tier 2) standard levels. These standards apply to all products listed in Table I.1 and manufactured in, or imported into, the United States starting on December 31, 2023, for Tier 1 standards and on December 31, 2025, for Tier 2 standards.

[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] The Joint Stakeholders include the Association of Home Appliance Manufacturers (''AHAM''), Appliance Standards Awareness Project (''ASAP''), American Council for an Energy-Efficient Economy (''ACEEE''), Consumer Federation of America (''CFA''), Natural Resources Defense Council (''NRDC''), the New York State Energy Research and Development Authority (''NYSERDA''), and the Pacific Gas and Electric Company (''PG&E''). AHAM is representing the companies who manufacture consumer room air cleaners and are members of the Portable Appliance Division (DOE has included names of all manufacturers listed in the footnote on page 1 of the Joint Proposal and the signatories listed on pages 13–14): 3M Co.; Access Business Group, LLC; ACCO Brands Corporation; Air King, Air King Ventilation Products; Airgle Corporation; Alticor, Inc.; Beijing Smartmi Electronic Technology Co., Ltd.; BISSELL Inc.; Blueair Inc.; BSH Home Appliances Corporation; De'Longhi America, Inc.; Dyson Limited; Essick Air Products; Fellowes Inc.; Field Controls; Foxconn Technology Group; GE Appliances, a Haier company; Gree Electric Appliances Inc.; Groupe SEB; Guardian Technologies, LLC; Haier Smart Home Co., Ltd.; Helen of Troy-Health & Home; iRobot; Lasko Products, Inc.; Molekule Inc.; Newell Brands Inc.; Oransi LLC; Phillips Domestic Appliances NA Corporation; SharkNinja Operating, LLC; Sharp Electronics Corporation; Sharp Electronics of Canada Ltd.; Sunbeam Products, Inc.; Trovac Industries Ltd; Vornado Air LLC; Whirlpool Corporation; Winix Inc.; and Zojirushi America Corporation.

[3] DOE Docket No. EERE–2021–BT–STD–0035–0016.

[4] Section 2.8 of the industry standard AHAM AC–7–2022 defines $PM_{2.5}$ as particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers as measured by a reference method based on 40 CFR part 50, appendix I, and designated in accordance with 40 CFR part 53 or by an equivalent method designated in accordance with 40 CFR part 53.

TABLE I.1—ENERGY CONSERVATION STANDARDS FOR AIR CLEANERS
[Compliance starting December 31, 2023]

Product class	IEF ($PM_{2.5}$ CADR/W) [5]	
	Tier 1 December 31, 2023	Tier 2 December 31, 2025
PC1: 10 ≤ $PM_{2.5}$ CADR < 100	1.7	1.9
PC2: 100 ≤ $PM_{2.5}$ CADR < 150	1.9	2.4
PC3: $PM_{2.5}$ CADR ≥ 150	2.0	2.9

A. Benefits and Costs to Consumers

Table I.2 summarizes DOE's evaluation of the economic impacts of the adopted standards on consumers of air cleaners, as measured by the average life-cycle cost (''LCC'') savings and the simple payback period (''PBP'').[6] The average LCC savings are positive for all product classes, and the PBP is less than the average lifetime of air cleaners, which is estimated to be 9.0 years (see section IV.F of this document).

TABLE I.2—IMPACTS OF ADOPTED ENERGY CONSERVATION STANDARDS ON CONSUMERS OF AIR CLEANERS

Air cleaners class	Tier	Average LCC savings (2021$)	Simple payback period (years)
Product Class 1: 10–100 $PM_{2.5}$ CADR	Tier 1	$18	0.9
	Tier 2	12	1.4
Product Class 2: 100–150 $PM_{2.5}$ CADR	Tier 1	38	0.4
	Tier 2	50	0.5
Product Class 3: 150+ $PM_{2.5}$ CADR	Tier 1	105	0.1
	Tier 2	94	0.1

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

The industry net present value (''INPV'') is the sum of the discounted cash flows to the industry from the base year through the end of the analysis period (2023–2057). Using a real discount rate of 6.6 percent, DOE estimates that the INPV for manufacturers of air cleaners in the case without new standards is $1,565.9 million in 2021$. Under the adopted standards, DOE estimates the change in INPV to range from −4.3 percent to −2.6 percent, which is approximately −$66.7 million to −$40.7 million. In order to bring products into compliance with standards, it is estimated that industry will incur total conversion costs of $57.3 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 [7]

DOE's analyses indicate that the adopted energy conservation standards for air cleaners would save a significant amount of energy. Relative to the case without standards, the lifetime energy savings for air cleaners purchased in the analysis period that begins in the anticipated year of compliance with the standards (2024–2057), amount to 1.80 quadrillion British thermal units (''Btu''), or quads.[8] This represents a cumulative savings of 27 percent relative to the energy use of these products in the case without standards (referred to as the ''no-new-standards case'').

The cumulative net present value (''NPV'') of total consumer benefits of the standards for air cleaners ranges from $5.8 billion (at a 7-percent discount rate) to $13.7 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 air cleaners purchased in 2024–2057.

In addition, the adopted standards for air cleaners 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 57.7 million metric tons (''Mt'') [9] of carbon dioxide (''CO_2''), 24.2 thousand tons of sulfur dioxide (''SO_2''), 91.2 thousand tons of nitrogen oxides (''NO_X''), 411.4 thousand tons of methane (''CH_4''), 0.6 thousand tons of nitrous oxide (''N_2O''), and 0.2 tons of mercury (''Hg'').[10] The estimated cumulative reduction in CO_2 emissions through 2030 amounts to 2.5 million Mt, which is equivalent to the emissions

[5] These values from the Joint Proposal are rounded according to the sampling plan in 10 CFR 429.68. The rounding has no functional impact on the standards as compared to the levels in the Joint Proposal.

[6] The average LCC savings refer to consumers that are affected by a standard and are measured relative to the efficiency distribution in the no-new-standards case, which depicts the market in the compliance year in the absence of new or amended standards (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).

[7] All monetary values in this document are expressed in 2021 dollars. and, where appropriate, are discounted to 2022 unless explicitly stated otherwise.

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

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

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

resulting from the annual electricity use of almost 500 thousand homes.

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'').[11] DOE used interim SC–GHG values developed by an Interagency Working Group on the Social Cost of Greenhouse Gases (''IWG'').[12] The derivation of these values is discussed in section IV.L of this document. For presentational purposes, the climate benefits associated with the average SC–GHG at a 3-percent discount rate are estimated to be $2.8 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 $1.8 billion using a 7-percent discount rate, and $4.7 billion using a 3-percent discount rate.[13] DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions.

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

TABLE I.3—SUMMARY OF ECONOMIC BENEFITS AND COSTS OF ADOPTED ENERGY CONSERVATION STANDARDS FOR AIR CLEANERS

	Billion ($2021)
3% discount rate	
Consumer Operating Cost Savings	14.1
Climate Benefits *	2.8
Health Benefits **	4.7
Total Benefits †	21.6
Consumer Incremental Product Costs	0.5
Net Benefits	21.1
7% discount rate	
Consumer Operating Cost Savings	6.0
Climate Benefits * (3% discount rate)	2.8
Health Benefits **	1.8
Total Benefits †	10.6
Consumer Incremental Product Costs	0.2
Net Benefits	10.3

Note: This table presents the costs and benefits associated with product name shipped in 2024–2057. These results include benefits to consumers which accrue after 2057 from the products shipped in 2024–2057.

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

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

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

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

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

[13] 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 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.[14]

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 air cleaners shipped in 2024–2057. The benefits associated with reduced emissions achieved as a result of the adopted standards are also calculated based on the lifetime of air cleaners shipped in 2024–2057. DOE notes that DOE used its typical analytical time horizon of 30-years and then added 4 additional years to reflect the early compliance dates that are part of the standard level being adopted in this final rule. 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 V.C.2 of this document.

Table I.4 presents the total estimated monetized benefits and costs associated with the 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 $19.8 million per year in increased equipment costs, while the estimated annual benefits are $499 million in reduced equipment operating costs, $136 million in climate benefits, and $149 million in health benefits. In this case, the net benefit would amount to $764 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the standards is $23.4 million per year in increased equipment costs, while the estimated annual benefits are $690 million in reduced operating costs, $136 million in climate benefits, and $228 million in health benefits. In this case, the net benefit would amount to $1,030 million per year.

TABLE I.4—ANNUALIZED BENEFITS AND COSTS OF ADOPTED STANDARDS FOR AIR CLEANERS

	Million (2021$/year)		
	Primary estimate	Low-net-benefits estimate	High-net-benefits estimate
3% discount rate			
Consumer Operating Cost Savings	689.7	623.7	773.4
Climate Benefits *	135.6	124.2	149.9
Health Benefits **	228.4	210.1	251.0
Total Benefits †	1,053.6	958.1	1,174.2
Consumer Incremental Product Costs ‡	23.4	22.8	24.7
Net Benefits	1,030.2	935.3	1,149.5
7% discount rate			
Consumer Operating Cost Savings	498.8	459.8	546.9
Climate Benefits * (3% discount rate)	135.6	124.2	149.9
Health Benefits **	149.3	139.7	160.9
Total Benefits †	783.7	723.7	857.7
Consumer Incremental Product Costs ‡	19.8	19.3	20.7
Net Benefits	763.9	704.4	837.0

Note: This table presents the costs and benefits associated with air cleaners shipped in 2024–2057. These results include benefits to consumers which accrue after 2057 from the products shipped in 2024–2057. The Primary, Low Net Benefits, and High Net Benefits Estimates utilize projections of energy prices from the AEO2022 Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental equipment costs reflect a medium decline rate in the Primary Estimate, a low decline rate in the Low Net Benefits Estimate, and a high decline rate in the High Net Benefits Estimate. The methods used to derive projected price trends are explained in section IV.F.1 of this document. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

* Climate benefits are calculated using four different estimates of the global SC–GHG (see section IV.L of this document). For presentational purposes of this table, the climate benefits associated with the average SC–GHG at a 3-percent discount rate are shown, but the Department does not have a single central SC–GHG point estimate, and it emphasizes the importance and value of considering the benefits calculated using all four sets of SC–GHG estimates. To monetize the benefits of reducing greenhouse gas emissions this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990* published in February 2021 by the Interagency Working Group on the Social Cost of Greenhouse Gases (IWG).

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

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

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

[14] To convert the time-series of costs and benefits into annualized values, DOE calculated a present value in 2021, the year used for discounting the NPV of total consumer costs and savings. For the benefits, DOE calculated a present value associated with each year's shipments in the year in which the shipments occur (*e.g.,* 2020 or 2030), and then discounted the present value from each year to 2021. 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.

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 Proposal containing recommendations with respect to energy conservation standards for air cleaners 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 analysis 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 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. Namely, the Secretary has 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 outweighing 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 air cleaners is $19.8 million per year in increased product costs, while the estimated annual benefits are $499 million in reduced product operating costs, $136 million in climate benefits, and $149 million in health benefits. The net benefit amounts to $764 million per year.

The significance of energy savings offered by a new or amended energy conservation standard cannot be determined without knowledge of the specific circumstances surrounding a given rulemaking.[15] 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 1.80 quads FFC, the equivalent of the primary annual energy use of 19 million homes. The NPV of consumer benefit for these projected energy savings is $5.8 billion using a discount rate of 7 percent, and $13.7 billion using a discount rate of 3 percent. The cumulative emissions reductions associated with these energy savings are 57.7 Mt of CO_2, 24.2 thousand tons of SO_2, 91.2 thousand tons of NO_X, 0.2 tons of Hg, 411.4 thousand tons of CH_4, 0.6 thousand tons of N_2O. The estimated monetary value of the climate benefit from reduced GHG emissions (associated with the average SC–GHG at a 3-percent discount rate) is $2.8 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions is $1.8 billion using a 7 percent discount rate and $4.7 billion using a 3 percent discount rate. As such, 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 technical support document (''TSD'').

Under the authority provided by 42 U.S.C. 6295(p)(4), DOE is issuing this direct final rule establishing the energy conservation standards for air cleaners. Consistent with this authority, DOE is also publishing elsewhere in this issue of the **Federal Register** a notice of proposed rulemaking 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 air cleaners.

A. Authority

EPCA grants DOE authority to prescribe an energy conservation standard for any type (or class) of covered products of a type specified in 42 U.S.C. 6292(a)(20) if the requirements of 42 U.S.C. 6295(o) and 42 U.S.C. 6295(p) are met and the Secretary determines that—

(A) the average per household energy use within the United States by products of such type (or class) exceeded 150 kWh (or its Btu equivalent) for any 12-month period ending before such determination;

(B) the aggregate household energy use within the United States by products of such type (or class) exceeded 4,200,000,000 kWh (or its Btu equivalent) for any such 12-month period;

(C) substantial improvement in the energy efficiency of products of such type (or class) is technologically feasible; and

(D) the application of a labeling rule under 42 U.S.C. 6294 to such type (or class) is not likely to be sufficient to induce manufacturers to produce, and consumers and other persons to purchase, covered products of such type (or class) which achieve the maximum energy efficiency which is technologically feasible and economically justified. (42 U.S.C. 6295(*l*)(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 the 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(r)) Manufacturers of covered products must use the prescribed DOE test procedure as the basis for certifying to DOE that their products comply with the applicable energy conservation standards adopted

[15] 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).

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 air cleaners appear at title 10 of the Code of Federal Regulations (''CFR'') part 430, subpart B, appendix FF (''appendix FF'').

DOE must follow specific statutory criteria for prescribing new or amended standards for covered products, including air cleaners. Any new or amended standard for a covered product must be designed to achieve the maximum improvement in energy efficiency that the Secretary of Energy determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A) and 42 U.S.C. 6295(o)(3)(B)) Furthermore, DOE may not adopt any standard that would not result in the significant conservation of energy. (42 U.S.C. 6295(o)(3)) Moreover, DOE may not prescribe a standard (1) for certain products, including air cleaners, 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))

Additionally, EPCA specifies requirements when promulgating an energy conservation standard for a covered product that has two or more subcategories. DOE must specify a different standard level for a type or class of 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 must 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, any final rule for new or amended energy conservation standards promulgated after July 1, 2010, is required to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) Specifically, when DOE adopts a standard for a covered product after that date, it must, if justified by the criteria for adoption of standards under EPCA (42 U.S.C. 6295(o)), incorporate standby mode and off mode energy use into a single standard, or, if that is not feasible, adopt a separate standard for such energy use for that product. (42 U.S.C. 6295(gg)(3)(A)–(B)) DOE's current test procedures for air cleaners address standby mode and off mode energy use, through the IEF metric. As IEF includes annual energy consumption in standby mode and off mode as part of the annual energy consumption metric and DOE is adopting standards for air cleaners based on IEF the standards in this direct final rule account for standby mode and off mode energy use of an air cleaner.

Finally, EISA 2007 amended EPCA, in relevant part, to grant DOE authority to issue a final rule (hereinafter referred to as a ''direct final rule'') establishing an energy conservation standard on 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 that are in accordance with the requirements in 42 U.S.C. 6295(o). (42 U.S.C. 6295(p)(4))

A NOPR that proposes an identical energy efficiency standard must be published simultaneously with the direct final rule, and DOE must provide a public comment period of at least 110 days on the proposal. (42 U.S.C. 6295(p)(4)(A)–(B)) 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. 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.* After withdrawing a direct final rule, DOE must proceed with the notice of proposed rulemaking published simultaneously with the direct final rule and publish in the **Federal Register** the reasons why the direct final rule was withdrawn. *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 explained that, because the direct final rule authority does not refer to any of the other requirements in EPCA, DOE interprets that provision as not subject to any of those other requirements. 86 FR 70892, 70912 (Dec. 13, 2021). Rather, DOE's authority under 42 U.S.C. 6295(p)(4) is constrained only by the requirements of 42 U.S.C. 6295(o). DOE's overarching statutory mandate in issuing energy conservation standards is to choose 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.*

B. Background

1. Current Standards

Air cleaners are not currently subject to federal energy conservation standards. However, some states have adopted standards. Specifically, the District of Columbia adopted standards in 2020, Maryland adopted standards in 2022, and Nevada and New Jersey adopted standards in 2021, as shown in Table II.1. The District of Columbia and New Jersey State standards went into effect in 2022, while the Nevada State standard is expected to go into effect in 2023 and the Maryland State standard is expected to go into effect in 2024.

TABLE II.1—AIR CLEANER STANDARDS ADOPTED BY THE DISTRICT OF COLUMBIA AND THE STATES OF MARYLAND, NEVADA, AND NEW JERSEY

Smoke CADR bins	Minimum smoke CADR/W
$30 \leq PM_{2.5}$ CADR < 100	1.7
$100 \leq PM_{2.5}$ CADR < 150	1.9
$PM_{2.5}$ CADR $\geq$ 150	2.0

Note: These standards are based on smoke clean air delivery rate (''CADR'') divided by the active mode power consumption in watts (''W''), which is different from the IEF metric specified in appendix FF.

Washington State adopted the standards shown in Table II.2 in 2022 with an effective date in 2024.

TABLE II.2—AIR CLEANER STANDARDS ADOPTED BY WASHINGTON STATE

Smoke CADR Bins	Minimum smoke CADR/W
$30 \leq PM_{2.5}$ CADR < 100	1.9
$100 \leq PM_{2.5}$ CADR < 150	2.4
$PM_{2.5}$ CADR $\geq$ 150	2.9

Note: These standards are based on smoke CADR divided by the active mode power consumption in W, which is different from the IEF metric specified in appendix FF.

2. History of Standards Rulemaking for Air Cleaners

DOE has not previously conducted an energy conservation standards rulemaking for air cleaners. On January 25, 2022, DOE published a request for information (''January 2022 RFI''), seeking comments on potential test procedure and energy conservation standards for air cleaners. 87 FR 3702. In the January 2022 RFI, DOE requested information to aid in the development of the technical and economic analyses to support energy conservation standards for air cleaners, should they be warranted. 87 FR 3702, 3705.

DOE determined in the July 2022 Final Determination that coverage of air cleaners is necessary or appropriate to carry out the purposes of EPCA; the average U.S. household energy use for air cleaners is likely to exceed 100 kWh/yr; and thus, air cleaners qualify as a ''covered product'' under EPCA. 87 FR 42297.

On March 6, 2023, DOE published a final rule (''March 2023 TP Final Rule'') establishing a new test procedure (TP) at appendix FF for air cleaners that references the industry standard, Association of Home Appliance Manufacturers (''AHAM'') AC–7–2022, ''Energy Test Method for Consumer Room Air Cleaners'' and includes methods to (1) measure the performance of the covered product and (2) use the measured results to calculate an IEF to represent the energy efficiency of air cleaners. 88 FR 14014.

DOE received comments in response to the January 2022 RFI from the interested parties listed in Table II.4.

TABLE II.4—LIST OF COMMENTERS WITH WRITTEN SUBMISSIONS IN RESPONSE TO THE JANUARY 2022 RFI

Commenter(s)	Abbreviation	Docket No.	Commenter type
ACEEE, ASAP, AHAM, CFA, and NRDC	Joint Commenters	8	Efficiency Organizations and Trade Association.
Blueair IAQ	Blueair	10	Manufacturer.
Electrolux Home Products Inc. North America	Electrolux	6	Manufacturer.
Daikin U.S. Corporation	Daikin	12	Manufacturer.
Lennox International Inc	Lennox	7	Manufacturer.
Madison Indoor Air Quality	MIAQ	5	Manufacturer.
Molekule	Molekule	11	Manufacturer.
Northwest Energy Efficiency Alliance	NEEA	13	Efficiency Organization.
Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison; collectively, the California Investor-Owned Utilities.	CA IOUs	9	Utilities.
Synexis LLC	Synexis	14	Manufacturer.
Trane Technologies	Trane	3	Manufacturer.
Air-Conditioning, Heating, & Refrigeration Institute	AHRI	15	Trade Association.

A parenthetical reference at the end of a comment quotation or paraphrase provides the location of the item in the public record.[16] In response to the January 2022 RFI, DOE received certain

[16] The parenthetical reference provides a reference for information located in the docket of DOE's rulemaking to determine coverage for air cleaners. (Docket No. EERE–2021–BT–DET–0022, which is maintained at *www.regulations.gov*). The references are arranged as follows: (commenter name, comment docket ID number, page of that document). When referring to comments received on another docket, the docket number is included prior to the commenter's name.

comments pertaining to the scope of coverage and definition for air cleaners, which DOE addressed and discussed in the July 2022 Final Determination. Additionally, DOE addressed comments pertaining to the test procedure in a NOPR published on October 18, 2022 as part of the test procedure rulemaking establishing appendix FF. 87 FR 63324. All remaining comments provided by stakeholders in response to the January 2022 RFI are addressed in this direct final rule.

3. Joint Proposal Submitted by the Joint Stakeholders

This section summarizes the recommendations included in the Joint Proposal submitted by the Joint Stakeholders. The Joint Proposal submitted by the Joint Stakeholders urged DOE to publish final rules adopting the consumer room air cleaner test procedure and standards and compliance dates contained in the Joint Proposal, as soon as possible, but not later than December 31, 2022. (Joint Stakeholders, No. 16 at p. 1) The Joint Proposal also recommended that DOE adopt AHAM AC–7–2022 as the DOE test procedure. (*Id.* at p. 6) In regards to energy conservation standards, the Joint Proposal specified two-tiered Tier 1 and Tier 2 standard levels, as shown in Table II.5, for conventional room air cleaners with proposed compliance dates of December 31, 2023, and December 31, 2025, respectively. (*Id.* at p. 9)

TABLE II.5—TIER 1 AND TIER 2 STANDARDS PROPOSED BY THE JOINT STAKEHOLDERS IN THE JOINT PROPOSAL

Product description	IEF ($PM_{2.5}$ CADR/W) Tier 1 *	IEF ($PM_{2.5}$ CADR/W) Tier 2 **
$10 \le PM_{2.5}$ CADR < 100	1.69	1.89
$100 \le PM_{2.5}$ CADR < 150	1.90	2.39
$PM_{2.5}$ CADR ≥ 150	2.01	2.91

* Tier 1 standards would have an effective date of December 31, 2023.
** Tier 2 standards would have an effective date of December 31, 2025.

The Tier 1 standards are equivalent to the state standards established by the States of Maryland, Nevada, and New Jersey, and the District of Columbia. (*Id.* at p. 9) Tier 2 standards are equivalent to the voluntary standards specified in the U.S. Environmental Protection Agency's (''EPA's'') ENERGY STAR Version 2.0 Room Air Cleaners Specification, Rev. May 2022, (''ENERGY STAR V. 2.0'') and those adopted by the State of Washington. (*Id.*) While the standards established by the States and those specified in ENERGY STAR V. 2.0 are based on smoke CADR and include only active mode energy consumption in the calculation of the CADR/W metric, the Joint Stakeholders presented data to show that there is a strong relationship between the $PM_{2.5}$ CADR calculation and the measured smoke and dust CADR values. (*Id.* at p. 6) Additionally, DOE compared the IEF metric, calculated using $PM_{2.5}$ CADR and annual energy consumption in active mode and standby mode (''AEC''), to the smoke CADR/W metric, calculated using smoke CADR and active mode power consumption, using the ENERGY STAR database,[17] and found a strong relationship between IEF and the CADR/W metric specified in ENERGY STAR V. 2.0 and the State standards. The Joint Stakeholders stated that the Tier 1 and Tier 2 standards are estimated to save 1.9 quads of FFC energy nationally over 30 years of sales. (*Id.* at p. 9)

After carefully considering the consensus recommendations for establishing energy conservation standards for air cleaners submitted by the Joint Stakeholders, DOE has determined that these recommendations are in accordance with the statutory requirements of 42 U.S.C. 6295(p)(4) for the issuance of a direct final rule.

More specifically, these recommendations comprise a statement submitted by interested persons who are fairly representative of relevant points of view on this matter. In appendix A to subpart C of 10 CFR part 430 (''appendix A''), DOE explained that to be ''fairly representative of relevant points of view,'' the group submitting a joint statement must, where appropriate, include larger concerns and small business in the regulated industry/manufacturer community, energy advocates, energy utilities, consumers, and States. However, it will be necessary to evaluate the meaning of ''fairly representative'' on a case-by-case basis, subject to the circumstances of a particular rulemaking, to determine whether fewer or additional parties must be part of a joint statement in order to be ''fairly representative of relevant points of view.'' Section 10 of appendix A. In reaching this determination, DOE took into consideration the fact that the Joint Stakeholders consist of representatives of manufacturers of the covered product at issue, a state corporation, and efficiency advocates—all of which are groups specifically identified by Congress as relevant parties to any consensus recommendation. (42 U.S.C. 6295(p)(4)(A)) As delineated above, the Joint Proposal was signed and submitted by a broad cross-section of interests, including the trade association representing small and large manufacturers who produce the subject products, consumer groups, climate and health advocates, and energy-efficiency advocacy organizations, each of which signed the Joint Proposal on behalf of their respective manufacturers and efficiency advocacy organizations, which includes consumer groups, utilities, and a state corporation. Moreover, DOE does not read the statute as requiring a statement submitted by all interested parties before the Department may proceed with issuance of a direct final rule, nor does appendix A require the statement be submitted by all interested parties listed in the appendix. By explicit language of the statute, the Secretary has the discretion to determine when a joint recommendation for an energy or water conservation standard has met the requirement for representativeness (*i.e.,* ''as determined by the Secretary''). *Id.*

DOE also evaluated whether the recommendation satisfies 42 U.S.C. 6295(o), as applicable. In making this determination, DOE conducted an analysis to evaluate whether the potential energy conservation standards under consideration achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified and result in significant energy conservation. The evaluation is the

[17] Available at: *https://data.energystar.gov/Active-Specifications/ENERGY-STAR-Certified-Room-Air-Cleaners/jmck-i55n/data.* Last accessed: December 2022.

same comprehensive approach that DOE typically conducts whenever it considers potential energy conservation standards for a given type of product or equipment.

Upon review, the Secretary determined that the Joint Proposal comports with the standard-setting criteria set forth under 42 U.S.C. 6295(p)(4)(A). Accordingly, the consensus-recommended efficiency levels were included as the ''recommended TSL'' for air cleaners (see section V.A of this document for description of all of the considered TSLs). The details regarding how the consensus-recommended TSLs comply with the standard-setting criteria are discussed and demonstrated in the relevant sections throughout this document.

In sum, as the relevant criteria under 42 U.S.C. 6295(p)(4) have been satisfied, the Secretary has determined that it is appropriate to adopt the consensus-recommended new energy conservation standards for air cleaners through this direct final rule. Also, in accordance with the provisions described in section II.A of this document, DOE is simultaneously publishing, elsewhere in this issue of the **Federal Register**, a NOPR proposing that the identical standard levels contained in this direct final rule be adopted.

III. General Discussion

DOE developed this direct final rule after considering oral and written comments, data, and information that DOE received in response to the January 2022 RFI from interested parties that represent a variety of interests. The following discussion addresses issues raised by these commenters.

A. General Comments

While DOE received comments in response to the January 2022 RFI pertaining to the specific subtopics in section IV of this document, DOE also received several general comments in response to the January 2022 RFI from interested parties regarding the rulemaking timing and process. These comments are summarized and addressed in the following paragraphs.

The Joint Commenters stated support for DOE's proposal to include consumer room air cleaners as a covered product and indicated they were working to negotiate possible Federal energy conservation standards for consumer room air cleaners, along with an applicable test procedure for DOE's consideration. (Joint Commenters, No. 8 at p.1) The CA IOUs also stated that they were engaged with stakeholders on test procedures, metrics, and efficiency standards for air cleaners. (CA IOUs, No. 9 at pp. 1–2)

Trane commented that a new energy conservation standard for consumer air cleaners is necessary because consumers need guidance at a time of unprecedented energy bills and the opportunity to avoid unnecessary energy consumption. (Trane, No. 3 at p. 2) Blueair also commented that it supported energy conservation standards for air cleaners, citing its own HEPASilent™ technology as proof that reduced energy consumption and maximum clean air delivery were compatible. Blueair also stated that it has demonstrated that it is technologically possible to design and manufacture air cleaners with reduced energy usage without loss of air cleaning performance. (Blueair, No. 10 at p. 4) Synexis commented that energy conservation standards for consumer air cleaners were economically justified, technologically feasible, and would lead to energy savings. Synexis commented that implementing uniform Federal test methods and standards would likely reduce costs by standardizing the evaluation processes and would provide common criteria so consumers can make informed decisions. (Synexis, No. 14 at pp. 6–7)

NEEA stated its support for DOE's effort to adopt test procedures and standards for air cleaners and shared sales data from 2015–2019 compiled from retail store sales in the U.S. Northwest. (NEEA, No. 13 at pp. 1–2) NEEA commented that the compiled data reflected the dramatic increases in sales and usage of air cleaners caused by the pandemic and wildfires, making a compelling case for DOE regulation. (NEEA, No. 13 at p. 2) The CA IOUs also stated that the growth of air cleaner usage has been accelerated because of the pandemic and California wildfires, necessitating EPCA energy conservation standards. (CA IOUs, No. 9 at p. 2)

DOE recognizes the comments supporting DOE regulation of air cleaners, and as discussed elsewhere in this document, DOE has determined that energy conservation standards for air cleaners are economically justified, technologically feasible, and would result in the significant conservation of energy.

Daikin commented that DOE's effort to initiate the test procedure and energy conservation standards rulemakings for consumer air cleaners was premature without first finalizing the coverage determination, segmenting the market based on types of air cleaners, and identifying the categories that would provide the most energy savings. (Daikin, No. 12 at p. 1) Daikin commented that since this is a new product rulemaking, DOE must first finalize its coverage determination and then a test procedure before establishing an energy conservation standard. Daikin further commented that DOE should provide sufficient time to comply with the test procedures before determining minimum efficiency standards. Daikin additionally stated that there may be laboratory test chamber shortages after a DOE test procedure is established. (Daikin, No. 12 at p. 3)

DOE appreciates Daikin's concern over the timing and order of rulemaking publications. DOE notes that the January 2022 RFI sought to solicit general feedback on air cleaner test procedures and standards only under the condition that air cleaners are determined to be a covered product. DOE further notes that the July 2022 Final Determination was published prior to DOE proposing a test procedure and establishing an energy conservation standard. The timeline of this rulemaking is accelerated compared to DOE's typical timeline in order to follow as closely as possible the schedule outlined in the Joint Proposal.

MIAQ also commented that it was disappointed by the shortening of the 75-day comment period to 30 days for the January 2022 RFI and the combination of the test procedure and standards rulemakings into a single RFI. MIAQ commented that this impacted its ability to investigate test laboratory capacity or capabilities. (MIAQ, No. 5 at p. 2)

DOE notes that while it initially established a 30-day comment period to allow DOE to review comments received in response to the January 2022 RFI before finalizing its coverage determination, it reopened the comment period to provide a 45-day extension. 87 FR 11326.

Lennox commented that DOE must maintain consumer utility of air cleaners when promulgating new standards and must ensure that any new standards are economically justified. (Lennox, No. 7 at p. 3)

DOE agrees with Lennox and, as discussed elsewhere in this document, DOE screened out technology options from consideration that would not maintain consumer utility. DOE is also establishing standards that are economically justified and did not select more stringent standards that would have negative economic impacts on consumers.

The Joint Stakeholders commented that the Joint Proposal comports with the standards-setting criteria in EPCA and that the Joint Proposal was designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified as required by 42 U.S.C. 6295(o). The Joint Stakeholders additionally stated that the standards proposed in the Joint Proposal would decrease maximum energy use of a covered product in both Tier 1 and Tier 2, and thus comply with EPCA's prohibition against standards that increase maximum allowable energy use of a covered product. 42 U.S.C. 6295(o)(1). (Joint Stakeholders, No. 16 at pp. 11)

DOE agrees that the Joint Proposal provides standards criteria that are technologically feasible and economically justified, as discussed throughout this document. DOE believes the standards criteria set by the Joint Proposal will provide an improvement in energy efficiency and decrease maximum energy use of covered products.

B. Scope of Coverage

DOE has defined an ''air cleaner'' as a product for improving indoor air quality, other than a central air conditioner, room air conditioner, portable air conditioner, dehumidifier, or furnace, that is an electrically-powered, self-contained, mechanically encased assembly that contains means to remove, destroy, or deactivate particulates, volatile organic compound (VOC), and/or microorganisms from the air. 10 CFR 430.2. It excludes products that operate solely by means of ultraviolet light without a fan for air circulation. *Id.*

In response to the January 2022 RFI, the Joint Commenters commented that minimum energy conservation standards should apply to conventional room air cleaners with a measured $PM_{2.5}$ CADR of 10 or greater in order to capture tabletop/desk portable room air cleaners. (Joint Commenters, No. 8 at p. 4)

In the March 2023 TP Final Rule, DOE established the scope of the air cleaners test procedure at appendix FF to ''conventional room air cleaners,'' which are a subset of products that meet the definition of ''air cleaner'' as defined in 10 CFR 430.2. 88 FR 14014, 14044. DOE established a definition for a conventional room air cleaner as a consumer room air cleaner that (1) is a portable or wall mounted (fixed) unit, excluding ceiling mounted unit, that plugs in to an electrical outlet; (2) operates with a fan for air circulation; and (3) contains means to remove, destroy, and/or deactivate particulates. The term ''portable'' is defined in section 2.1.3.1 of AHAM AC–7–2022 and ''fixed'' is defined in section 2.1.3.2 of AHAM AC–7–2022. 88 FR 14014, 14044. The scope of appendix FF is limited to conventional room air cleaners with smoke CADR and dust CADR greater than or equal to 10 cubic feet per minute (''cfm'') and less than or equal to 600 cfm.

This direct final rule covers those consumer products that meet the definition of conventional room air cleaners with smoke CADR and dust CADR greater than or equal to 10 cfm and less than or equal to 600 cfm as defined in section 1 of appendix FF. As discussed in section III.C of this document, $PM_{2.5}$ CADR is calculated as the geometric average of smoke CADR and dust CADR, which is very similar in value to both the smoke CADR and dust CADR. Therefore, the scope of products covered in this direct final rule is consumer products that meet the definition of conventional room air cleaners with $PM_{2.5}$ CADR greater than or equal to 10 cfm and less than or equal to 600 cfm.

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

C. Test Procedure

EPCA sets forth generally applicable criteria and procedures for DOE's adoption and amendment of test procedures. (42 U.S.C. 6293) Manufacturers of covered products must use these test procedures to certify to DOE that their product complies with energy conservation standards and to quantify the efficiency of their product. DOE does not currently prescribe energy conservation standards for air cleaners.

As stated, in the March 2023 TP Final Rule, DOE established a new test procedure for air cleaners at appendix FF. 88 FR 14014. Specifically, appendix FF establishes an IEF metric, expressed in terms of $PM_{2.5}$ CADR/W, which measures the reduction rate of $PM_{2.5}$ particulates in a given room volume per unit power. The numerator of the IEF metric is $PM_{2.5}$ CADR, which is the geometric average of smoke CADR and dust CADR, where each of these CADR metrics refers to the reduction rate of smoke and dust particles, respectively, in a given room volume with the air cleaner operating. The denominator of the IEF metric is the annual energy consumption in active mode and standby mode (AEC) divided by the annual operating hours in active mode.[18]

Additionally, DOE discussed in the March 2023 TP Final Rule that for compliance with the standards in Tier 1 of the Joint Proposal, the Joint Stakeholders recommended that DOE permit section 6.2 of AHAM AC–1–2020[19] for dust CADR to be applied as an alternative for calculating $PM_{2.5}$ CADR. The Joint Stakeholders stated that the dust CADR, determined according to section 6.2 of AHAM AC–1–2020, is nearly identical to the subset dust CADR used to calculate $PM_{2.5}$ CADR. The Joint Stakeholders further stated that given many products have already been tested per AHAM AC–1–2020, allowing this alternative would ensure that manufacturers are not required to retest using AHAM AC–7–2022 to demonstrate compliance with a new standard on a short timeline. (Joint Stakeholders, No. 16 a p. 6); 88 FR 14014, 14030.

According to section 5.1.1 of appendix FF, $PM_{2.5}$ CADR is obtained by combining the CADR of smoke (which includes particle sizes ranging from 0.1 to 0.5 micrometers (''µm'')) with the CADR of dust (which includes particle sizes ranging from 0.5 to 2.5 µm) and performing a geometric average calculation as follows:

$$PM_{2.5}CADR = \sqrt{Smoke\ CADR\ (0.1 - 0.5\ \mu m) \times Dust\ CADR\ (0.5 - 2.5\ \mu m)}$$

The tests to determine smoke CADR and dust CADR are specified in sections 5 and 6 of AHAM AC–1–2020. The allowable particle size for smoke particles is 0.1 to 1 µm for the smoke CADR test in AHAM AC–1–2020 and the allowable particle size for dust particles is 0.5 to 3 µm for the dust CADR test in AHAM AC–1–2020. However, the calculation of $PM_{2.5}$ CADR in section 5.1.1 of appendix FF specifies a narrower range of allowable particle sizes for the smoke CADR and dust CADR than the smoke CADR and dust

[18] For more details on the AEC and IEF metrics, refer to section III.H of the March 2023 TP Final Rule. 88 FR 14014.

[19] American National Standards Institute (''ANSI'')/AHAM standard, ANSI/AHAM AC–1–2020 (''AHAM AC–1–2020''), ''Method for Measuring Performance of Portable Household Electric Room Air Cleaners''.

CADR tests in sections 5 and 6, respectively, of AHAM AC–1–2020.

While the allowable smoke and dust particle size for the smoke CADR and dust CADR tests in sections 5 and 6 of AHAM AC–1–2020 is larger (*i.e.,* 0.1 to 1 µm for smoke particles and 0.5 to 3 µm for dust particles) than the allowable smoke and dust particle size for the calculation of $PM_{2.5}$ CADR in section 5.1.1 of appendix FF (*i.e.,* 0.1 to 0.5 µm for smoke particles and 0.5 to 2.5 µm for dust particles), the subset smoke CADR and dust CADR used to calculate $PM_{2.5}$ are nearly identical to the smoke CADR and dust CADR calculated according to sections 5 and 6 of AHAM AC–1–2020, as shown in the figures included in the Joint Proposal.[20] Accordingly, in the March 2023 TP Final Rule, DOE specified in section 5.1.2 of appendix FF that $PM_{2.5}$ CADR may alternatively be calculated using the full range of particles used to calculate smoke CADR and dust CADR according to sections 5 and 6 of AHAM AC–1–2020, respectively. 88 FR 14014. DOE additionally stated that it may revisit allowing the use of both approaches to calculate $PM_{2.5}$ CADR in a future standards rulemaking. *Id.*

In this direct final rule, DOE continues to allow the full range of particles used to calculate smoke CADR and dust CADR according to sections 5 and 6 of AHAM AC–1–2020, respectively, may be used to determine compliance only with the Tier 1 standards specified in this document. Compliance with Tier 2 standards must be determined using the smoke and dust particle size specified in the calculation of $PM_{2.5}$ CADR in section 5.1.1 of appendix FF. This aligns with the test parameters of the Joint Proposal and allows manufacturers more time to adjust to the tighter particle size requirements specified in AHAM AC–7–2022. Accordingly, DOE is amending section 5.1.2 of appendix FF to specify that the alternate calculation for $PM_{2.5}$ CADR may be used for determining compliance only with Tier 1 standards specified at 10 CFR 430.32(ee).

D. Technological Feasibility

1. General

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

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 appendix A. Section IV.B of this document discusses the results of the screening analysis for air cleaners, 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 prescribes new or amended standards for a type or class of covered product, it must determine the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible for such product. (42 U.S.C. 6295(p)(1)) Accordingly, in the engineering analysis, DOE determined the maximum technologically feasible (''max-tech'') improvements in energy efficiency for air cleaners, 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.

E. Energy Savings

1. Determination of Savings

For each TSL, DOE projected energy savings from application of the TSL to air cleaners purchased in the 30-year period that begins in the year of compliance with the standards (2024–2057 for the recommended TSL, and 2028–2057 for the other TSLs).[21] The savings are measured over the entire lifetime of air cleaners 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 energy conservation standards.

DOE used its national impact analysis (''NIA'') spreadsheet models to estimate national energy savings (''NES'') from potential standards for air cleaners. The NIA spreadsheet model (described in section IV.H of this document) calculates energy savings in terms of site energy, which is the energy directly consumed by products at the locations where they are used. For electricity, DOE reports national energy savings in terms of primary energy savings, which is the savings in the energy that is used to generate and transmit the site electricity. For natural gas, the primary energy savings are considered to be equal to the site energy savings. DOE also calculates NES in terms of FFC energy savings. The FFC metric includes the energy consumed in extracting, processing, and transporting primary fuels (*i.e.,* coal, natural gas, petroleum fuels), and thus presents a more complete picture of the impacts of energy conservation standards.[22] DOE's approach is based on the calculation of an FFC multiplier for each of the energy types used by covered products or equipment. For more information on FFC energy savings, see section IV.H.2 of this document.

2. Significance of Savings

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

The significance of energy savings offered by a new or amended energy conservation standard cannot be determined without knowledge of the specific circumstances surrounding a given rulemaking.[23] For example, some

[20] *See* Joint Stakeholders, No. 16 at p. 6.

[21] For the standards recommended in the Joint Proposal, DOE considered an analysis period beginning in the year of compliance with the Tier 1 standards (2024) and ending in the same year as the 30-year analysis periods considered for the other analyzed TSLs (2057) to align the end dates of the analysis periods. DOE also presents a sensitivity analysis that considers impacts for products shipped in a 9-year period.

[22] 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).

[23] Procedures, Interpretations, and Policies for Consideration in New or Revised Energy Conservation Standards and Test Procedures for

Continued

covered products and equipment have most of their energy consumption occur during periods of peak energy demand. The impacts of these products on the energy infrastructure can be more pronounced than products with relatively constant demand. Accordingly, DOE evaluates the significance of energy savings on a case-by-case basis, taking into account the significance of cumulative FFC national energy savings, the cumulative FFC emissions reductions, and the need to confront the global climate crisis, among other factors.

As stated, the standard levels adopted in this direct final rule are projected to result in national energy savings of 1.80 quads of FFC energy savings, the equivalent of the annual electricity use of 19 million homes. 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).

F. Economic Justification

1. Specific Criteria

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

a. Economic Impact on Manufacturers and Consumers

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

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

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

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

The LCC is the sum of the purchase price of a product (including its installation) and the operating 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 establishing product classes, and in evaluating design options and the impact of potential standard levels, DOE evaluates potential standards that would not lessen the utility or performance of the considered products. (42 U.S.C. 6295(o)(2)(B)(i)(IV)) Based on data available to DOE, the standards 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 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 proceed with the direct final rule. DOE will also publish and respond to the DOJ's comments in the **Federal Register** in a separate notice.

f. Need for National Energy Conservation

DOE also considers the need for national energy and water conservation in determining whether a new or

Consumer Products and Commercial/Industrial Equipment, 86 FR 70892, 70901 (Dec. 13, 2021).

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 effects 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 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 new or 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 air cleaners. Separate subsections address each component of DOE's analyses.

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 NIA uses a second spreadsheet set that provides shipments projections and calculates NES and NPV 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-2021-BT-STD-0035/document.* 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 air cleaners. 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

When evaluating and establishing energy conservation standards, DOE may establish separate standards for a group of covered products (*i.e.,* establish a separate product class) if DOE determines that separate standards are justified based on the type of energy used, or if DOE determines that a product's capacity or other performance-related feature justifies a different standard. (42 U.S.C. 6295(q)) In making a determination whether a performance-related feature justifies a different standard, DOE must consider such factors as the utility of the feature to the consumer and other factors DOE determines are appropriate. (*Id.*)

DOE currently does not specify any energy conservation standards or associated product classes for air cleaners. In the January 2022 RFI, DOE noted that it may use CADR as a measurement of capacity to establish product classes. 87 FR 3702, 3711. DOE requested comment on whether capacity or any other performance-related features, such as air cleaning technology (*i.e.,* whether the product destroys or deactivates contaminants from the air or removes them), would justify establishing different product classes. *Id.*

NEEA commented that, based on a review of NEEA Retail Products Platform (''RPP'') sales data for air cleaners and sales from the ENERGY STAR Retail Products Platform (''ESRPP'') data, product class distinctions based on CADR and smoke CADR/W would be appropriate. (NEEA, No. 13 at p. 3)

Trane commented that different classes of air cleaners could be useful to consumers, who have varying performance goals. (Trane, No. 3 at p. 3)

Synexis stated that the definition of a standard should be applicable to all devices operating in the air cleaning technology space as sub-classes would likely confuse the issue and be difficult to apply equally across all technologies. (Synexis, No. 14 at p. 7)

DOE agrees with NEEA and Trane's comments and, for reasons discussed later in this section, is establishing three separate air cleaner product classes based on CADR as a measurement of capacity. DOE's testing and teardown analysis showed that air cleaning technology, particularly UV and ion generation, did not significantly impact the measured energy use or efficiency of air cleaners. Accordingly, DOE is not establishing additional product class distinction based on air cleaning technology.

Regarding Synexis' comment, DOE notes that energy conservation standards are applicable to all conventional room air cleaners, as defined in the March 2023 TP Final Rule, but that the applicable standard level varies based on the product class. The standards are technology-neutral, and apply to all configurations of conventional room air cleaners with a $PM_{2.5}$ CADR rating within the specified ranges for the three product classes.

The Joint Stakeholders proposed product classes as shown in Table IV.1 and noted that it was proposing separate product classes because it is more difficult for smaller air cleaners to reach higher levels of efficiency because smaller products require smaller components such as fan blades. The Joint Stakeholders stated that as the blade design is made more efficient despite its smaller diameter, the optimization point is tight to achieve adequate air movement while not increasing noise levels beyond a tolerable level. They further stated that this makes achieving higher levels of efficiency a more difficult design challenge while retaining the utility of the smaller size. (Joint Stakeholders, No. 16 at pp. 9–10)

The Joint Stakeholders also stated that were smaller products required to meet the same efficiency levels as larger and higher CADR/W models, a greater change in efficiency of the motor would be necessary, which could require more expensive motor technology that could lead to standards that are not economically justified. The Joint Stakeholders stated that the recommended product classes will help ensure that a broad range of capacity changes remain available for consumers. (Joint Stakeholders, No. 16 at p. 10)

TABLE IV.1—JOINT STAKEHOLDER RECOMMENDED AIR CLEANER PRODUCT CLASSES

Product class	$PM_{2.5}$ CADR bins
PC1	$10 \leq PM_{2.5}$ CADR < 100.
PC2	$100 \leq PM_{2.5}$ CADR < 150.
PC3	$PM_{2.5}$ CADR ≥ 150.

DOE notes that the product classes are defined based on $PM_{2.5}$ CADR, rather than smoke CADR as recommended by NEEA and as specified in the ENERGY STAR V. 2.0 Specification. In the March 2023 TP Final Rule, DOE established the IEF metric based on $PM_{2.5}$ CADR, which is based on the geometric average of the measured smoke CADR and dust CADR values, consistent with the Joint Stakeholder recommendation.

As discussed in the following paragraphs, based on investigatory testing, product teardowns, and a review of the ENERGY STAR V. 2.0 specification, DOE agrees with the Joint Stakeholders that reaching higher efficiencies is more difficult for smaller capacity products due to size and component constraints. Therefore, consistent with the Joint Proposal, DOE is establishing three product classes for air cleaners as shown in Table IV.1.

DOE determined the three product classes specified in Table IV.1 to be appropriate based on an analysis of ENERGY STAR-qualified products. As seen in Figure IV–1, the ENERGY STAR database shows that air cleaner models at lower CADR values generally have lower efficiencies compared to models at higher CADR. DOE expects that this is likely due to the smaller motor and/or filter required for the lower-CADR units, which are typically intended to be used in rooms with smaller areas (*e.g.,* units in Product Class 1 would be recommended for a maximum room size of 155 square feet). To achieve a certain level of cleaning performance, a smaller unit would need to include more filtration by volume in a more limited chassis space (*i.e.,* the air cleaner cabinet). This would increase the pressure drop across the filter, which would require more blower power to maintain the same air delivery performance. These factors impact the overall efficiency of the unit. At higher CADR values (*i.e.,* air cleaners designed for larger rooms), the cabinet volume is much larger, which allows the incorporation of a much larger filter (*i.e.,* the filtration can be spread across a larger filter area), thereby reducing the pressure drop across the filter and necessary blower power, and therefore improving efficiency.

Establishing separate product classes for units that are intended to be used in both smaller and larger rooms is necessary to maintain consumer utility. For example, Product Class 1 units have a small cabinet volume (<0.6 cubic feet (''ft^3'')), are designed for use in a single small room, such as a bathroom or bedroom (<155 sq. ft), and are easily portable, which can allow product configurations such as tabletop or wall plug-ins. Units with larger capacities and corresponding larger cabinet volumes provide different utility to consumers. Product Class 2 includes medium cabinet-sized units (0.6–1.2 ft^3), which are designed for a larger room (155–235 sq. ft) such as a kitchen or living space. The size and weight of these units generally allow single-person portability without necessitating the use of wheels. Finally, Product Class 3 units have a large cabinet (>1.2 ft^3), are typically less portable than lower-capacity units, in some cases being equipped with wheels to facilitate moving, and are designed to be used for an extended duration in a large room (>235 sq. ft) such as a classroom, office, or large living area. Establishing these product classes is necessary because the three ranges of capacity each provide distinct consumer utility in terms of the application based on room size and portability of the unit and are associated with inherently different efficiency due to the different filter size and configurations that can be accommodated. Further, these product class distinctions will help ensure that higher-capacity units installed in smaller-sized rooms, which achieve higher efficiencies at the same active mode power consumption than smaller-capacity units and which warrant more stringent energy conservation standards, do not lead to unnecessarily high AEC.

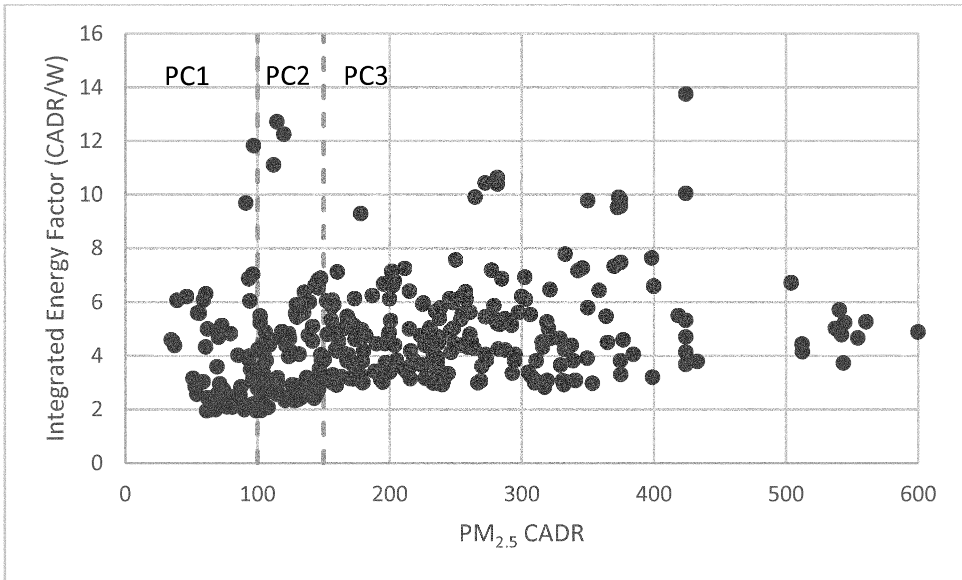

Figure IV-1 ENERGY STAR Qualified Air Cleaners as of December 2022

Finally, DOE is establishing Product Class 1 with a $PM_{2.5}$ CADR lower limit of 10 cfm as opposed to 30 cfm, as specified in the ENERGY STAR V. 2.0 specification, so that tabletop and desktop portable room air cleaners as well as plug-in air cleaners, which is a growing segment of the market, will be required to demonstrate compliance with the adopted standards. DOE notes that the $PM_{2.5}$ CADR lower limit of 10 cfm for Product Class 1 is also recommended by the Joint Stakeholders in the Joint Proposal.

2. Technology Options

In analyzing the feasibility of new energy conservation standards, DOE uses information about technology options and prototype designs to identify technologies that manufacturers could use to meet and/or exceed a given energy conservation standard level. In the January 2022 RFI, DOE requested information on technologies that are used to improve the energy efficiency of air cleaners. Specifically, DOE sought information on the range of efficiencies or performance characteristics that are available for each technology option. 87 FR 3702, 3711. For each technology option suggested by stakeholders, DOE also sought information regarding its market adoption, costs, and any concerns with incorporating the technology into products (*e.g.,* impacts on consumer utility, potential safety concerns, manufacturing or production challenges, *etc.*). 87 FR 3702, 3711–3712.

MIAQ and AHRI commented that they could not provide concrete information on the availability or lack thereof of technologies for improving energy efficiency of air cleaners for non-portable products until DOE altered the scope and definitions to exclude products inappropriate for regulation. MIAQ and AHRI noted that ducted products, with fans primarily used for ventilating, cooling, and heating, employ different technologies than portable products, with distinctly different energy use patterns. (MIAQ, No. 5 at p. 8; AHRI, No. 15 at p. 9)

As discussed in section III.B of this document, the scope of this standards rulemaking includes conventional room air cleaners with $PM_{2.5}$ CADR between 10 and 600 cfm (inclusive). Products not meeting the definition of conventional room air cleaners, such as ceiling-mounted and whole-home units are not included in the scope of this rulemaking. Accordingly, DOE has analyzed technology options only for conventional room air cleaners that are in the scope of this standards rulemaking.

Trane commented that portable HEPA and other high filter efficiency filter-based units should be prioritized highest in a new standard because of their use in classrooms. (Trane, No. 3 at p. 2)

DOE is aware of the prevalence of HEPA filters in air cleaners, and DOE's teardown sample largely comprised conventional room air cleaners that utilize a HEPA filter or other high efficiency filters. The teardown analysis confirmed that, by effectively removing $PM_{2.5}$ particulates, such high efficiency filters are a technology option for improving air cleaner efficiency as measured according to the DOE test procedure at appendix FF.

Synexis commented that safety standards should be considered for air cleaners that generate hazardous by-products, such as ozone, which can be harmful to humans at levels above established thresholds. (Synexis, No. 14 at p. 7) Trane also commented that since certain air cleaning devices, like electronic/reactive air cleaners, may produce by-products such as ozone, organic acids, and ultrafine particles, this fact complicates attempts at standards or creates a need for additional standards. (Trane No. 3 at p. 2) DOE is aware that technology options that generate ozone or other harmful by-products can have adverse impacts on health or safety and, as discussed in section IV.B of this document, DOE has screened-out such technology options accordingly.

In the market analysis and technology assessment, DOE identified 19 technology options for air cleaners, as shown in Table IV.2. These technology options have been determined to improve the efficiency of air cleaners, as measured by the DOE test procedure. In general, the technology options with the most significant impact on efficiency represent improvements to the filter and motor. The motor and filter relationship is crucial to improving efficiency, as optimization of the airflow across the filter is the largest factor contributing to an air cleaner's active mode power consumption.

TABLE IV.2—AIR CLEANER TECHNOLOGY OPTIONS

1. High efficiency particulate air (''HEPA'')-type filter (99 percent of 0.2µm particles).
2. True HEPA filter (99.97 percent of 0.3µm particles).
3. Activated carbon filter.
4. High density polyethylene (''HDPE'') pre-filter.
5. Photoelectrochemical oxidation (''PECO'') filter.
6. Photocatalytic oxidation (''PCO'') filter.
7. Electrostatic/Polarizing media.
8. Filter shape.
9. Improved Motor Technologies.
10. Low standby-power electronic controls.
11. Direct double-ended blower assembly.
12. Ionization brush.
13. Ionization plates.
14. Air quality sensor.
15. Ozone generators.
16. Thermodynamic sterilization system (''TSS'').
17. Bioreactor.

After identifying all potential technology options for improving the efficiency of air cleaners, DOE performed a screening analysis (see section IV.B of this document) to determine which technologies merited further consideration in the engineering analysis.

B. Screening Analysis

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

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

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

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

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

(5) *Unique-pathway proprietary technologies.* If a technology has proprietary protection and represents a unique pathway to achieving a given efficiency level, it will not be considered further, due to the potential for monopolistic concerns. Sections 6(b)(3) and 7(b) of appendix A.

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

In the January 2022 RFI, DOE requested feedback on whether any air cleaner technology options would be screened out based on the five screening criteria described in this section. DOE also requested information on the technologies that would be screened out and the screening criteria that would be applicable to each screened out technology option. 87 FR 3702, 3712.

The subsequent paragraphs 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.

Molekule commented that its PECO technology includes energy requirements different from traditional air cleaners and requested an exemption from Federal energy efficiency standards since its air cleaners have been cleared by the U.S. Food and Drug Administration (''FDA'') as Class II medical devices, which allows medical professionals to use these devices in medical settings to purify the air for viruses and bacteria. (Molekule, No. 11 at pp. 1–2) Molekule commented that while the removal and destruction of airborne microbes is a key benefit in medical settings, it is not measured by CADR tests for particulate matter. Molekule further stated that any modifications to meet DOE energy efficiency standards would be burdensome, requiring the company to re-apply for FDA clearance. (Molekule, No. 11 at p. 3). While FDA classification is not one of the five screening criteria that DOE applies, DOE notes that it has screened out PECO technology because it is a proprietary technology. DOE additionally notes that many air cleaners are capable of removing or destroying contaminants other than particulate matter (*i.e.,* air cleaners that can remove, destroy, or deactivate smoke, dust, or pollen may also remove, destroy or deactivate microorganisms and/or gaseous pollutants) and that such air cleaners would be in the scope of this rulemaking and subject to applicable standards as long as the unit ''contains means to remove, destroy, and/or deactivate particulates,'' as included in the definition of a conventional room air cleaner.

Synexis commented that DOE should eliminate this criterion [24] because it is in direct and fundamental conflict with intellectual property rights. Synexis stated that if the United States government grants monopolistic rights to certain technology options through the patent process, then DOE should not eliminate those same technology options. (Synexis, No. 14 at p. 7) DOE clarifies that the intent of the unique-pathway proprietary technologies screening criterion is to screen out proprietary technologies as a design pathway for achieving higher efficiencies for the purposes of DOE's analysis only. That is, if the only way to reach a given efficiency would be to utilize a proprietary technology, DOE would not include it in its analysis because manufacturers that do not have access to the proprietary technology would not be able to meet the efficiency level under consideration. This would not preclude manufacturers from utilizing such technologies in their products. The intent of DOE's analysis is to identify a pathway to achieve higher efficiencies that would generally be available to all manufacturers, but DOE recognizes that manufacturers may have more than one pathway to achieve higher efficiencies, including using proprietary technologies.

1. Screened-Out Technologies

Photoelectrochemical Oxidation

PECO is a type of photoreactor-based air purification, similar to PCO technology (described in the next section) with some important variations. PECO processes pollutants in a photoreactor that utilizes photons to initiate a reaction that oxidizes and destroys organic pollutants in the air. The reaction converts pollutants into non-toxic substances. Specifically, PECO works by shining UV–A light on the catalytic surface of the PECO filter. Once the catalyst is activated by the UV–A light, it forms hydroxyl radicals that combine and react with airborne

[24] DOE understands Synexis to be referring to the unique-pathway proprietary technology screening criterion.

microbiological contaminants, which destroys them.

Since PECO technology is proprietary, DOE has screened out this technology option as a unique pathway proprietary technology.

Photocatalytic Oxidation (PCO)

The PCO process is similar to PECO in that it utilizes UV radiation combined with a catalyst to break down pollutants. The major difference between PCO and PECO is the filter material, UV light, and subsequent byproducts. While the PECO filter is a proprietary technology, PCO uses a catalyst such as titanium dioxide. Additionally, PECO does not emit any harmful byproducts such as ozone and formaldehyde as compared to the catalysts on PCO filters. Finally, the PECO system utilizes a UV–A light, instead of a UV–C light found in PCO systems.

When the titanium dioxide used with PCO is activated by UV–C radiation, it forms oxidizing hydroxyl radicals which react with pollutants. When a pollutant comes into contact with UV-activated titanium dioxide, the reaction destroys the pollutant and releases non-toxic compounds, such as carbon dioxide and water, as byproducts, as well as certain harmful byproducts such as ozone and formaldehyde.

DOE is screening out the PCO technology option due to health and safety concerns stemming from the byproducts generated by the reaction of the PCO filter. Formaldehyde is a known human carcinogen that can cause irritation of the skin, eyes, nose, and throat. High levels of exposure may cause some types of cancers, according to EPA.[25] For ozone, DOE describes these concerns in more detail in the following section.

Ozone Generation

Ozone is a strong oxidizer and cleaning agent. Ozone generators work by creating an electrical discharge to split oxygen molecules in ambient air into single oxygen atoms, which then bind with existing oxygen molecules in the air to form ozone. Ozone is highly unstable and reactive, so after it is produced by the generator, it is released in the air and is claimed to chemically react with air pollutants such as chemicals, mold, viruses, bacteria, and odors.

DOE has identified concerns with air cleaners that rely on ozone generation in terms of both efficacy and safety. The same chemical properties that allow ozone to be highly reactive with organic material in the air mean that ozone can impact organic material inside the respiratory system. EPA investigated the use of ozone generation for air cleaning and in a 1996 publication,[26] determined that relatively low amounts of ozone can pose harmful health effects such as decrease in lung function, aggravation of asthma, throat irritation and coughing, chest pain and shortness of breath, inflammation of lung tissue and high susceptibility to respiratory infection. EPA further researched the effectiveness of ozone at removing indoor air contaminants and found that there is evidence to suggest that at concentrations that do not exceed public health standards, ozone is not effective at removing many odor-causing chemicals, viruses, bacteria, mold, or other biological pollutants. Additionally, ozone does not impact particulate matter such as dust or pollen.

Due to these health and safety concerns associated with ozone and lack of efficacy towards particulate removal, DOE has screened out this technology option.

Thermodynamic Sterilization System (TSS)

DOE has identified air cleaners on the market that use TSS in a ceramic core to destroy microorganisms and particle pollutants. These air cleaners do not rely on filter media to trap or remove particles, but rather utilize air convection to force air through the devices' internal ceramic core which heats up to about 200 degrees Celsius (''°C'') (392 degrees Fahrenheit (''°F'')) and incinerates pollutants. Manufacturers of these air cleaners claim that TSS can kill mold, bacteria, germs, and viruses and destroy pollutants such as dust, pollen, pet dander, hair, and other airborne particulates. After the air is heated and cleaned, it is immediately cooled using heat transfer plates and released back out of the device.

TSS is a proprietary technology implemented by a single company. Therefore, DOE has screened out this technology option as a unique pathway proprietary technology.

Bioreactor

DOE has identified two air cleaner models on the market that utilize a bioreactor system to produce clean air. The air cleaners that use this technology option rely on convection and fans to draw large particulate matter of over 0.5 microns such as dust and dander into the bioreactor chamber. Smaller ultra-fine air pollutants and VOCs are drawn into the chamber of the air purifier by a process of molecular attraction through an electrostatic grounded air zone.

Once the various types of air contaminants are drawn into the bioreactor, an activated solution of water, oxygen, enzymes, and the trapped contaminants lead to an accelerated process of natural oxidation that digests the air contaminants and breaks them down into water, carbon dioxide, and base elements. This results in cleaner air that is released from the air purifier.

Given the scarcity of models on the market with this technology, DOE has screened out this technology option as it is not proven to be practicable to manufacture, install, and service this technology on a scale necessary to serve the relevant market at the time of the compliance date of new standards.

2. Remaining Technologies

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

1. HEPA-type filter (99 percent of 0.2μm particles)
2. True HEPA filter (99.97 percent of 0.3μm particles)
3. Activated carbon filter
4. HDPE pre-filter
5. Electrostatic/Polarizing media
6. Filter shape
7. Improved Motor Technologies
8. Low standby-power electronic controls
9. Direct double ended blower assembly
10. Ionization brush
11. Ionization plates
12. Air quality sensor

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.

[25] *www.epa.gov/sites/default/files/2016-09/documents/formaldehyde.pdf.*

[26] *www.epa.gov/indoor-air-quality-iaq/ozone-generators-are-sold-air-cleaners.*

C. Engineering Analysis

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

Chapter 5 of the direct final rule TSD provides additional details regarding the engineering analysis.

1. Efficiency Analysis

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

In this rulemaking, DOE primarily used the efficiency-level approach. This approach involved reviewing the ENERGY STAR V. 2.0 database to identify the market distribution of existing products. DOE also used the design-option approach, testing and physically disassembling commercially available products to fill gaps where data was not available from the efficiency-level approach (*e.g.,* to identify efficiency levels below the ENERGY STAR level). From this information, DOE estimated the manufacturer production costs (''MPCs'') for a range of products available at that time on the market. DOE then analyzed the steps manufacturers took to improve product efficiencies. In its analysis, DOE determined that manufacturers would likely rely on certain design options to reach higher efficiencies. From this information, DOE estimated the incremental cost and efficiency impacts of incorporating specific design options at each efficiency level. This section provides more detail on the development of efficiency levels for the air cleaner engineering analysis.

In response to the January 2022 RFI, Molekule commented that air cleaners that utilize combined technologies such as a fan and UV that are intended to capture and destroy a wide range of potentially harmful pollutants should be subject to adjusted requirements. Molekule additionally commented that devices that feature technologies with capabilities outside of AHAM AC–1 and its scope of smoke, dust, and pollen test should receive an additional 15-percent energy allowance. (Molekule, No. 11 at pp. 2, 5) Molekule commented that air cleaners that are designed to work against contaminants such as microbes and organic chemicals may require technology stacks and energy usage beyond what is needed for mechanical filtration. Molekule further stated that evaluating such air cleaners solely on particle removal efficiency without considering these other pollutant classes is an inappropriate measure of an air cleaner's energy efficiency relative to its potential benefits. Molekule commented that many proposed and existing standards for microbes and chemicals, including proposed AHAM AC–4 and AHAM AC–5 tests and NRCC_54013 [27] protocol, will only gauge the initial reduction of pollutants, while an important benefit of its devices is the destruction of pollutants. (Molekule, No. 11 at p. 4) DOE notes that the air cleaners test procedure at appendix FF requires that all features pertaining to air cleaning (*e.g.,* UV, ion generator, *etc.*) must be activated and set to their highest setting during testing, while features unrelated to air cleaning are disabled. That is, the air cleaners test procedure already accounts for these technologies and to the extent it is necessary, DOE's analysis accounts for the additional energy consumed by such technologies. Regarding comments related to the AHAM AC–4 and AHAM AC–5 industry test standards, DOE is not introducing a test procedure for microbes and chemicals at this time and is not establishing an additional energy allowance for products that target these pollutants.

Molekule also commented that air cleaners that utilize automatic or standby functionality should receive a credit and that DOE should delay the implementation of energy conservation standards for such air cleaners until the appropriate standards or credit has been determined. (Molekule, No. 11 at p. 2) Molekule stated that energy efficiency requirements should account for the typical operation of the air cleaner rather than only the maximum performance mode, particularly for air cleaners that employ air quality sensors. Molekule stated that the continuous use case is to operate in ''Auto'' mode or at a level lower than the maximum running speed and that its internal data indicates that the use of Auto Mode, coupled with other common user behavior of selecting speeds lower than the maximum speed, results in more than 50-percent energy savings as compared to the energy use if the device was operated continuously at maximum speed. (Molekule, No. 11 at p. 5) DOE notes that the current test procedure at appendix FF requires all air cleaners to be tested in the maximum performance mode, not in automatic mode. Accordingly, a credit or separate standards are not necessary for such units at this time. DOE is aware that an AHAM task force is currently engaged in discussions to develop an industry test method to test air cleaners in automatic mode, and DOE is participating in these meetings. However, DOE's test procedure specifies testing only in maximum performance mode (consistent with the existing industry standard) and accordingly, DOE is not providing a credit for units with automatic mode.

a. Baseline Efficiency Levels

For each product class, DOE generally selects a baseline model as a reference

[27] National Research Council Canada (''NRCC'')-54013, ''Method for Testing Portable Air Cleaners,'' April 2011. Available online at: *https://nrc-publications.canada.ca/eng/view/ft/?id=cc1570e0-53cc-476d-b2ee-3e252d8bd739.*

point for each class, and measures changes resulting from potential energy conservation standards against the baseline. The baseline model in each product class represents the characteristics of a product typical of that class (*e.g.,* capacity, physical size). Generally, a baseline model is one that just meets current energy conservation standards, or, if no standards are in place, the baseline is typically the most common or least efficient unit on the market. In the January 2022 RFI, DOE requested feedback on appropriate baseline efficiency levels for DOE to apply, and the product classes to which these baseline efficiency levels would be applicable, in evaluating whether to establish energy conservation standards for air cleaners. 87 FR 3702, 3712.

NEEA commented that using the ENERGY STAR V. 2.0 levels as the baseline efficiency level would be appropriate because of the high percentage of sales of ENERGY STAR units, comprising 87 percent of the 2015 room air cleaner sales. (NEEA, No. 13 at p. 4)

Based on publicly available data from ENERGY STAR and AHAM, DOE estimated that 60 percent of air cleaners on the market do not meet the ENERGY STAR V. 2.0 levels. Based on the large number of products available on the market that do not meet the ENERGY STAR V. 2.0 specification, DOE is establishing the baseline efficiency levels below the ENERGY STAR V. 2.0 levels.

As a first step to determine baseline and incremental efficiency levels, DOE selected units for testing and teardowns using the AHAM Verifide [28] and ENERGY STAR databases and identified the CADR values at which most models were clustered. The ENERGY STAR database includes smoke CADR, dust CADR, and pollen CADR values in addition to providing power consumption data, but the AHAM Verifide database includes only smoke CADR, dust CADR, and pollen CADR values. Using these databases, DOE selected a representative sample of products for testing and teardowns. From its test sample, DOE identified a representative nominal $PM_{2.5}$ CADR value for each product class based on the most commonly occurring $PM_{2.5}$ CADR value for each product class in its test sample, which are 50 CADR/W, 125 CADR/W, and 200 CADR/W for Product Class 1, Product Class 2, and Product Class 3, respectively.

For each product class, DOE then selected the baseline efficiency level based on a commercially available unit below the levels established by certain States and the ENERGY STAR V. 2.0 level. Given there is no database that contains energy use data for air cleaners other than the ENERGY STAR database, which provides a list of products that meet or exceed ENERGY STAR V. 2.0 levels, DOE identified the baseline efficiency levels by testing a representative sample of commercially available units that were not included in the ENERGY STAR database. Through this approach, DOE was able to identify the baseline efficiency level using the IEF of the least efficient unit tested in each product class for Product Classes 1 and 3. For Product Class 2, DOE did not identify any unit in its test sample with an IEF below the State or ENERGY STAR levels from its limited test sample. Accordingly, DOE used the baseline unit from Product Class 1, scaled to the representative $PM_{2.5}$ CADR for Product Class 2, to determine a representative baseline unit for Product Class 2. Table IV.3 summarizes the baseline efficiency levels defined for each product class:

TABLE IV.3—BASELINE EFFICIENCY LEVELS

Product class	$PM_{2.5}$ CADR bins	Minimum IEF
PC1	10 ≤ CADR < 100	1.53
PC2	100 ≤ CADR < 150	1.53
PC3	CADR ≥ 150	1.2

b. Higher Efficiency Levels

In the January 2022 RFI, DOE requested feedback on design options that manufacturers would use to increase energy efficiency in air cleaners above the baseline, including information on the order in which manufacturers would incorporate the different technologies to incrementally improve efficiency of products. DOE also requested feedback on whether the increased energy efficiency would lead to other design changes that would not occur otherwise. DOE further requested information regarding any potential impact of design options on a manufacturer's ability to incorporate additional functions or attributes in response to consumer demand and on whether certain design options may not be applicable to (or incompatible with) certain types of air cleaners. 87 FR 3702, 3713.

NEEA commented that it analyzed the ENERGY STAR database and identified the max-tech units shown in Table IV.4 for each product class:

TABLE IV.4—MAX-TECH UNITS IDENTIFIED BY NEEA

Product class	$PM_{2.5}$ CADR (cfm)	IEF * ($PM_{2.5}$ CADR/W)	AEC (kWh/year)
PC1: 10 ≤ $PM_{2.5}$ CADR < 100	91.2	9.9	55.0
PC2: 100 ≤ $PM_{2.5}$ CADR < 150	120.0	12.5	57.2
PC3: $PM_{2.5}$ CADR ≥ 150	424.3	14.0	180.2

* Note that NEEA provided each unit's CADR/W in terms of smoke CADR. DOE calculated the $PM_{2.5}$ CADR values using the information available from the ENERGY STAR database.

[28] Available at: *https://ahamverifide.org/directory-of-air-cleaners/*. Last accessed: January 2022.

(NEEA, No. 13 at p. 5)

As part of DOE's analysis, the maximum available efficiency level is the highest efficiency unit currently available on the market. DOE also defines a ''max-tech'' efficiency level to represent the maximum possible efficiency for a given product. Table IV.5 shows the units that DOE determined to be the maximum available and max-tech units for each product class. These units are the highest efficiency units currently available on the market that provide complete consumer utility. DOE is not aware of any additional technologies that could be implemented to the identified units, and therefore has determined that the units represent the max-tech efficiency level in each product class. The following paragraphs in this section explain DOE's selection of max-tech units as well as its reasons for deviating from the units suggested by NEEA.

TABLE IV.5—MAX-TECH UNITS ANALYZED BY DOE

Product class	Representative $PM_{2.5}$ CADR (cfm)	IEF ($PM_{2.5}$ CADR/W)	AEC (kWh/yr)
PC1: 10 ≤ $PM_{2.5}$ CADR < 100	50	5.4	54.1
PC2: 100 ≤ $PM_{2.5}$ CADR < 150	125	12.8	57.3
PC3: $PM_{2.5}$ CADR ≥ 150	200	7.4	157.6

DOE recognizes that the air cleaners included in NEEA's comment may be the highest efficiency units available on the market for each product class; however, as noted previously, DOE strived to select units at the representative $PM_{2.5}$ CADR value for each product class, and especially at the max-tech. For Product Class 1 and Product Class 3, the models suggested by NEEA have roughly twice the capacity, expressed in terms of $PM_{2.5}$ CADR, as the representative capacities selected by DOE—91.2 cfm compared to DOE's representative $PM_{2.5}$ CADR value of 50 cfm for Product Class 1 and 424.3 cfm compared to DOE's representative $PM_{2.5}$ CADR value of 200 cfm for Product Class 3. For Product Class 2, the $PM_{2.5}$ CADR of the model suggested by NEEA falls within the range of CADR values that DOE considered for its analysis and DOE's max-tech unit for Product Class 2 is fairly similar to the unit suggested by NEEA.

In addition to selecting units within a representative $PM_{2.5}$ CADR range for each product class, to determine its max-tech units DOE also selected units that utilized a true HEPA filter, which is a filter that is rated to remove at least 99.97 percent of particles that have a size of 0.3 µm. DOE selected this criterion because, according to EPA, the diameter specification of 0.3 µm corresponds to the most penetrating particle size; that is, particles of 0.3 µm are the most difficult size particles to capture and particles either larger or smaller than 0.3 µm are generally captured more easily.[29] Therefore, DOE selected its max-tech unit to include a true HEPA filter to ensure that there would not be any loss in product utility at the selected max-tech efficiency level. The Product Class 1 and Product Class 3 units suggested by NEEA do not include a true HEPA filter and instead utilize ionic plates or a filter that is rated to capture 98 percent of 5 µm particles, neither of which meet the rating requirement of a HEPA filter for capturing at least 99.97 percent of particles that have a size of 0.3 µm, which DOE determined is required to maintain full consumer functionality. DOE notes that the pressure drop across a HEPA filter would be greater due to the design of such a filter, which would require a more powerful motor to move the same quantity of air across the filter as compared to a less effective filter.

While the max-tech units selected by DOE for Product Class 2 and Product Class 3 are the most-efficient units at the representative $PM_{2.5}$ CADR value, for Product Class 1, DOE observed another unit that had a higher IEF compared to its selected unit. However, DOE ultimately selected the unit shown in Table IV.5 because the other unit did not include a true HEPA filter; instead, it included a filter that is rated to remove only up to 97 percent of particles that have a size of 0.3 µm, which DOE determined did not maintain full consumer functionality.

To establish other incremental higher efficiency levels between the baseline and max-tech, DOE reviewed data in the ENERGY STAR database to evaluate the range of efficiencies for air cleaners currently available on the market. For all three product classes, DOE considered Efficiency Level 1 (''EL 1'') to correspond to the level established by certain States. EL 1 also corresponds to the Tier 1 level provided in the Joint Proposal. DOE selected EL 2 for all product classes to correspond to the ENERGY STAR V. 2.0 level, which is also the Tier 2 level provided in the Joint Proposal. Finally, DOE identified EL 3 as a ''gap-fill'' level between EL 2 and max-tech (*i.e.,* EL 4) based on number of available models grouped (or ''clustered'') between EL 2 and max-tech for each product class. Table IV.6 through Table IV.8 summarize the efficiency levels analyzed for each product class.

TABLE IV.6—EFFICIENCY LEVELS FOR PRODUCT CLASS 1

EL	Efficiency level description	IEF ($PM_{2.5}$ CADR/W)
Baseline	Minimum available from tested units	1.5
1	State Standard Levels; Joint Proposal Tier 1	1.7
2	ENERGY STAR V. 2.0; Joint Proposal Tier 2	1.9
3	Gap-fill	3.4
4	Maximum available	5.4

[29] *www.epa.gov/indoor-air-quality-iaq/what-hepa-filter.*

TABLE IV.7—EFFICIENCY LEVELS FOR PRODUCT CLASS 2

EL	Efficiency level description	IEF ($PM_{2.5}$ CADR/W)
Baseline	Minimum available from tested units	1.5
1	State Standard Levels; Joint Proposal Tier 1	1.9
2	ENERGY STAR V. 2.0; Joint Proposal Tier 2	2.4
3	Gap-fill	5.4
4	Maximum available	12.8

TABLE IV.8—EFFICIENCY LEVELS FOR PRODUCT CLASS 3

EL	Efficiency level description	IEF ($PM_{2.5}$ CADR/W)
Baseline	Minimum available from tested units	1.2
1	State Standard Levels; Joint Proposal Tier 1	2.0
2	ENERGY STAR V. 2.0; Joint Proposal Tier 2	2.9
3	Gap-fill	6.6
4	Maximum available	7.4

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 air cleaners on the market. The cost approaches are summarized as follows:

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

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

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

In the present case, DOE conducted the analysis primarily using the physical teardown approach. For each product class, DOE tore down a representative sample of models spanning the entire range of efficiency levels, as well as multiple manufacturers within each product class. DOE aggregated the results so that the cost-efficiency relationship developed for each product class reflects DOE's assessment of a market-representative ''path'' to achieve each higher efficiency level. The resulting bill of materials from each teardown provides the basis for the MPC estimates. In addition to determining MPCs for each efficiency level, DOE disaggregated the overall MPCs to find the filter costs, which are used later in the LCC and PBP analyses.

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

In the January 2022 RFI, DOE sought input on the increase in MPC associated with incorporating each particular design option. DOE also requested information on the investments necessary to incorporate specific design options, including, but not limited to, costs related to new or modified tooling (if any), materials, engineering and development efforts to implement each design option, and manufacturing/production impacts. 87 FR 3702, 3713.

NEEA commented that it had analyzed the incremental cost of air cleaners and found the incremental cost was $6.00 for large-capacity room air cleaners and about $26 for smaller-capacity units. (NEEA, No. 13 at p. 5)

As discussed in the following sections, DOE's teardown results also showed that incremental MPC between baseline and max-tech units for Product Class 3 was much smaller compared to the incremental MPC between baseline and max-tech units for Product Classes 1 and 2. DOE estimated the incremental MPC between max-tech and baseline for Product Classes 1 and 2 to be approximately $12, as compared to $26 as stated by NEEA. This is likely due to the difference in how NEEA and DOE conducted their analyses—DOE's analysis is based on MPC, which accounts for the costs associated only with efficiency-related components, while it is DOE's understanding that NEEA's analysis is based on retail prices, which could include costs attributed to non-efficiency-related features.

3. Cost-Efficiency Results

The results of the engineering analysis are reported as incremental MPCs associated with each efficiency level and product class. At each efficiency level, DOE tore down a representative unit and excluded the non-efficiency related components from the MPC calculation. Due to slight variations in the $PM_{2.5}$ CADR of each unit, DOE applied a normalization to the MPCs using a single representative $PM_{2.5}$ CADR for each product class. See chapter 5 of the direct final rule TSD for complete cost-efficiency results.

a. Product Class 1

Table IV.9 summarizes the MPCs at each efficiency level for Product Class 1.

TABLE IV.9—MANUFACTURER PRODUCTION COSTS FOR PRODUCT CLASS 1

[2022$]

EL	IEF ($PM_{2.5}$ CADR/W)	MPC	Incremental MPC
Baseline	1.5	$31.24	
1	1.7	32.25	$1.01
2	1.9	33.39	2.15
3	3.4	39.27	8.03
4	5.4	44.06	12.82

The baseline unit in Product Class 1 is typically smaller than the baseline units in the other two product classes and is equipped with a shaded pole motor (''SPM'') and rectangular HEPA filter. At EL 1, efficiency improvements are achievable by optimizing the motor-filter relationship, typically by reducing the restriction of airflow (and therefore, the pressure drop across the filter) by increasing the surface area of the filter, reducing filter thickness, and/or increasing air inlet/outlet size. Optimizing the air flow across the filter enables reducing the size and power draw of the motor for an EL 1 unit. Other than alterations to the cabinet size to accommodate the filter design, these changes do not significantly increase the MPC at EL 1.

At EL 2, typically the SPM is upgraded to a permanent split capacitor (''PSC'') motor, which improves overall efficiency while increasing MPC slightly.

EL 3 and EL 4 units are typically designed to house a cylindrical filter, and the cabinets of these units are also typically cylindrical in shape. A cylindrical filter design further reduces the restriction in air flow across the filter without compromising on performance because a cylindrical shape allows for a much larger surface area for the same volume of filter material. The larger surface area reduces the resistance across the filter material, which reduces the pressure drop and improves efficiency overall. EL 3 and EL 4 units also utilize a variable-speed brushless direct-current (''BLDC'') motor, which is much more efficient than an SPM or PSC motor. EL 4 units additionally improve energy efficiency by further optimizing the motor-filter relationship. The incremental costs associated with EL 3 and EL 4 are typically much higher due to the significant motor upgrade and cylindrical filter and case design.

b. Product Class 2

When selecting representative units for Product Class 2, DOE was unable to identify commercially available units for the baseline and EL 1 due to lack of published data for units with efficiencies below the ENERGY STAR V.2.0 level; the units that DOE selected for its test sample based on product features did not have measured efficiencies at EL 1 or lower. Therefore, DOE extrapolated costs from baseline and EL 1 units in Product Class 1 with similar measured IEFs as the Product Class 2 baseline and EL 1 efficiency levels. Table IV.10 summarizes the MPCs at each efficiency level for Product Class 2.

TABLE IV.10—MANUFACTURER PRODUCTION COSTS FOR PRODUCT CLASS 2

[2022$]

EL	IEF ($PM_{2.5}$ CADR/W)	MPC	Incremental MPC
Baseline	1.5	$42.97	
1	1.9	44.26	$1.29
2	2.4	45.62	2.65
3	5.4	50.45	7.48
4	12.8	55.55	12.58

DOE estimated that the typical baseline unit for Product Class 2 is similar to the baseline unit from Product Class 1, although it has a larger cabinet, rectangular filter, and SPM motor in order to achieve a higher $PM_{2.5}$ CADR value. At EL 1, DOE estimated that the air cleaner would require a motor upgrade to a PSC motor to be able to provide the increasing power required to maintain the desired IEF for an EL 1 unit at a representative $PM_{2.5}$ CADR value of 125. At EL 2, DOE observed a direct, double-ended PSC motor with a blower on each end, compared to a single-ended blower assembly in the lower-efficiency units.

Similar to Product Class 1, the EL 3 and EL 4 units utilize a cylindrical filter and cabinet to improve filter surface area and airflow as well as a BLDC motor to improve efficiency. At EL 4, the max-tech unit uses lower-standby power components along with optimizations to the motor-filter relationship that allowed for the use of a smaller motor due to a lower pressure drop across the filter.

c. Product Class 3

For Product Class 3, DOE was unable to identify and teardown an EL 1 unit, again due to a lack of published power consumption data for commercially available units below ENERGY STAR V.2.0. Therefore, DOE estimated the EL 1 MPC for Product Class 3 by developing a best-fit curve from the IEF and MPCs of the other efficiency levels for Product Class 3 and using this best-fit curve to estimate the MPC for EL 1. Table IV.11 summarizes the MPCs at each efficiency level for the 150+ $PM_{2.5}$ CADR product class.

TABLE IV.11—MANUFACTURER PRODUCTION COSTS FOR PRODUCT CLASS 3
[2022$]

EL	IEF ($PM_{2.5}$ CADR/W)	MPC	Incremental MPC
Baseline	1.2	$70.50	
1	2.0	71.66	$1.17
2	2.9	72.50	2.00
3	6.6	74.33	3.84
4	7.4	74.61	4.11

DOE estimated that the typical baseline unit for Product Class 3 is equipped with an electronic interface, a PSC motor, and a rectangular HEPA filter. For an EL 1 unit, DOE estimated that a PSC motor is still used, but the motor-filter relationship is optimized along with lower-standby power components to increase unit efficiency. The representative EL 2 unit also uses a PSC motor; however, the unit has a filter with a larger surface area and a larger case with larger air inlets/outlets to improve airflow compared to the baseline and EL 1 units. The EL 3 and EL 4 units utilize a cylindrical HEPA filter and BLDC motor to improve airflow through the filter while reducing power consumption. However, the EL 3 and EL 4 units are typically smaller in cabinet size compared to lower-efficiency units within Product Class 3. Therefore, the incremental MPCs at EL 3 and EL 4 is smaller compared to the incremental MPCs at EL 3 and EL 4 for the other two product classes.

In addition to determining the MPCs for each representative unit at each efficiency level, DOE also disaggregated the overall MPC at each efficiency level to determine filter costs, which are used to determine the maintenance and repair costs for the LCC and PBP. These costs are shown in Table IV.12.

TABLE IV.12—FILTER COSTS (2022$) DISAGGREGATED FROM OVERALL MPCS FOR EACH REPRESENTATIVE UNIT

Efficiency level	Product class 1	Product class 2	Product class 3
Baseline	$2.62	$5.83	$9.06
EL 1	1.92	5.00	8.68
EL 2	1.79	4.16	8.29
EL 3	6.71	10.25	12.10
EL 4	7.05	7.78	12.69

DOE observed that the filter MPC typically decreased going from baseline to EL 2 and then increased for EL 3 and EL 4. This is because the baseline unit typically has a larger rectangular filter compared to EL 1 and EL 2 filters, leading to higher filter costs for the baseline unit. EL 3 and EL 4 units have cylindrical filters with plastic casing, compared to the paper/cardboard casing seen at baseline through EL 2, both of which lead to much higher filter costs at these levels.

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.

The detailed description of DOE's determination of costs for baseline and higher efficiency levels is provided in chapter 5 of the direct final rule TSD. The detailed description of DOE's determination of the industry average manufacturer markup is provided in chapter 12 of the direct final rule TSD

D. Markups Analysis

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

For air cleaners, DOE relied on the TechSci Research report,[30] and manufacturer inputs from the manufacturer interviews to develop the distribution channels and the corresponding market share. DOE developed baseline and incremental markups for each link in the distribution chains (after the product leaves the manufacturer). 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.[31]

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,[32] and the 2017 Annual Wholesale Trade Survey for both ''Machinery, equipment, and supplies merchant wholesalers'' and ''Household appliances and electrical and electronic goods merchant wholesalers'' business types to develop the markups for distributors.[33]

To differentiate the retailer markups in the online and offline retail channels,

[30] TechSci Research. 2022. United States air purifier market, forecast and opportunity. June 2022. *www.techsciresearch.com/report/us-air-purifier-market/3711.html.*

[31] 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.

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

[33] U.S. Census Bureau, Annual Wholesale Trade Survey, 2017. *www.census.gov/programs-surveys/awts.html.*

DOE compared the retail prices of top-selling models provided in the TechSci Research report from major home improvement centers (offline retail sales) and e-commerce websites (online retail sales) and estimated that the online retail prices are on average 1.1% lower than the offline retail prices. Hence, DOE applied the price ratio to the retailer markups estimated from the 2017 Annual Retail Trade Survey to derive separate markups for the offline retail channel.

Chapter 6 of the direct final rule TSD provides details on DOE's development of markups for air cleaners.

E. Energy Use Analysis

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

DOE determined the annual energy consumption of air cleaners by multiplying the per operating mode annual operating hours by the power of standby and active modes. DOE used the Energy Information Administration's (''EIA'') Residential Energy Consumption Survey (''*RECS*'') 2020 [34] data and EIA's Commercial Building Energy Consumption Survey (''*CBECS*'') 2018 [35] data to represent residential and commercial consumer samples. In the absence of air cleaner ownership and usage information in both datasets, for the residential sector, DOE included all household samples, but adjusted the residential sample weights based on the geographic distribution of air cleaner stocks reported by TechSci Research, and the number of air cleaners per sample based on household size. For the commercial sector, DOE excluded the vacant and non-used buildings from the *CBECS 2018* samples and adjusted the remaining building sample weights based on the building occupancy, the square footage of the climate-controlled space, and the stock distribution by building principal activity reported by TechSci Research.

Daikin requested that DOE disclose its methodology and results of the Annual Energy Use assessment. Daikin recognizes that the actual hours of operation will obviously have a significant impact on the annual energy consumption of a product. (Daikin, No. 12 at p. 6) NEEA stated it typically estimates average operation to be 8 hours per day based on seasonal operation or part-day operation, but noted that the Northwest Regional Technical Forum estimates 16 hours per day. (NEEA, No. 11 at p. 5)

The DOE test procedure produces standardized results that can be used to assess or compare the performance of products operating under specified laboratory conditions. The test procedure assumes air cleaners are used 16 hours of the day on active mode (maximum power) and 8 hours on standby mode which aligns with the ENERGY STAR description.[36] 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.

To estimate the actual annual air cleaner energy consumption in the residential sector, DOE relied on the *RECS 2020* consumer sample, in conjunction with the county-based 2020 air quality data published by the EPA,[37] and a market research report conducted by Evergreen Economics [38] submitted by stakeholders to determine the annual operating hours. DOE estimated that the air cleaners operated on average 10.6 hours per day, and 248 days per year in the residential sector.

To determine the commercial sector air cleaner annual energy consumption, DOE used the *CBECS 2018* building sample regarding the reported building principal activities, building schedule and occupancy information. DOE estimated an average of 4,198 annual operating hours, which is equivalent to 12.9 operating hours per day and 325 operating days per year.

Chapter 7 of the direct final rule TSD provides details on DOE's energy use analysis for air cleaners.

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

- The LCC is the total consumer expense of an appliance or product over the life of that product, consisting of total installed cost (manufacturer selling price, distribution chain markups, sales tax, and installation costs) plus operating costs (expenses for energy use, maintenance, and repair). To compute the operating costs, DOE discounts future operating costs to the time of purchase and sums them over the lifetime of the product.
- The PBP is the estimated amount of time (in years) it takes consumers to recover the increased purchase cost (including installation) of a more-efficient product through lower operating costs. DOE calculates the PBP by dividing the change in purchase cost at higher efficiency levels by the change in annual operating cost for the year that amended or new standards are assumed to take effect.

For any given efficiency level, DOE measures the change in LCC relative to the LCC in the no-new-standards case, which reflects the estimated efficiency distribution of air cleaners 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 U.S. households and commercial buildings. As stated previously, DOE developed household samples from the *RECS 2020* and commercial building samples from the *CBECS 2018.* For each sample household, DOE determined the energy consumption for the air cleaners and the appropriate energy price. By developing a representative sample of households

[34] U.S. Department of Energy—Energy Information Administration. Residential Energy Consumption Survey. 2020. *www.eia.gov/consumption/residential/data/2020/.*

[35] U.S. Department of Energy—Energy Information Administration. Commercial Buildings Energy Consumption Survey. 2018. *www.eia.gov/consumption/commercial/data/2018/.*

[36] ENERGY STAR Certified Room Air Cleaners Database. Description of ''Annual Energy Use (kWh/yr)'' ''This is the estimated annual energy use of the room air cleaner under typical conditions, including the energy used in active modes and partial on modes . . . The active mode [. . .] is on average 16 hours active and 8 hours inactive per day. Actual energy consumption will vary depending on various factors such as the amount of usage in active model and the settings chosen.'' *data.energystar.gov/Active-Specifications/ENERGY-STAR-Certified-Room-Air-Cleaners/jmck-i55n/data.*

[37] U.S. Environmental Protection Agency. Air Quality System. Air Quality Index per County. 2020. *www.epa.gov/air-trends/air-quality-cities-and-counties.*

[38] Evergreen Economics. Air Purifier Study Results. February 8, 2021. The document can be found in docket, *www.regulations.gov/comment/EERE-2021-BT-STD-0035-0009.*

and commercial buildings, the analysis captured the variability in energy consumption and energy prices associated with the use of air cleaners.

Inputs to the calculation of total installed cost include the cost of the product—which includes MPCs, manufacturer markups, retailer markups, and sales taxes—and filter 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 air cleaner user samples. For this rulemaking, the Monte Carlo approach is implemented in MS Excel together with the Crystal Ball™ add-on.[39] The model calculated the LCC for products at each efficiency level for 10,000 housing units and commercial building units per simulation run. The analytical results include a distribution of 10,000 data points showing the range of LCC savings for a given efficiency level relative to the no-new-standards case efficiency distribution. In performing an iteration of the Monte Carlo simulation for a given consumer, product efficiency is chosen based on its probability. If the chosen product efficiency is greater than or equal to the efficiency of the standard level under consideration, the LCC calculation reveals that a consumer is not impacted by the standard level. By accounting for consumers who already purchase more-efficient products, DOE avoids overstating the potential benefits from increasing product efficiency. DOE calculated the LCC for consumers of air cleaners as if each were to purchase a new product in the first year of required compliance with new or amended standards. New standards apply to air cleaners manufactured five years after the date on which any new standard is published. (42 U.S.C. 6295(*l*)(2)) However, on August 23, 2022, DOE received a Joint Proposal from the Joint Stakeholders regarding energy conservation standards for air cleaners recommending a two-tier approach. Therefore, DOE used 2024 and 2026 as the first years of compliance in one of the scenarios analyzed based on the Joint Proposal's two-tier standard recommendation, and used 2028 as the first year of compliance with any new standards for air cleaners for the other scenarios analyzed based on the statutory requirement.

Table IV.13 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.13—SUMMARY OF INPUTS AND METHODS FOR THE LCC AND PBP ANALYSIS *

Inputs	Source/method
Product Cost	Derived by multiplying MPCs by manufacturer and retailer markups and sales tax, as appropriate. Used historical data to derive a price scaling index to project product costs.
Installation Cost	No change with efficiency level.
Annual Energy Use	The total annual energy use by operating mode multiplied by the hours per year. Variability: Based on the *RECS 2020* and *CBECS 2018.*
Energy Prices	Electricity: Based on Edison Electric Institute data for 2021. Variability: Regional energy prices determined for 50 states and Washington DC.
Energy Price Trends	Based on *AEO2022* price projections.
Repair and Maintenance Costs	Considered filter change cost only. Filter change frequency assumed to be associated with usage. On average 1.7 filters used per year for residential sector and 2 filters used per year for commercial sector.
Product Lifetime	Average: 9.0 years.
Discount Rates	Approach involves identifying all possible debt or asset classes that might be used to purchase the considered appliances, or might be affected indirectly. Primary data source was the Federal Reserve Board's Survey of Consumer Finances.
Compliance Date	2024/2026 for tiered trial standard level (TSL) and 2028 for the other TSLs.

* Not used for PBP calculation. References for the data sources mentioned in this table are provided in the sections following the table or in chapter 8 of the direct final rule TSD.

1. Product Cost

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

Economic literature and historical data suggest that the real costs of many products may trend downward over time according to ''learning'' or ''experience'' curves. An 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. To derive the learning rate parameter for air cleaners, DOE obtained historical Producer Price Index (''PPI'') data for air cleaners from the Bureau of Labor Statistics (''BLS''). A PPI for ''small electric household appliances'' was available for the time period between 1982 and 2015.[40] However, the small electric household appliances PPI was discontinued beyond 2015 due to insufficient sample size. To extend the price index beyond 2015, DOE assumed that the more aggregated product series, small electrical appliances price index, is representative of the trend of small electric household appliances. Inflation-adjusted price indices were calculated by dividing the PPI series by the gross

[39] Crystal Ball™ is commercially-available software tool to facilitate the creation of these types of models by generating probability distributions and summarizing results within Excel, available at *www.oracle.com/technetwork/middleware/crystalball/overview/index.html* (last accessed July 6, 2018).

[40] U.S. Bureau of Labor Statistics, PPI Industry Data, Small electric household appliance manufacturers, Product series ID: PCU33521033521014. Data series available at: *www.bls.gov/ppi/.*

domestic product index from Bureau of Economic Analysis for the same years. Using data from 1982–2021, the estimated learning rate (defined as the fractional reduction in price expected from each doubling of cumulative production) is 6 percent. DOE assumed that the air cleaner manufacturers do not typically manufacture the air filters themselves; thus, DOE applied the price learning to the non-filter portion of the cost only.

2. Installation Cost

Installation costs include labor, overhead, and any miscellaneous materials and parts needed to install the product. DOE found no data showing that installation costs would be impacted with increased efficiency levels.

3. Annual Energy Consumption

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

4. Energy Prices

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

DOE derived electricity prices in 2021 using data from EEI Typical Bills and Average Rates reports. Based upon comprehensive, industry-wide surveys, this semi-annual report presents typical monthly electric bills and average kWh 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).[41] For the commercial sector, DOE calculated electricity prices using the methodology described in Coughlin and Beraki (2019).[42]

To estimate energy prices in future years, DOE multiplied the 2021 energy prices by the projection of annual average price changes for each of the nine census divisions from the reference case in *AEO2022,* which has an end year of 2050.[43] For the years after 2050, DOE held constant the 2050 electricity prices.

See chapter 8 of the direct final rule TSD for details.

5. Maintenance and Repair Costs

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

In this direct final rule analysis, DOE included no changes in maintenance or repair costs for air cleaners that exceed the baseline efficiency other than the filter change costs. As described in section IV.C of this document, differences in filter size, shape, and material lead to variations in filter costs at each efficiency level within each product class. DOE determined that replacement filters have the same distribution channels and markups as the air cleaner units. No price learning was considered and applied to the filter change costs. Based on the information received from the manufacturer interviews, for commercial buildings, DOE estimated a flat filter change frequency of twice per year. For the residential sector, DOE associated the filter change frequency with the air cleaner usage. DOE correlated higher filter change frequency with higher operating hours with the highest frequency of once every six months and the lowest frequency of once per year. This filter change rate aligns with the range suggested by manufacturer interviews. DOE also takes into account that a small percentage of consumers may never change the air cleaner filters.

6. Product Lifetime

For air cleaners, DOE developed a distribution of lifetimes from which specific values are assigned to the appliances in the samples. DOE ensured that the average lifetime estimate of 9 years aligned with those lifetime estimates suggested by ENERGY STAR,[44] and by CA IOUs (who cited EPA and various State Technical Reference Manuals). (CA IOUs, No. 9 at p. 2) NEEA also cited an estimated lifetime of 9 years. (NEEA, No. 11 at p. 5)

7. Discount Rates

In the calculation of LCC, DOE applies discount rates appropriate to households and commercial buildings to estimate the present value of future operating cost savings. DOE estimated a distribution of discount rates for air cleaners based on the opportunity cost of consumer funds.

DOE applies weighted average discount rates calculated from consumer debt and asset data, rather than marginal or implicit discount rates.[45] 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

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

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

[43] U.S. Department of Energy—Energy Information Administration. *Annual Energy Outlook 2022 with Projections to 2050.* Washington, DC. Available at *www.eia.gov/forecasts/aeo/* (last accessed December 9, 2022).

[44] Room Air Cleaners Final Version 2.0 Program Requirements—Data and Analysis Package. October 2019. *www.energystar.gov/products/spec/room_air_cleaners_version_2_0_pd.*

[45] 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.

Finances[46] (''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 standards would take effect. DOE assigned each sample household a specific discount rate drawn from one of the distributions. The average rate across all types of household debt and equity and income groups, weighted by the shares of each type, is 4.3 percent.

For commercial consumers, DOE used the cost of capital to estimate the present value of cash flows to be derived from a typical company project or investment. Most companies use both debt and equity capital to fund investments, so the cost of capital is the weighted-average cost to the firm of equity and debt financing. This corporate finance approach is referred to as the weighted-average cost of capital. DOE used currently available economic data in developing discount rates. See chapter 8 of the direct final rule TSD for further details on the development of consumer discount rates.

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

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

To estimate the energy efficiency distribution of air cleaners for 2028 (as well as 2024 and 2026), DOE combined market share information submitted by manufacturers[47] and model efficiency distribution from the ENERGY STAR database, and assumed no annual efficiency improvement for the no-new-standards case. The estimated market shares for the no-new-standards case for air cleaners are shown in Table IV.14. See chapter 8 of the direct final rule TSD for further information on the derivation of the efficiency distributions.

TABLE IV.14—NO-NEW-STANDARDS CASE EFFICIENCY DISTRIBUTION FOR AIR CLEANERS IN 2028 (AND IN 2024 AND 2026)

PC	PC1: 10–100 $PM_{2.5}$ CADR		PC2: 100–150 $PM_{2.5}$ CADR		PC3: 150+ $PM_{2.5}$ CADR	
Market Share	26%		24%		50%	
EL	Efficiency ($PM_{2.5}$ CADR/W)	Market share (%)	Efficiency ($PM_{2.5}$ CADR/W)	Market share (%)	Efficiency ($PM_{2.5}$ CADR/W)	Market share (%)
Baseline	1.53	28.0	1.53	24.4	1.20	22.2
1	1.69	42.1	1.90	36.6	2.01	33.3
2	1.89	19.1	2.39	28.1	2.91	37.7
3	3.37	7.5	5.44	10.5	6.55	3.1
4	5.40	3.3	12.75	0.4	7.41	3.8

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

9. Payback Period Analysis

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

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

As noted previously, EPCA establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the first year's energy savings resulting from the standard, as calculated under the applicable test procedure. (42 U.S.C. 6295(o)(2)(B)(iii)) For each considered efficiency level, DOE determined the value of the first year's energy savings by calculating the energy savings in accordance with the applicable DOE test procedure, and multiplying those savings by the average energy price projection for the year in which compliance with the 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.[48] 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.

While demand for the replacement of existing products is dependent only on past shipments and estimated product lifetimes, new demand must be independently projected into the future. DOE projected new demand by estimating new demand in 2020, and applying an annual growth rate. In order to estimate new demand in 2020, DOE took estimates of past shipments (2007–2020) from a EuroMonitor product sales

[46] U.S. Board of Governors of the Federal Reserve System. Survey of Consumer Finances. 1995, 1998, 2001, 2004, 2007, 2010, 2013, 2016, and 2019. *www.federalreserve.gov/econresdata/scf/scfindex.htm.*

[47] *https://www.regulations.gov/comment/EERE-2021-BT-STD-0035-0018.*

[48] 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.

report[49] and estimated lifetimes to calculate an amount of retiring units in 2020. Overall new demand in 2020 was computed as the difference between the EuroMonitor estimate of all units shipped that year, and the estimated retirement demand. Separately, DOE estimated an average annual shipments growth rate of 4.87 percent from the 2021–2028 shipments projection provided by EuroMonitor which is a more conservative estimate compared to the 7 percent annual shipments growth rate estimated by the TechSci Research report.[50] New demand was projected using this annual growth rate. In all shipments projection years, based on the TechSci Research data, DOE assumed that 40 percent of shipments were directed to the commercial sector, and 60 percent were directed to the residential sector. For both sectors and based on manufacturers data, DOE also estimated that 26 percent of shipments were comprised of 10–99 CADR units, 24 percent were comprised of 100–149 CADR units, and the remaining 50 percent were ≥150 CADR units.

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.[51] (''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 air cleaners sold through 2057.

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

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

Table IV.15 summarizes the inputs and methods DOE used for the NIA analysis for the direct final rule. Discussion of these inputs and methods follows Table IV.15. See chapter 10 of the direct final rule TSD for further details.

TABLE IV.15—SUMMARY OF INPUTS AND METHODS FOR THE NATIONAL IMPACT ANALYSIS

Inputs	Method
Shipments	Annual shipments from shipments model.
Compliance Date of Standard	2024/2026 (Tiered TSL), 2028 (other TSLs).
Efficiency Trends	No-new-standards case: fixed efficiency distribution provided by manufacturers with no annual improvements. Standard cases: No-new-standards case market share below the standard level is rolled up to the minimum qualifying level.
Annual Energy Consumption per Unit	Annual weighted-average values are a function of energy use at each TSL.
Total Installed Cost per Unit	Annual weighted-average values are a function of cost at each TSL. Incorporates projection of future product prices based on historical data.
Annual Energy Cost per Unit	Annual weighted-average values as a function of the annual energy consumption per unit and energy prices.
Repair and Maintenance Cost per Unit	Annual values estimated in the LCC analysis do not change across the analysis period except for the first year.
Energy Price Trends	*AEO2022* projections (to 2050) and constant values thereafter.
Energy Site-to-Primary and FFC Conversion.	A time-series conversion factor based on *AEO2022.*
Discount Rate	Three and seven percent.
Present Year	2022.

1. Product Efficiency Trends

A key component of the NIA is the trend in energy efficiency projected for the no-new-standards case and each of the standards cases. Section IV.F.8 of this document describes how DOE developed an energy efficiency distribution for the no-new-standards case (which yields a shipment-weighted average efficiency) for each of the considered product classes for the year of anticipated compliance with a new standard. In the no-new-standards case, DOE determined that the present efficiency distribution would remain fixed over time due to the lack of evidence of efficiency improvement in the no-new-standards case. The approach is further described in chapter 10 of the direct final rule TSD.

For the standards cases, DOE used a ''roll-up'' scenario to establish the shipment-weighted efficiency for the year that standards are assumed to become effective (2024 and 2026 for TSL3 and 2028 for the other TSLs). 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

[49] Euromonitor International. 2021. Air treatment products in the U.S. December. *www.euromonitor.com/air-treatment-products-in-the-us/report.*

[50] TechSci Research. 2022. United States air purifier market, forecast and opportunity. June 2022. *www.techsciresearch.com/report/us-air-purifier-market/3711.html.*

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

the new standard level, and the market share of products above the standard would remain unchanged.

2. National Energy Savings

The national energy savings analysis involves a comparison of national energy consumption of the considered products between each TSL and the case with no new or amended energy conservation standards. DOE calculated the national energy consumption by multiplying the number of units (stock) of each product (by vintage or age) by the unit energy consumption (also by vintage). DOE calculated annual NES based on the difference in national energy consumption for the no-new-standards case and for each higher efficiency standard case. DOE estimated energy consumption and savings based on site energy and converted the electricity consumption and savings to primary energy (*i.e.,* the energy consumed by power plants to generate site electricity) using annual conversion factors derived from *AEO2022.* Cumulative energy savings are the sum of the NES for each year over the timeframe of the analysis.

Use of higher-efficiency 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 and reduction in operating cost. However, DOE did not find any data on a rebound effect specific to air cleaners, and so applied no rebound for air cleaners.

In 2011, in response to the recommendations of a committee on ''Point-of-Use and Full-Fuel-Cycle Measurement Approaches to Energy Efficiency Standards'' appointed by the National Academy of Sciences, DOE announced its intention to use FFC measures of energy use and greenhouse gas and other emissions in the national impact analyses and emissions analyses included in future energy conservation standards rulemakings. 76 FR 51281 (Aug. 18, 2011). After evaluating the approaches discussed in the August 18, 2011 notice, DOE published a statement of amended policy in which DOE explained its determination that EIA's National Energy Modeling System (''NEMS'') is the most appropriate tool for its FFC analysis and its intention to use NEMS for that purpose. 77 FR 49701 (Aug. 17, 2012). NEMS is a public domain, multi-sector, partial equilibrium model of the U.S. energy sector [52] 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.1 of this document, DOE developed air cleaners price trends based on an experience curve that depends on cumulative product shipments. DOE applied the same trends to the non-filter part of the projected prices for each product class at each considered efficiency level. By 2057, which is the end date of the projection period, the average air cleaner price is projected to drop 17 percent relative to 2021. 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 air cleaners. In addition to the default price trend, DOE considered two product price sensitivity cases: (1) a high price decline case based on the small electric household appliance PPI from 2014 to 2021, and (2) a low price decline case based on the small electric household appliance PPI from 2009 to 2014. 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 operating cost savings consist of repair and maintenance costs savings, and energy cost savings. The repair and maintenance cost savings are estimated based on the filter change frequency and costs in the LCC analysis, which are held constant during the lifetime of the air cleaner in the NIA except for the first year.[53] 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 *AEO2022,* which has an end year of 2050. To estimate price trends after 2050, the 2050 value was used for all years. As part of the NIA, DOE also analyzed scenarios that used inputs from variants of the *AEO2022* Reference case that have lower and higher economic growth. Those cases have lower and higher energy price trends compared to the Reference case. NIA results based on these cases are presented in appendix 10C of the 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.[54] 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

[52] For more information on NEMS, refer to *The National Energy Modeling System: An Overview 2018,* DOE/EIA–0581(2019), April 2019. Available at *www.eia.gov/outlooks/aeo/nems/overview/pdf/0581(2018).pdf* (last accessed December 5, 2022).

[53] A new air cleaner unit usually comes with a new filter, which is why the first year of operation has a lower repair and maintenance cost compared to the other years during the lifetime of a unit.

[54] United States Office of Management and Budget. *Circular A–4: Regulatory Analysis.* September 17, 2003. Section E. Available at *obamawhitehouse.archives.gov/omb/circulars_a004_a-4/* (last accessed December 9, 2022).

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 three subgroups: (1) low-income households, (2) senior-only households and (3) small businesses. There may be other subgroups affected by standards for air cleaners, *e.g.,* those with occupants who have chronic respiratory health conditions. However, DOE does not have information indicating that these consumers may be disproportionately affected by new air cleaner standards and DOE did not analyze these consumers as a separate consumer subgroup. The analysis used subsets of the *RECS 2020* and *CBECS 2018* samples composed of households and commercial buildings that meet the criteria for the considered subgroups. DOE used the LCC and PBP spreadsheet model to estimate the impacts of the considered efficiency levels on these subgroups. Chapter 11 in the direct final rule TSD describes the consumer subgroup analysis.

J. Manufacturer Impact Analysis

1. Overview

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

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

The qualitative part of the MIA addresses manufacturer characteristics and market trends. Specifically, the MIA considers such factors as a potential standard's impact on manufacturing capacity, competition within the industry, the cumulative impact of other DOE and non-DOE regulations, and impacts on manufacturer subgroups. The complete MIA is outlined in chapter 12 of the 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 air cleaners manufacturing industry based on the market and technology assessment, preliminary manufacturer interviews, and publicly-available information. This included a top-down analysis of air cleaner 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 air cleaners manufacturing industry, including results of the engineering analysis, the U.S. Census Bureau's ''Economic Census,'' [55] and reports from Dunn & Bradstreet.[56]

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

In addition, during Phase 2, DOE developed interview guides to distribute to manufacturers of air cleaners 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 typically conducts structured, detailed interviews with representative manufacturers. During these interviews, DOE typically discusses engineering, manufacturing, procurement, and financial topics to validate assumptions used in the GRIM and to identify key issues or concerns. For this air cleaners rulemaking, DOE conducted preliminary interviews that focused on key issues, product classes, and the engineering analysis. As part of Phase 3, DOE also evaluated subgroups of manufacturers that may be disproportionately impacted by standards or that may not be accurately represented by the average cost assumptions used to develop the industry cash flow analysis. Such manufacturer subgroups may include small business manufacturers, low-volume manufacturers (''LVMs''), niche players, and/or manufacturers exhibiting a cost structure that largely differs from the industry average. DOE identified one subgroup for a separate impact analysis: small business manufacturers. The small business subgroup is discussed in section VI.B, ''Review under the Regulatory Flexibility Act'' and in chapter 12 of the 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 new standards that result in a higher or lower industry value. The GRIM uses a standard, annual discounted cash-flow analysis that incorporates manufacturer costs, markups, shipments, and industry financial information as inputs. The GRIM models changes in costs, distribution of shipments, investments, and manufacturer margins that could result from an energy conservation standard. The GRIM spreadsheet uses the inputs to arrive at a series of annual cash flows, beginning in 2023 (the base

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

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

year of the analysis) and continuing to 2057. DOE calculated INPVs by summing the stream of annual discounted cash flows during this period. For manufacturers of air cleaners, DOE used a real discount rate of 6.6 percent. Given the lack of publicly-listed original equipment manufacturers (OEMs) of air cleaners, DOE relied on industry parameters from the portable air conditioners final rule published in January 2020. 85 FR 1378 (Jan. 9, 2020). In reviewing other appliance standards rulemakings where DOE had sufficient data to estimate product-specific manufacturer markups and other financial parameters, DOE found portable air conditioners to be the most recent rulemaking covering a product similar to air cleaners in terms of product and market attributes.

The GRIM calculates cash flows using standard accounting principles and compares changes in INPV between the no-new-standards case and each standards case. The difference in INPV between the no-new-standards case and a standards case represents the financial impact of the energy conservation standard on manufacturers. As discussed previously, DOE developed critical GRIM inputs using a number of sources, including publicly available data, results of the engineering 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 manufacturer production costs (''MPCs'') of covered products can affect the revenues, gross margins, and cash flow of the industry.

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

In this rulemaking, DOE applied a hybrid approach of efficiency-level and design-option approaches described above. This approach involved reviewing publicly available efficiency data and physically disassembling commercially available products. From this information, DOE estimated the MPCs for a range of products available at that time on the market. DOE then analyzed the steps manufacturers took to improve product efficiencies. In its analysis, DOE determined that manufacturers would likely rely on certain design options to reach higher efficiencies. From this information, DOE estimated the cost and efficiency impacts of incorporating specific design options at each efficiency level. 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 2023 (the base year) to 2057 (the end year of the analysis period). See chapter 9 of the direct final rule TSD for additional details.

c. Product and Capital Conversion Costs

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

To evaluate the level of product conversion costs industry would likely incur to comply with n energy conservation standard, DOE evaluated the testing costs for manufacturers to certify models to DOE and the investments necessary to update product designed to comply with standards. DOE relied on testing costs from the March 2023 TP Final Rule, which estimated $6,000 for 3rd party lab testing of a basic model. To estimate investment levels, DOE relied on financial parameters to estimate annual spending on R&D; complexity of design options; and percentage of industry shipments that would require redesign. Product conversion costs by efficiency level are presented in Table IV.16 through Table IV.18. To evaluate the level of capital conversion costs for the industry, DOE relied on its product teardowns and analysis of the equipment and tooling required to produce conventional air cleaners. The conversion cost estimates are driven by the number of injection mold dies that would require replacement as a result of standards. Capital conversion costs by efficiency level are presented in Table IV.16 through Table IV.18.

TABLE IV.16—CONVERSION COST ($M) FOR PC1 (10 > $PM_{2.5}$ CADR <100)

Efficiency level	Product conversion cost	Capital conversion cost
1	$3.6	$6.1
2	9.0	8.4
3	19.0	14.2
4	20.6	15.1

TABLE IV.17—CONVERSION COST ($M) FOR PC2 (100 > $PM_{2.5}$ CADR <150)

Efficiency level	Product conversion cost	Capital conversion cost
1	$3.1	$5.6
2	7.8	7.6
3	26.7	13.9
4	29.8	15.0

TABLE IV.18—CONVERSION COST ($M) FOR PC3 ($PM_{2.5}$ CADR ≥150)

Efficiency level	Product conversion cost	Capital conversion cost
1	$6.9	$5.5
2	17.2	7.3
3	48.5	14.3
4	50.1	14.7

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 standard. 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 a 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 31 percent for all air cleaners.[57] This scenario represents a high bound of industry profitability under an energy conservation standard.

Under 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 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

In response to the request for comment published in January 2022, Molekule stated manufacturers may incur costs if energy efficiency redesign results in a repeat verification and testing for the Federal Drug Administration (FDA)-cleared device requirements. Additionally, manufacturers may need to re-submit new Premarket Notifications 510(k) to the FDA. (Molekule, No. 11, pp. 3–4)

DOE evaluated the FDA requirements and does not anticipate air cleaner standards affecting submissions of Premarket Notifications 510(k) because any design options that (1) significantly affect the safety or effectiveness of the device or (2) change or modify the intended use of the device would be screened out in the screening analysis. Thus, DOE's analysis does not include costs for Premarket Notifications 510(k) verification.

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 emission factors intended to represent the marginal impacts of the change in electricity consumption associated with amended or new standards. The methodology is based on results published for the *AEO,* including a set of side cases that implement a variety of efficiency-related policies. The methodology is described in appendix 13A in the direct final rule TSD. The analysis presented in this document uses projections from *AEO2022.*

Power sector emissions of CH_4 and N_2O from fuel combustion are estimated using Emission Factors for Greenhouse Gas Inventories published by EPA.[58]

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-hours (''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 NIA.

[57] The gross margin percentage of 31 percent is based on manufacturer markup of 1.45.

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

1. Air Quality Regulations Incorporated in DOE's Analysis

DOE's no-new-standards case for the electric power sector reflects the *AEO,* which incorporates the projected impacts of existing air quality regulations on emissions. *AEO2022* generally represents current legislation and environmental regulations, including recent government actions, that were in place at the time of preparation of *AEO2022,* including the emissions control programs discussed in the following paragraphs.[59]

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.[60] *AEO2022* incorporates implementation of CSAPR, including the update to the CSAPR ozone season program emission budgets and target dates issued in 2016. 81 FR 74504 (Oct. 26, 2016).[61] Compliance with CSAPR is flexible among EGUs and is enforced through the use of tradable emissions allowances. Under existing EPA regulations, any excess SO_2 emissions allowances resulting from the lower electricity demand caused by the adoption of an efficiency standard could be used to permit offsetting increases in SO_2 emissions by another regulated EGU.

However, beginning in 2016, SO_2 emissions began to fall as a result of the Mercury and Air Toxics Standards (''MATS'') for power plants. 77 FR 9304 (Feb. 16, 2012). In the MATS final rule, EPA established a standard for hydrogen chloride as a surrogate for acid gas hazardous air pollutants (''HAP'') and also established a standard for SO_2 (a non-HAP acid gas) as an alternative equivalent surrogate standard for acid gas HAP. The same controls are used to reduce HAP and non-HAP acid gas; thus SO_2 emissions are being reduced as a result of the control technologies installed on coal-fired power plants to comply with the MATS requirements for acid gas. In order to continue operating, coal 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 *AEO2022.*

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

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

L. Monetizing Emissions Impacts

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

DOE requests comment on how to address the climate benefits and other non-monetized effects of this direct final rule.

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

[59] For further information, see the Assumptions to *AEO2022* report that sets forth the major assumptions used to generate the projections in the Annual Energy Outlook. Available at *www.eia.gov/outlooks/aeo/assumptions/* (last accessed December 5, 2022).

[60] 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).

[61] In Sept. 2019, the DC Court of Appeals remanded the 2016 CSAPR Update to EPA. In April 2021, EPA finalized the 2021 CSAPR Update which resolved the interstate transport obligations of 21 states for the 2008 ozone NAAQS. 86 FR 23054 (April 30, 2021); *see also,* 86 FR 29948 (June 4, 2021) (correction to preamble). The 2021 CSAPR Update became effective on June 29, 2021. The release of AEO 2022 in February 2021 predated the 2021 CSAPR Update.

of conflict, environmental migration, and the value of ecosystem services.

DOE exercises its own judgment in presenting monetized climate benefits as recommended by applicable Executive orders, and DOE would reach the same conclusion presented in this direct final rule 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 published by DOE.

DOE estimated the global social benefits of CO_2, CH_4, and N_2O reductions (*i.e.,* SC–GHGs) using the estimates presented in the Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990, published in February 2021 by the IWG. The SC–GHGs is the monetary value of the net harm to society associated with a marginal increase in emissions in a given year, or the benefit of avoiding that increase. In principle, SC–GHGs includes the value of all climate change impacts, including (but not limited to) changes in net agricultural productivity, human health effects, property damage from increased flood risk and natural disasters, disruption of energy systems, risk of conflict, environmental migration, and the value of ecosystem services. The SC–GHGs therefore, reflects the societal value of reducing emissions of the gas in question by one metric ton. The SC–GHGs is the theoretically appropriate value to use in conducting benefit-cost analyses of policies that affect CO_2, N_2O, and CH4 emissions. As a member of the IWG involved in the development of the February 2021 SC–GHG TSD, DOE agrees that the interim SC–GHG estimates represent the most appropriate estimate of the SC–GHG until revised estimates have been developed reflecting the latest, peer-reviewed science.

The SC–GHGs estimates presented here were developed over many years, using transparent process, peer-reviewed methodologies, the best science available at the time of that process, and with input from the public. Specifically, in 2009, the IWG, that included the DOE and other executive branch agencies and offices was established to ensure that agencies were using the best available science and to promote consistency in the social cost of carbon (SC–CO_2) values used across agencies. The IWG published SC–CO_2 estimates in 2010 that were developed from an ensemble of three widely cited integrated assessment models (IAMs) that estimate global climate damages using highly aggregated representations of climate processes and the global economy combined into a single modeling framework. The three IAMs were run using a common set of input assumptions in each model for future population, economic, and CO_2 emissions growth, as well as equilibrium climate sensitivity—a measure of the globally averaged temperature response to increased atmospheric CO_2 concentrations. These estimates were updated in 2013 based on new versions of each IAM. In August 2016, the IWG published estimates of the social cost of methane (SC–CH_4) and nitrous oxide (SC–N_2O) using methodologies that are consistent with the methodology underlying the SC–CO_2 estimates. The modeling approach that extends the IWG SC–CO_2 methodology to non-CO_2 GHGs has undergone multiple stages of peer review. The SC–CH_4 and SC–N_2O estimates were developed by Marten *et al.*[62] and underwent a standard double-blind peer review process prior to journal publication. In 2015, as part of the response to public comments received to a 2013 solicitation for comments on the SC–CO_2 estimates, the IWG announced a National Academies of Sciences, Engineering, and Medicine review of the SC–CO_2 estimates to offer advice on how to approach future updates to ensure that the estimates continue to reflect the best available science and methodologies. In January 2017, the National Academies released their final report, Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide, and recommended specific criteria for future updates to the SC–CO_2 estimates, a modeling framework to satisfy the specified criteria, and both near-term updates and longer-term research needs pertaining to various components of the estimation process (National Academies, 2017).[63] Shortly thereafter, in March 2017, President Trump issued Executive Order 13783, which disbanded the IWG, withdrew the previous TSDs, and directed agencies to ensure SC–CO_2 estimates used in regulatory analyses are consistent with the guidance contained in OMB's Circular A–4, ''including with respect to the consideration of domestic versus international impacts and the consideration of appropriate discount rates'' (E.O. 13783, section 5(c)). Benefit-cost analyses following E.O. 13783 used SC–GHG estimates that attempted to focus on the U.S.-specific share of climate change damages as estimated by the models and were calculated using two discount rates recommended by Circular A–4, 3 percent and 7 percent. All other methodological decisions and model versions used in SC–GHG calculations remained the same as those used by the IWG in 2010 and 2013, respectively.

On January 20, 2021, President Biden issued Executive Order 13990, which re-established the IWG and directed it to ensure that the U.S. Government's estimates of the social cost of carbon and other greenhouse gases reflect the best available science and the recommendations of the National Academies (2017). The IWG was tasked with first reviewing the SC–GHG estimates currently used in Federal analyses and publishing interim estimates within 30 days of the E.O. that reflect the full impact of GHG emissions, including by taking global damages into account. The interim SC–GHG estimates published in February 2021 are used here to estimate the climate benefits for this 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

[62] 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.

[63] 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.

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 direct final rule DOE centers attention on a global measure of SC–GHG. This approach is the same as that taken in DOE regulatory analyses from 2012 through 2016. A robust estimate of climate damages that accrue only to U.S. citizens and residents does not currently exist in the literature. As explained in the February 2021 TSD, existing estimates are both incomplete and an underestimate of total damages that accrue to the citizens and residents of the U.S. because they do not fully capture the regional interactions and spillovers discussed above, nor do they include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature. As noted in the February 2021 SC–GHG TSD, the IWG will continue to review developments in the literature, including more robust methodologies for estimating a U.S.-specific SC–GHG value, and explore ways to better inform the public of the full range of carbon impacts. As a member of the IWG, DOE will continue to follow developments in the literature pertaining to this issue.

Second, the IWG found that the use of the social rate of return on capital (7 percent under current OMB Circular A–4 guidance) to discount the future benefits of reducing GHG emissions inappropriately underestimates the impacts of climate change for the purposes of estimating the SC–GHG. Consistent with the findings of the National Academies (2017) and the economic literature, the IWG continued to conclude that the consumption rate of interest is the theoretically appropriate discount rate in an intergenerational context,[64] and recommended that discount rate uncertainty and relevant aspects of intergenerational ethical considerations be accounted for in selecting future discount rates.

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

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

As a member of the IWG involved in the development of the February 2021 SC–GHG TSD, DOE agrees with the previous 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

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

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.[65] Second, the IAMs used to produce these interim estimates do not include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature and the science underlying their ''damage functions''—*i.e.,* the core parts of the IAMs that map global mean temperature changes and other physical impacts of climate change into economic (both market and nonmarket) damages—lags behind the most recent research. For example, limitations include the incomplete treatment of catastrophic and non-catastrophic impacts in the integrated assessment models, their incomplete treatment of adaptation and technological change, the incomplete way in which inter-regional and intersectoral linkages are modeled, uncertainty in the extrapolation of damages to high temperatures, and inadequate representation of the relationship between the discount rate and uncertainty in economic growth over long time horizons. Likewise, the socioeconomic and emissions scenarios used as inputs to the models do not reflect new information from the last decade of scenario generation or the full range of projections. The modeling limitations do not all work in the same direction in terms of their influence on the SC–CO_2 estimates. However, as discussed in the February 2021 TSD, the IWG has recommended that, taken together, the limitations suggest that the interim SC–GHG estimates used in this 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 DFR 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 in the IWG's February 2021 TSD. Table IV.19 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. 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.[66]

TABLE IV.19—ANNUAL SC–CO_2 VALUES FROM 2021 INTERAGENCY UPDATE, 2020–2050

[2021$ Per metric ton CO_2]

Year	Discount rate and statistic			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
2025	18	59	86	176
2030	20	64	93	194
2035	23	70	100	214
2040	26	76	107	234
2045	30	82	114	253
2050	33	88	121	271

For 2051 to 2070, DOE used SC–CO_2 estimates published by EPA, adjusted to 2021$.[67] These estimates are based on methods, assumptions, and parameters identical to the 2020–2050 estimates published by the IWG.

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

b. Social Cost of Methane and Nitrous Oxide

The SC–CH_4 and SC–N_2O values used for this direct final rule were based on the values developed for the February 2021 TSD.[68] Table IV.20 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

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

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

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

[68] Interagency Working Group on Social Cost of Greenhouse Gases, Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide. Interim Estimates Under Executive Order 13990, Washington, DC, February 2021. *www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf?source=email.*

recommended by the IWG. DOE derived values after 2050 using the approach described above for the SC–CO_2.

TABLE IV.20—ANNUAL SC–CH_4 AND SC–N_2O VALUES FROM 2021 INTERAGENCY UPDATE, 2020–2050
[2020$ Per metric ton]

Year	SC–CH_4				SC–N_2O			
	Discount rate and statistic				Discount rate and statistic			
	5%	3%	2.5%	3%	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile	Average	Average	Average	95th percentile
2020	670	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	2,500	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 2021$ using the implicit price deflator for gross domestic product (''GDP'') from the Bureau of Economic Analysis. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the cases using the specific discount rate that had been used to obtain the SC–CH_4 and SC–N_2O estimates in each case.

2. Monetization of Other Emissions Impacts

For this direct final rule, DOE estimated the monetized value of NO_X and SO_2 emissions reductions from electricity generation using the latest benefit-per-ton estimates for that sector from the EPA's Benefits Mapping and Analysis Program.[69] DOE used EPA's values for $PM_{2.5}$-related benefits associated with NO_X and SO_2 and for ozone-related benefits associated with NO_X for 2025 and 2030, and 2040, calculated with discount rates of 3 percent and 7 percent. DOE used linear interpolation to define values for the years not given in the 2025 to 2040 range; for years beyond 2040 the values are held constant. DOE derived values specific to the sector for air cleaners using a method described in appendix 14B of the direct final rule TSD.

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

M. Utility Impact Analysis

The utility impact analysis estimates the changes in installed electrical capacity and generation projected to result for each considered TSL. The analysis is based on published output from the NEMS associated with *AEO2022.* NEMS produces the *AEO* Reference case, as well as a number of side cases that estimate the economy-wide impacts of changes to energy supply and demand. For the current analysis, impacts are quantified by comparing the levels of electricity sector generation, installed capacity, fuel consumption and emissions in the *AEO2022* Reference case and various side cases. Details of the methodology are provided in the appendices to chapters 13 and 15 of the 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.[70] 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

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

[70] As defined in the U.S. Census Bureau's 2016 *Annual Survey of Manufactures,* production workers include ''Workers (up through the line-supervisor level) engaged in fabricating, processing, assembling, inspecting, receiving, packing, warehousing, shipping (but not delivering), maintenance, repair, janitorial, guard services, product development, auxiliary production for plant's own use (*e.g.,* power plant), record keeping, and other closely associated services (including truck drivers delivering ready-mixed concrete)'' Non-production workers are defined as ''Supervision above line-supervisor level, sales (including a driver salesperson), sales delivery (truck drivers and helpers), advertising, credit, collection, installation, and servicing of own products, clerical and routine office functions, executive, purchasing, finance, legal, personnel (including cafeteria, *etc.*), professional and technical.''

economy, as well as the jobs created elsewhere in the economy by this same economic activity. Data from BLS indicate that expenditures in the utility sector generally create fewer jobs (both directly and indirectly) than expenditures in other sectors of the economy.[71] There are many reasons for these differences, including wage differences and the fact that the utility sector is more capital-intensive and less labor-intensive than other sectors. Energy conservation standards have the effect of reducing consumer utility bills. Because reduced consumer expenditures for energy likely lead to increased expenditures in other sectors of the economy, the general effect of efficiency standards is to shift economic activity from a less labor-intensive sector (*i.e.,* the utility sector) to more labor-intensive sectors (*e.g.,* the retail and service sectors). Thus, the BLS data suggest that net national employment may increase due to shifts in economic activity resulting from energy conservation standards.

DOE estimated indirect national employment impacts for the standard levels considered in this direct final rule using an input/output model of the U.S. economy called Impact of Sector Energy Technologies version 4 (''ImSET'').[72] ImSET is a special-purpose version of the ''U.S. Benchmark National Input-Output'' (''I–O'') model, which was designed to estimate the national employment and income effects of energy-saving technologies. The ImSET software includes a computer- based I–O model having structural coefficients that characterize economic flows among 187 sectors most relevant to industrial, commercial, and residential building energy use.

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, where these uncertainties are reduced. For more details on the employment impact analysis, see chapter 16 of the direct final rule TSD.

V. Analytical Results and Conclusions

The following section addresses the results from DOE's analyses with respect to the considered energy conservation standards for air cleaners. It addresses the TSLs examined by DOE, the projected impacts of each of these levels if adopted as energy conservation standards for air cleaners, 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 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 air cleaner 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 five TSLs for air cleaners. DOE developed TSLs that combine efficiency levels for each analyzed product class. DOE presents the results for the TSLs in this document, while the results for all efficiency levels that DOE analyzed are in the direct final rule TSD.

Table V.1 presents the TSLs and the corresponding efficiency levels that DOE has identified for potential energy conservation standards for air cleaners. TSL 5 represents the maximum technologically feasible (''max-tech'') energy efficiency for all product classes and corresponds to EL 4 for all product classes. TSL 4 represents an intermediate efficiency level and corresponds to EL 3 for all product classes. TSL 3 corresponds to the two-tier approach from the Joint Proposal which comprises efficiency level EL 1[73] for Tier 1 standards (going to effect in 2024) and the current ENERGY STAR V.2.0 efficiency level (EL 2) for Tier 2 standards (going to effect in 2026) for all the product classes. TSL 2 comprises the current ENERGY STAR V.2.0 efficiency level (EL 2) for all product classes. TSL 1 represents EL 1 for all product classes. For all TSLs other than TSL 3, the compliance year is considered to be 2028.

TABLE V.1—TRIAL STANDARD LEVELS FOR AIR CLEANERS

TSL	Compliance year	PC1: 10–100 $PM_{2.5}$ CADR		PC2: 100–150 $PM_{2.5}$ CADR		PC2: 100–150 $PM_{2.5}$ CADR	
		Efficiency level	Efficiency ($PM_{2.5}$ CADR/W)	Efficiency level	Efficiency ($PM_{2.5}$ CADR/W)	Efficiency level	Efficiency ($PM_{2.5}$ CADR/W)
1	2028	1	1.7	1	1.9	1	2.0
2	2028	2	1.9	2	2.4	2	2.9
3	2024 (Tier 1)	1	1.7	1	1.9	1	2.0
	2026 (Tier 2)	2	1.9	2	2.4	2	2.9
4	2028	3	3.4	3	5.4	3	6.6
5	2028	4	5.4	4	12.8	4	7.4

B. Economic Justification and Energy Savings

1. Economic Impacts on Individual Consumers

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

a. Life-Cycle Cost and Payback Period

In general, higher-efficiency products affect consumers in two ways: (1) purchase price increases and (2) annual

[71] *See* U.S. Department of Commerce–Bureau of Economic Analysis. *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (''RIMS II'').* 1997. U.S. Government Printing Office: Washington, DC. Available at *www.bea.gov/scb/pdf/regional/perinc/meth/rims2.pdf* (last accessed July 1, 2021).

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

[73] EL 1 also corresponds to individual standards established by certain states and the District of Columbia.

operating costs decrease.[74] 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.

Table V.2 through Table V.7 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 no-new-standards case in the compliance year (see section IV.F.8 of this document). Because some consumers purchase products with higher efficiency in the no-new-standards case, the average savings are less than the difference between the average LCC of the baseline product and the average LCC at each TSL. The savings refer only to consumers who are affected by a standard at a given TSL. Those who already purchase a product with efficiency at or above a given TSL are not affected. Consumers for whom the LCC increases at a given TSL experience a net cost.

TABLE V.2—AVERAGE LCC AND PBP RESULTS FOR PRODUCT CLASS 1: 10–100 $PM_{2.5}$ CADR

TSL *	Efficiency level	Average costs (2021$)				Simple payback (years)	Average lifetime (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
	Baseline	$64	$13	$117	$181		9.0
1	1	65	11	98	163	0.9	9.0
2	2	67	10	91	158	1.4	9.0
3 **	1	65	11	98	163	0.9	9.0
	2	67	10	91	158	1.4	9.0
4	3	78	15	178	255	NA	9.0
5	4	86	14	176	262	NA	9.0

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.
* All TSLs except TSL 3 have a compliance year of 2028.
** For TSL 3, the first results row has a 2024 compliance year. The second results row has a 2026 compliance year.

TABLE V.3—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR PRODUCT CLASS 1: 10–100 $PM_{2.5}$ CADR

TSL **	Efficiency level	Life-cycle cost savings	
		Average LCC savings * (2021$)	Percent of consumers that experience net cost (%)
1	1	$18	0
2	2	12	6
3 ***	1	18	0
	2	12	6
4	3	(87)	88
5	4	(87)	94

* The savings represent the average LCC for affected consumers.
** All TSLs except TSL 3 have a compliance year of 2028.
*** For TSL 3, the first results row has a 2024 compliance year. The second results row has a 2026 compliance year.

TABLE V.4—AVERAGE LCC AND PBP RESULTS FOR PRODUCT CLASS 2: 100–150 $PM_{2.5}$ CADR

TSL *	Efficiency level	Average costs (2021$)				Simple payback (years)	Average lifetime (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
	Baseline	$88	$31	$273	$361		9.0
1	1	90	26	232	322	0.4	9.0
2	2	92	22	195	287	0.5	9.0
3 **	1	90	26	232	322	0.4	9.0
	2	92	22	195	287	0.5	9.0
4	3	101	24	280	381	NA	9.0
5	4	109	17	207	317	1.6	9.0

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.
* All TSLs except TSL 3 have a compliance year of 2028.

[74] For air cleaners, operating costs may increase at certain efficiency levels as filter costs increase due to recurring costs for filter replacements.

** For TSL 3, the first results row has a 2024 compliance year. The second results row has a 2026 compliance year.

TABLE V.5—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR PRODUCT CLASS 2: 10–100 $PM_{2.5}$ CADR

TSL **	Efficiency level	Life-cycle cost savings	
		Average LCC savings * (2021$)	Percent of consumers that experience net cost (%)
1	1	$38	0
2	2	50	0
3 ***	1	38	0
	2	50	0
4	3	(60)	75
5	4	11	54

* The savings represent the average LCC for affected consumers.
** All TSLs except TSL 3 have a compliance year of 2028.
*** For TSL 3, the first results row has a 2024 compliance year. The second results row has a 2026 compliance year.

TABLE V.6—AVERAGE LCC AND PBP RESULTS FOR PRODUCT CLASS 3: 150+ $PM_{2.5}$ CADR

TSL *	Efficiency level	Average costs (2021$)				Simple payback (years)	Average lifetime (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
	Baseline	$144	$57	$485	$629		9.0
1	1	146	41	377	523	0.1	9.0
2	2	147	34	323	470	0.1	9.0
3 **	1	146	41	377	523	0.1	9.0
	2	147	34	323	470	0.1	9.0
4	3	151	31	347	497	0.3	9.0
5	4	151	31	354	505	0.3	9.0

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.
* All TSLs except TSL 3 have a compliance year of 2028.
** For TSL 3, the first results row has a 2024 compliance year. The second results row has a 2026 compliance year.

TABLE V.7—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR PRODUCT CLASS 3: 10–100 $PM_{2.5}$ CADR

TSL **	Efficiency level	Life-cycle cost savings	
		Average LCC savings * (2021$)	Percent of consumers that experience net cost (%)
1	1	$105	0
2	2	94	0
3 ***	1	105	0
	2	94	0
4	3	29	50
5	4	20	56

* The savings represent the average LCC for affected consumers.
** All TSLs except TSL 3 have a compliance year of 2028.
*** For TSL 3, the first results row has a 2024 compliance year. The second results row has a 2026 compliance year.

b. Consumer Subgroup Analysis

In the consumer subgroup analysis, DOE estimated the impact of the considered TSLs on low-income households, senior-only households, and small businesses. Table V.8 through Table V.13 compare the average LCC savings and PBP at each efficiency level for the consumer subgroups with similar metrics for the entire consumer sample for all product classes. In most cases, the average LCC savings and PBP for low-income households and senior-only households at the considered efficiency levels are not substantially different from the average for all households. Chapter 11 of the direct final rule TSD presents the complete LCC and PBP results for the subgroups.

TABLE V.8—COMPARISON OF LCC SAVINGS AND PBP FOR RESIDENTIAL CONSUMER SUBGROUPS AND ALL HOUSEHOLDS; PRODUCT CLASS 1: 10–100 $PM_{2.5}$ CADR

TSL **	Low-income households ‡	Senior-only households §	All households
Average LCC Savings * (2021$)			
TSL 1	$17	$19	$17
TSL 2	10	13	11
TSL 3 ***	17	19	17
	10	13	11
TSL 4	(95)	(87)	(95)
TSL 5	(97)	(85)	(95)
Payback Period (years)			
TSL 1	1.2	1.0	1.2
TSL 2	1.9	1.5	1.8
TSL 3 ***	1.2	1.0	1.2
	1.9	1.5	1.8
TSL 4	NA	NA	NA
TSL 5	NA	NA	NA
Consumers With Net Benefit (%)			
TSL 1	29	29	29
TSL 2	61	64	63
TSL 3 ***	29	29	29
	61	64	63
TSL 4	0	1	0
TSL 5	1	2	1
Consumers With Net Cost (%)			
TSL 1	0	0	0
TSL 2	10	7	9
TSL 3 ***	0	0	0
	10	7	9
TSL 4	89	89	89
TSL 5	96	94	95

* The savings represent the average LCC for affected consumers.
** All TSLs except TSL 3 have a compliance year of 2028.
*** For TSL 3, the first results row has a 2024 compliance year. The second results row has a 2026 compliance year.
‡ Low-income households represent 13.8 percent of all households for this product class.
§ Senior-only households represent 22.7 percent of all households for this product class.

TABLE V.9—COMPARISON OF LCC SAVINGS AND PBP FOR COMMERCIAL CONSUMER SUBGROUP AND ALL COMMERCIAL BUILDINGS; PRODUCT CLASS 1: 10–100 $PM_{2.5}$ CADR

TSL **	Small business ‡	All commercial buildings
Average LCC Savings * (2021$)		
TSL 1	$18	$19
TSL 2	14	14
TSL 3 ***	18	19
	14	14
TSL 4	(77)	(77)
TSL 5	(75)	(75)
Payback Period (years)		
TSL 1	0.7	0.7
TSL 2	1.0	1.0
TSL 3 ***	0.7	0.7
	1.0	1.0
TSL 4	NA	NA
TSL 5	NA	NA
Consumers With Net Benefit (%)		
TSL 1	28	28
TSL 2	68	68
TSL 3 ***	28	28

TABLE V.9—COMPARISON OF LCC SAVINGS AND PBP FOR COMMERCIAL CONSUMER SUBGROUP AND ALL COMMERCIAL BUILDINGS; PRODUCT CLASS 1: 10–100 $PM_{2.5}$ CADR—Continued

TSL **	Small business ‡	All commercial buildings
	68	68
TSL 4	0	0
TSL 5	3	3
Consumers With Net Cost (%)		
TSL 1	0	0
TSL 2	1	1
TSL 3 ***	0	0
	1	1
TSL 4	87	86
TSL 5	92	91

* The savings represent the average LCC for affected consumers.
** All TSLs except TSL 3 have a compliance year of 2028.
*** For TSL 3, the first results row has a 2024 compliance year. The second results row has a 2026 compliance year.
‡ Small business buildings represent 70.9 percent of all commercial buildings for this product class.

TABLE V.10—COMPARISON OF LCC SAVINGS AND PBP FOR RESIDENTIAL CONSUMER SUBGROUPS AND ALL HOUSEHOLDS; PRODUCT CLASS 2: 100–150 $PM_{2.5}$ CADR

TSL **	Low-income households ‡	Senior-only households §	All households
Average LCC Savings * (2021$)			
TSL 1	34	43	35
TSL 2	44	56	46
TSL 3 ***	34	43	35
	44	56	46
TSL 4	(78)	(54)	(75)
TSL 5	(9)	23	(4)
Payback Period (years)			
TSL 1	0.6	0.4	0.6
TSL 2	0.7	0.5	0.6
TSL 3 ***	0.6	0.4	0.6
	0.7	0.5	0.6
TSL 4	NA	NA	NA
TSL 5	NA	1.5	NA
Consumers With Net Benefit (%)			
TSL 1	24	24	24
TSL 2	60	60	60
TSL 3 ***	24	24	24
	60	60	60
TSL 4	8	15	8
TSL 5	35	54	38
Consumers With Net Cost (%)			
TSL 1	0	0	0
TSL 2	0	0	0
TSL 3 ***	0	0	0
	0	0	0
TSL 4	82	74	81
TSL 5	64	46	61

* The savings represent the average LCC for affected consumers.
** All TSLs except TSL 3 have a compliance year of 2028.
*** For TSL 3, the first results row has a 2024 compliance year. The second results row has a 2026 compliance year.
‡ Low-income households represent 13.8 percent of all households for this product class.
§ Senior-only households represent 22.7 percent of all households for this product class.

TABLE V.11—COMPARISON OF LCC SAVINGS AND PBP FOR CONSUMER SUBGROUPS AND ALL COMMERCIAL BUILDINGS; PRODUCT CLASS 2: 100–150 $PM_{2.5}$ CADR

TSL **	Small business ‡	All commercial buildings
Average LCC Savings * (2021$)		
TSL 1	$44	$44
TSL 2	$57	$57
TSL 3 ***	$44	$44
	$57	$57
TSL 4	($38)	($38)
TSL 5	$32	$33
Payback Period (years)		
TSL 1	0.3	0.3
TSL 2	0.3	0.3
TSL 3 ***	0.3	0.3
	0.3	0.3
TSL 4	NA	NA
TSL 5	1.1	1.0
Consumers With Net Benefit (%)		
TSL 1	23%	23%
TSL 2	59%	59%
TSL 3 ***	23%	23%
	59%	59%
TSL 4	20%	20%
TSL 5	56%	55%
Consumers With Net Cost (%)		
TSL 1	0%	0%
TSL 2	0%	0%
TSL 3 ***	0%	0%
	0%	0%
TSL 4	67%	67%
TSL 5	41%	42%

* The savings represent the average LCC for affected consumers.
** All TSLs except TSL 3 have a compliance year of 2028.
*** For TSL 3, the first results row has a 2024 compliance year. The second results row has a 2026 compliance year.
‡ Small business buildings represent 70.9 percent of all commercial buildings for this product class.

TABLE V.12—COMPARISON OF LCC SAVINGS AND PBP FOR RESIDENTIAL CONSUMER SUBGROUPS AND ALL HOUSEHOLDS; PRODUCT CLASS 3: 150+ $PM_{2.5}$ CADR

TSL **	Low-income households ‡	Senior-only households §	All households
Average LCC Savings * (2021$)			
TSL 1	$85	$127	$88
TSL 2	$76	$111	$80
TSL 3 ***	$85	$127	$88
	$76	$111	$80
TSL 4	$2	$47	$7
TSL 5	($7)	$38	($2)
Payback Period (years)			
TSL 1	0.2	0.1	0.2
TSL 2	0.2	0.1	0.2
TSL 3 ***	0.2	0.1	0.2
	0.2	0.1	0.2
TSL 4	0.4	0.2	0.4
TSL 5	NA	0.3	NA
Consumers With Net Benefit (%)			
TSL 1	22%	22%	22%
TSL 2	56%	56%	56%
TSL 3 ***	22%	22%	22%
	56%	56%	56%

TABLE V.12—COMPARISON OF LCC SAVINGS AND PBP FOR RESIDENTIAL CONSUMER SUBGROUPS AND ALL HOUSEHOLDS; PRODUCT CLASS 3: 150+ $PM_{2.5}$ CADR—Continued

TSL **	Low-income households ‡	Senior-only households §	All households
TSL 4	32%	49%	35%
TSL 5	29%	47%	32%
Consumers With Net Cost (%)			
TSL 1	0%	0%	0%
TSL 2	0%	0%	0%
TSL 3 ***	0%	0%	0%
	0%	0%	0%
TSL 4	61%	44%	59%
TSL 5	67%	49%	64%

* The savings represent the average LCC for affected consumers.
** All TSLs except TSL 3 have a compliance year of 2028.
*** For TSL 3, the first results row has a 2024 compliance year. The second results row has a 2026 compliance year.
‡ Low-income households represent 13.8 percent of all households for this product class.
§ Senior-only households represent 22.7 percent of all households for this product class.

TABLE V.13—COMPARISON OF LCC SAVINGS AND PBP FOR COMMERCIAL CONSUMER SUBGROUPS AND ALL COMMERCIAL BUILDINGS; PRODUCT CLASS 3: 150+ $PM_{2.5}$ CADR

TSL **	Small business ‡	All commercial buildings
Average LCC Savings * (2021$)		
TSL 1	$133	$132
TSL 2	$117	$116
TSL 3 ***	$133	$132
	$117	$116
TSL 4	$61	$61
TSL 5	$54	$54
Payback Period (years)		
TSL 1	0.1	0.1
TSL 2	0.1	0.1
TSL 3 ***	0.1	0.1
	0.1	0.1
TSL 4	0.2	0.2
TSL 5	0.2	0.2
Consumers With Net Benefit (%)		
TSL 1	21%	21%
TSL 2	55%	54%
TSL 3 ***	21%	21%
	55%	54%
TSL 4	54%	54%
TSL 5	51%	51%
Consumers With Net Cost (%)		
TSL 1	0%	0%
TSL 2	0%	0%
TSL 3 ***	0%	0%
	0%	0%
TSL 4	37%	37%
TSL 5	43%	43%

* The savings represent the average LCC for affected consumers.
** All TSLs except TSL 3 have a compliance year of 2028.
*** For TSL 3, the first results row has a 2024 compliance year. The second results row has a 2026 compliance year.
‡ Small business buildings represent 70.9 percent of all commercial buildings for this product class.

c. Rebuttable Presumption Payback

As discussed in section III.F.2 of this document, EPCA establishes a rebuttable presumption that an energy conservation standard is economically justified if the increased purchase cost for a product that meets the standard is less than three times the value of the first-year energy savings resulting from the standard. (42 U.S.C. 6295(o)(2)(iii)) 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 air cleaners. In contrast, the PBPs presented in section V.B.1.a were calculated using distributions that reflect the range of energy use in the field.

Table V.14 presents the rebuttable-presumption payback periods for the considered TSLs for air cleaners. 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.14—REBUTTABLE-PRESUMPTION PAYBACK PERIODS

Product class	Trial standard level (years)					
	1	2	3		4	5
			Tier 1	Tier 2		
PC 1: 10–100 $PM_{2.5}$ CADR	0.6	0.7	0.6	0.7	0.9	1.1
PC 2: 100–150 $PM_{2.5}$ CADR	0.2	0.2	0.2	0.2	0.3	0.4
PC 3: 150+ $PM_{2.5}$ CADR	0.0	0.0	0.0	0.0	0.1	0.1

2. Economic Impacts on Manufacturers

DOE performed an MIA to estimate the impact of energy conservation standards on manufacturers of air cleaners. 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 energy conservation standards on manufacturers of air cleaners, as well as the conversion costs that DOE estimates manufacturers of air cleaners would incur at each TSL.

To evaluate the range of cash-flow impacts on the air cleaners industry, DOE modeled two manufacturer markup scenarios to evaluate a range of cash flow impacts on the air cleaners industry: (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. In the preservation of gross margin percentage scenario, DOE applied a gross margin percentage of 31 percent for all product classes and all efficiency levels.[75] As MPCs increase with efficiency, this scenario implies that the absolute dollar markup will increase. This scenario assumes that a manufacturer's absolute dollar markup 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 standards on industry.

Each of the modeled scenarios results in a unique set of cash flows and corresponding INPV for each TSL. INPV is the sum of the discounted cash flows to the industry from the base year through the end of the analysis period (2023–2057). The ''change in INPV'' results refer to the difference in industry value between the no-new-standards case and standards case at each TSL. To provide perspective on the short-run cash flow impact, DOE includes a comparison of free cash flow between the no-new-standards case and the standards case at each TSL in the year before standards would take effect. This figure provides an understanding of the magnitude of the required conversion costs relative to the cash flow generated by the industry 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 new or amended standards. As described in section IV.J.2.c of this document, conversion cost investments occur between the year of publication of the final rule and the year by which manufacturers must comply with the new standard. The conversion costs can have a significant impact on the short-term cash flow on the industry and generally result in lower free cash flow in the period between the publication of the final rule and the compliance date of potential standards. Conversion costs are independent of the manufacturer markup scenarios and are not presented as a range in this analysis.

Table V.15 and Table V.16 show the MIA results for each TSL using the manufacturer markup scenarios previously described.

[75] The gross margin percentage of 31 percent is based on manufacturer markup of 1.45.

TABLE V.15—MANUFACTURER IMPACT ANALYSIS FOR AIR CLEANERS UNDER THE PRESERVATION OF GROSS MARGIN SCENARIO

	Units	No-new-standards case	Trial standard level				
			1	2	3*	4	5
INPV	2021$ millions	1,565.9	1,535.7	1,528.0	1,525.2	1,535.8	1,574.0
Change in INPV	2021$ millions		(30.2)	(37.9)	(40.7)	(30.2)	8.1
	%		(1.9)	(2.4)	(2.6)	(1.9)	0.5
Free Cash Flow (2027)	2021$ millions	53.8	42.1	30.9	20.8 and 40.1**	(2.4)	(6.0)
Change in Free Cash Flow (2027)	%		(21.8)	(42.6)	(55.7) and (19.7)**	(104.5)	(111.2)
Product Conversion Costs	2021$ millions		17.2	23.2	23.2	42.4	44.7
Capital Conversion Costs	2021$ millions		13.6	34.1	34.1	94.1	100.5
Total Conversion Costs	2021$ millions		30.8	57.3	57.3	136.6	145.2

*TSL 3 represents the standards case presented in the Joint Proposal which corresponds to a two-tiered approach. Conversion costs reflect the sum of Tier 1 and Tier 2 standards.

**The Free Cash Flow and % Change in Free Cash Flow for TSL 3 is presented to the years 2023 and 2025 due to the 2-step structure of the Joint Proposal. DOE presents FCF in the year before the standard year.

TABLE V.16—MANUFACTURER IMPACT ANALYSIS FOR AIR CLEANERS UNDER THE PRESERVATION OF OPERATING PROFIT SCENARIO

	Units	No-new-standards case	Trial standard level				
			1	2	3*	4	5
INPV	2021$ millions	1,565.9	1,528.3	1,503.5	1,499.2	1,422.3	1,394.4
Change in INPV	2021$ millions		(37.7)	(62.4)	(66.7)	(143.7)	(171.5)
	%		(2.4)	(4.0)	(4.3)	(9.2)	(11.0)
Free Cash Flow (2027)	2021$ millions	53.8	42.1	30.9	20.8 and 40.1**	(2.4)	(6.0)
Change in Free Cash Flow (2027)	%		(21.8)	(42.6)	(55.7) and (19.7)**	(104.5)	(111.2)
Product Conversion Costs	2021$ millions		17.2	23.2	23.2	42.4	44.7
Capital Conversion Costs	2021$ millions		13.6	34.1	34.1	94.1	100.5
Total Conversion Costs	2021$ millions		30.8	57.3	57.3	136.6	145.2

*TSL 3 represents the standards case presented in the Joint Proposal which corresponds to a two-tiered approach. Conversion costs reflect the sum of Tier 1 and Tier 2 standards.

**The Free Cash Flow and % Change in Free Cash Flow for TSL 3 is presented to the years 2023 and 2025 due to the 2-step structure of the Joint Proposal. DOE presents FCF in the year before the standard year.

At TSL 1, DOE estimates that impacts on INPV will range from −$30.2 million to −$37.7 million, or a change in INPV of −2.4 to −1.9 percent. At TSL 1, industry free cash-flow is $42.1 million, which is a decrease of approximately $11.7 million compared to the no-new-standards case value of $53.8 million in 2027, the year leading up to the standards.

TSL 1 corresponds to EL 1 for all product classes. DOE noted in the engineering analysis, section IV.C.3, the efficiency improvements at EL 1 are achievable by optimizing the fan motor-filter relationship. In evaluating the design paths for optimization, DOE noted that increasing the surface area of the filter would improve test performance, but could also require changes to the injection molded component of air cleaners. DOE estimated capital conversion costs based on the costs for manufacturer to purchase new injection mold dies in order to accommodate filters with greater surface area. Manufacturers using soft tooling or that do not rely on injection molding would have lower capital conversion costs than modeled by DOE. DOE estimated the product conversion costs for testing all models, identifying product that would not meet the standard, and redesigning that portion of market offerings. DOE estimates capital conversion costs of $13.6 million and product conversion costs of $17.2 million for the industry. Conversion costs total $30.8 million.

At TSL 1, the shipment-weighted average MPC for all air cleaners is expected to increase by 1 percent relative to the no-new-standards case shipment-weighted average MPC for all air cleaners in 2028. Given this relatively small increase in production costs, DOE does not project a notable drop in shipments in the year the standard takes effect. In the preservation of gross margin percentage scenario, the slight increase in MSP is outweighed by the $30.8 million in conversion costs, causing a negative change in INPV at TSL 1 under this scenario. Under the preservation of operating profit scenario, the reduction in the manufacturer markup and the $30.8 million in conversion costs incurred by manufacturers cause a slightly negative change in INPV.

At TSL 2, the standard corresponds to current ENERGY STAR V.2.0 efficiency levels for air cleaners in all product classes. DOE estimates that impacts on INPV will range from −$62.4 million to −$37.9 million, or a change in INPV of −4.0 to −2.4 percent. At TSL 2, industry free cash-flow is $30.9 million, which is a decrease of approximately $22.9 million compared to the no-new-standards case value of $53.8 million in 2027, the year leading up to the standards.

TSL 2 corresponds to EL 2 for all product classes. A sizeable portion of the market, approximately 40 percent, can currently meet the TSL 2 level. Additionally, a substantial portion of existing models can be updated to meet TSL 2 through optimization and improved components rather than a full product redesign. In particular, manufacturers may be able to leverage their existing cabinet designs. However, the product interior may require updates to accommodate more efficient motors and larger filters. Some manufacturers may be able to alter existing tooling to accommodate minor changes in internal dimensions. To avoid underestimating costs to industry, DOE estimated capital conversion costs based on the cost to replace tooling—specifically injection molding dies. Also, DOE estimated the product conversion costs for testing all models, identifying product that would not meet the standard, and redesigning that portion of market offerings. Capital conversion costs may reach $34.1 million and product conversion costs may reach $23.2 million for the industry. Conversion costs total $57.3 million.

At TSL 2, the shipment-weighted average MPC for all air cleaners is expected to increase by 2 percent relative to the no-new-standards case shipment-weighted average MPC for all air cleaners in 2028. Given the relatively small increase in production costs, DOE does not project a notable drop in shipments in the year the standard takes effect. In the preservation of gross margin percentage scenario, the slight increase in MSP is outweighed by the $57.3 million in conversion costs, causing a negative change in INPV at TSL 2 under this scenario. Under the preservation of operating profit scenario, the manufacturer markup decreases in 2029, the year after the analyzed compliance year. This reduction in the manufacturer markup and the $57.3 million in conversion costs incurred by manufacturers cause a negative change in INPV at TSL 2 under the preservation of operating profit scenario.

At TSL 3, DOE estimates that impacts on INPV will range from −$66.7 million to −$40.7 million, or a change in INPV of −4.3 to −2.6 percent. At TSL 3, industry free cash-flow is $40.1 million in 2027, which is a decrease of approximately $9.9 million compared to the no-new-standards case value of $53.8 million in 2027, the year leading up to the standards.

For TSL 3, DOE analyzed the standards case presented in the Joint Proposal which corresponds to a two-tier approach of the lowest efficiency level (EL 1)[76] for Tier 1 standards (going to effect in 2024) and the current ENERGY STAR V.2.0 efficiency level (EL 2) for Tier 2 standards (going to effect in 2026) for all the product classes. The industry impacts at TSL 3 are very similar to the impacts at TSL 2 because both scenarios result in standards at the Tier 2 level. However, TSL 3 is a two-tier standard with earlier compliance dates. While conversion costs for TSL 3 and TSL 2 are identical, the timing of the costs are different. As a result, the earlier timing of conversion costs result in lower INPV values at TSL 3 than at TSL 2. However, industry may benefit from a national standard at Tier 1 in the 2024 timeframe in the form of potential reductions in stock keeping units (SKUs), marketing and sales complexity, and reduced consumer confusion associated with a patchwork of state-level energy performance standards for air cleaners. The MIA does not attempt to calculate the cost savings from industry that results from single national standard.

At TSL 3, the shipment-weighted average MPC for all air cleaners is expected to increase by 2 percent relative to the no-new-standards case shipment-weighted average MPC for all air cleaners in 2028. Given the relatively small increase in production costs, DOE does not project a notable drop in shipments in the year the standard takes effect. In the preservation of gross margin percentage scenario, the increase in MSP is outweighed by the $57.3 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 2029, the year after the analyzed compliance year. This reduction in the manufacturer markup and the $57.3 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, DOE estimates that impacts on INPV will range from −$143.7 million to −$30.2 million, or a change in INPV of −9.2 to −1.9 percent. At TSL 4, industry free cash-flow is −$2.4 million, which is a decrease of approximately $56.2 million compared to the no-new-standards case value of $53.8 million in 2027, the year leading up to the standards.

At TSL 4, all three product classes would likely incorporate cylindrical shaped filters and BLDC motors without an optimized motor-filter relationship. The cylindrical filter, which reduces the pressure drop across the filter because it allows for a larger surface area for the same volume of filter material, provides the improvement in efficiency at TSL 4 compared to TSL 3, which utilizes rectangular shaped filters. However, most models on the market today do not use BLDC motors and cannot accommodate cylindrical filters. Manufacturers would incur conversion costs to redesign the product to incorporate a different filter shape and more efficient components. Additionally, manufacturers that own tooling would incur conversion costs for updated cabinet designs. DOE estimates capital conversion costs of $94.1 million and product conversion of costs of $42.4 million. Conversion costs total $136.6 million.

At TSL 4, the shipment-weighted average MPC for all air cleaners is expected to increase by 8 percent relative to the no-new-standards case shipment-weighted average MPC for all air cleaners in 2028. Given the projected increase in production costs, DOE expects an estimated 4 percent drop in shipments in the year the standard takes effect. In the preservation of gross margin percentage scenario, the increase in MSP is outweighed by the $136.6 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 2029, the year after the analyzed compliance year. This reduction in the manufacturer markup and the $136.6 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, DOE estimates that impacts on INPV will range from −$171.5 million to $8.1 million, or a change in INPV of −11.0 to 0.5 percent. At TSL 5, industry free cash-flow is −$6.0 million, which is a decrease of approximately $59.8 million compared to the no-new-standards case value of $53.8 million in 2027, the year leading up to the standards.

At TSL 5, DOE's expected design path for TSL 5 incorporates cylindrical shaped filters and BLDC motors with an optimized motor-filter relationship. As noted for TSL 4, the adoption of cylindrical filters would necessitate platform level redesign for most products on the market. Additionally, the move to cylindrical filters could necessitate significantly different cabinet designs. DOE estimates capital conversion costs of $100.5 million and product conversion of costs of $44.7 million. Conversion costs total $145.2 million.

At TSL 5, the shipment-weighted average MPC for all air cleaners is expected to increase by 13 percent relative to the no-new-standards case shipment-weighted average MPC for all air cleaners in 2028. Given the projected increase in production costs, DOE expects an estimated 6 percent drop in shipments in the year the standard takes effect. In the preservation of gross margin percentage scenario, INPV remains roughly the same as in the no-new-standards scenario. Under the preservation of operating profit scenario, reduction in the manufacturer markup, reduction in shipments, and the $145.2 million in conversion costs incurred by manufacturers cause a negative change in INPV at TSL 5.

[76] EL 1 also corresponds to individual standards established by certain states and the District of Colombia.

b. Direct Impacts on Employment

To quantitatively assess the potential impacts of energy conservation standards on direct employment in the air cleaner industry, DOE used the GRIM to estimate the domestic labor expenditures and number of direct employees in the no-new-standards case and in each of the standards cases during the analysis period. DOE calculated these values using statistical data from the U.S. Census Bureau's 2020 Annual Survey of Manufacturers (''ASM''),[77] BLS employee compensation data,[78] results of the engineering analysis, and reports from Dunn & Bradstreet.[79]

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

The number of production employees is then multiplied by the U.S. labor percentage to convert total production employment to total domestic production employment. The U.S. labor percentage represents the industry fraction of domestic manufacturing production capacity for the covered product. This value is derived from manufacturer interviews, product database analysis, and publicly available information. DOE estimates that 2.5 percent of air cleaners 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. Using the amount of domestic production workers calculated previously, non-production domestic employees are extrapolated by multiplying the ratio of non-production workers in the industry compared to production employees. DOE assumes that this employee distribution ratio remains constant between the no-new-standards case and standards cases.

Using the GRIM, DOE estimates in the absence of new energy conservation standards there would be 58 domestic workers for air cleaners in 2028. Table V.17 shows the range of the impacts of energy conservation standards on U.S. manufacturing employment in the air cleaner industry. The following discussion provides a qualitative evaluation of the range of potential impacts presented in Table V.17.

TABLE V.17—DOMESTIC DIRECT EMPLOYMENT IMPACTS FOR AIR CLEANERS MANUFACTURERS IN 2028

	No-new-standards case	Trial standard level				
		1	2	3**	4	5
Domestic Production Workers in 2028	58	59	59	59	59	59
Domestic Non-Production Workers in 2028	25	26	26	26	26	26
Total Direct Employment in 2028	83	85	85	85	85	85
Potential Changes in Total Direct Employment in 2028		(58) to 1	(58) to 1	(58) to 1	(58) to 1	(58) to 1

* Parentheses denote negative values.
** For TSL 3, Tier 2 standard goes into effect in 2026. DOE presents 2028 Direct Employment for consistent comparison in this table.

The direct employment impacts shown in Table V.17 represent the potential domestic employment changes that could result following the compliance date of the air cleaner standards considered. The upper bound estimate corresponds to an increase in the number of domestic workers that would result from energy conservation standards if manufacturers continue to produce the same scope of covered equipment 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 their air cleaners in countries with lower labor costs.

Of the 300 air cleaner brands DOE identified, the vast majority are produced outside of the U.S. DOE identified 4 companies that have U.S. manufacturing. These companies have distinct designs and manufacturing processes from companies that import air cleaners. DOE found these companies largely do not rely on injection molding, the production process that drives capital expenditures resulting from the standard. Additionally, DOE found many of these companies focus on air cleaners for commercial applications. These companies leverage design and production processes used for their commercial air cleaner models to offer conventional air cleaners. Additionally, when product literature with technical detail were available, DOE found that most conventional air cleaners from these domestic manufacturers would likely meet standards for TSLs 1, 2, and 3. DOE concludes it is unlikely these companies would relocate production overseas solely due to the adoption of this final rule.

Additional detail on the analysis of direct employment can be found in chapter 12 of the direct final rule TSD.

[77] U.S. Census Bureau, Annual Survey of Manufacturers: Summary Statistics for Industry Groups and Industries in the U.S.: 2018–20201. Available at *https://www.census.gov/data/tables/time-series/econ/asm/2018-2021-asm.html* (last accessed June 29, 2022).

[78] U.S. Bureau of Labor Statistics. *Employer Costs for Employee Compensation.* June 17, 2021. Available at: *www.bls.gov/news.release/pdf/ecec.pdf.*

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

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

DOE did not observe any design options at the adopted level that would require changes to the fundamental construction or manufacturing of air cleaners. Generally, DOE observed incremental increases in cabinet dimension, incremental changes in filter volume and dimension, and improved motors or optimized motor/filter relationship in the more efficient products meeting the adopted level. Changes in cabinet and filter dimensions could require tooling adjustments and replacement, which DOE accounted for in its analysis of conversion costs. However, DOE's analysis does not suggest there would be design changes that could lead to insufficient availability of product to meet market demand.

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 analyzes the impacts on small businesses in a separate analysis in section VI.B of this document as part of the Regulatory Flexibility Analysis. In summary, the Small Business Administration (SBA) defines a ''small business'' as having 1,500 employees or less for North American Industry Classification System (NAICS) 335210, ''Small Electrical Appliance Manufacturing.'' [80] Based on this classification, DOE identified four domestic OEMs that qualify as small businesses. For a discussion of the impacts on the small business manufacturer subgroup, see chapter 12 of the direct final rule TSD.

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. Assessing the impact of a single regulation may overlook this cumulative regulatory burden. In addition to energy conservation standards, other regulations can significantly affect manufacturers' financial operations. Multiple regulations affecting the same manufacturer can strain profits and lead companies to abandon product lines or markets with lower expected future returns than competing products. For these reasons, DOE conducts an analysis of cumulative regulatory burden as part of its rulemakings pertaining to appliance efficiency.

TABLE V.18—COMPLIANCE DATES AND EXPECTED CONVERSION EXPENSES OF FEDERAL ENERGY CONSERVATION STANDARDS AFFECTING AIR CLEANER ORIGINAL EQUIPMENT MANUFACTURERS

Federal energy conservation standard	Number of OEMs *	Number of OEMs affected from this rule **	Approx. standards year	Industry conversion costs (Millions $)	Industry conversion costs/product revenue *** (%)
Residential Central Air Conditioners and Heat Pumps 82 FR 1786 (January 6, 2017)	30	1	2023	$342.6 (2015$)	0.50
Portable Air Conditioners 85 FR 1378 (January 10, 2020)	11	1	2025	320.90 (2015$)	6.70
Room Air Conditioners † 87 FR 20608 (April 7, 2022)	8	1	2026	22.80 (2020$)	0.50

* This column presents the total number of manufacturers identified in the energy conservation standard rule contributing to cumulative regulatory burden.
** This column presents the number of manufacturers producing room air conditioner products that are also listed as manufacturers in the listed energy conservation standard contributing to cumulative regulatory burden.
*** This column presents industry conversion costs as a percentage of product revenue during the conversion period. Industry conversion costs are the upfront investments manufacturers must make to sell compliant products/equipment. The revenue used for this calculation is the revenue from just the covered product/equipment associated with each row. The conversion period is the time frame over which conversion costs are made and lasts from the publication year of the final rule to the compliance year of the final rule. The conversion period typically ranges from 3 to 5 years, depending on the energy conservation standard.
† This rulemaking is in the proposed rule stage and all values are subject to change until finalized.

In a written comment, Lennox indicated heating, ventilation, air conditioning, and refrigeration (HVACR) manufacturers may be facing DOE standards for: Central Air Conditioners in 2023, Commercial Air Conditioners in 2023, Commercial Warm Air Furnaces in 2023, Consumer Furnaces, Air Cooled, Three-Phase, Small Commercial Air Conditioners and Heat Pumps With a Cooling Capacity of Less Than 65,000 Btu/h and Air-Cooled, Walk-In Coolers and Freezers, and Three-Phase, Variable Refrigerant Flow Air Conditioners and Heat Pumps With a Cooling Capacity of Less Than 65,000 Btu/h. The commenter also stated manufacturers may be impacted by test procedures for Variable Refrigerant Flow Air Conditioners and Heat Pumps, Commercial Warm Air Furnaces, and Walk-In Coolers and Freezers. Lennox mentioned manufacturers may also experience EPA Phase-down to lower global warming potential (GWP) refrigerants to meet the American Innovation and Manufacturing (AIM) Act objectives, National and Regional Cold Climate Heat Pump Specifications, EPA Energy Star 6.0+ for Residential

[80] U.S. Small Business Administration. ''Table of Small Business Size Standards.'' (Effective July 14, 2022). Available at: *www.sba.gov/document/support-table-size-standards* (last accessed September 28, 2022).

HVAC, and EPA Energy Star 4.0 for Light Commercial HVAC. (Lennox, No. 7, pp. 3–4)

Regarding the other rulemakings mentioned, DOE examines Federal, product-specific regulations that could affect air cleaner manufacturers that take effect approximately three years before the 2024 compliance date and three years after the 2026 compliance date of this final rule. In-duct devices, such as those offered by Lennox, were not included within the proposed scope of the test procedure. 87 FR 63324, 63331.

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 new or amended standards.

a. Significance of Energy Savings

To estimate the energy savings attributable to potential standards for air cleaners, 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 standards (2024–2057 for TSL 3 and 2028–2057 for the other TSLs). Table V.19 presents DOE's projections of the national energy savings for each TSL considered for air cleaners. The savings were calculated using the approach described in section IV.H.2 of this document.

TABLE V.19—CUMULATIVE NATIONAL ENERGY SAVINGS FOR AIR CLEANERS; 30 YEARS OF SHIPMENTS THROUGH 2057

	Trial standard level (quads)				
	1	2	3 *	4	5
Primary energy	0.73	1.67	1.73	3.90	4.42
FFC energy	0.76	1.73	1.80	4.05	4.59

* TSL3 has an analysis period of 2024–2057 to take into account the Joint Proposal recommended compliance dates for the two-tiered approach and to align the end of the analysis period with the other TSLs.

OMB Circular A–4 [81] 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.[82] The review timeframe established in EPCA is generally not synchronized with the product lifetime, product manufacturing cycles, or other factors specific to air cleaners. Thus, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology. The NES sensitivity analysis results based on a 9-year analytical period are presented in Table V.20. The impacts are counted over the lifetime of air cleaners purchased in 2024–2036.

TABLE V.20—CUMULATIVE NATIONAL ENERGY SAVINGS FOR AIR CLEANERS; 9 YEARS OF SHIPMENTS

[Through 2036]

	Trial standard level (quads)				
	1	2	3 *	4	5
Primary energy	0.12	0.28	0.34	0.65	0.73
FFC energy	0.13	0.29	0.36	0.68	0.76

* TSL3 has an analysis period of 2024–2036 to take into account the Joint Proposal recommended compliance dates for the two-tiered approach and to align the end of the analysis period with the other TSLs.

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 air cleaners. In accordance with OMB's guidelines on regulatory analysis,[83] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. Table V.21 shows the consumer NPV results with impacts counted over the lifetime of products purchased through 2057.

[81] U.S. Office of Management and Budget. *Circular A–4: Regulatory Analysis.* September 17, 2003. *https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/circulars/A4/a-4.pdf* (last accessed December 5, 2022).

[82] Section 325(m) of EPCA requires DOE to review its standards at least once every 6 years, and requires, for certain products, a 3-year period after any new standard is promulgated before compliance is required, except that in no case may any new standards be required within 6 years of the compliance date of the previous standards. While adding a 6-year review to the 3-year compliance period adds up to 9 years, DOE notes that it may undertake reviews at any time within the 6-year period and that the 3-year compliance date may yield to the 6-year backstop. A 9-year analysis period may not be appropriate given the variability that occurs in the timing of standards reviews and the fact that for some products, the compliance period is 5 years rather than 3 years.

[83] U.S. Office of Management and Budget. *Circular A–4: Regulatory Analysis.* September 17, 2003. *https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/circulars/A4/a-4.pdf* (last accessed December 5, 2022).

TABLE V.21—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR AIR CLEANERS; SHIPMENTS THROUGH 2057

Discount rate	Trial standard level (billion 2021$)				
	1	2	3 *	4	5
3 percent	5.4	12.8	13.7	(8.4)	(4.5)
7 percent	2.2	5.1	5.8	(3.4)	(1.9)

* TSL3 has an analysis period of 2024–2057 to take into account the Joint Proposal recommended compliance dates for the two-tiered approach and to align the end of the analysis period with the other TSLs.

The NPV results based on the aforementioned 9-year analytical period are presented in Table V.22. The impacts are counted over the lifetime of products purchased in 2024–2036. 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.22—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR AIR CLEANERS; SHIPMENTS THROUGH 2036

Discount rate	Trial standard level (billion 2021$)				
	1	2	3 *	4	5
3 percent	1.3	3.1	4.0	(1.9)	(0.9)
7 percent	0.8	1.9	2.5	(1.2)	(0.6)

* TSL3 has an analysis period of 2024–2036 to take into account the Joint Proposal recommended compliance dates for the two-tiered approach and to align the end of the analysis period with the other TSLs.

The previous results reflect the use of a trend to estimate the change in price for air cleaners over the analysis period (see section IV.F.1 of this document). DOE also conducted a sensitivity analysis that considered one scenario with a lower rate of price decline than the reference case and one scenario with a higher rate of price decline than the reference case. The results of these alternative cases are presented in appendix 10C of the 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 energy conservation standards for air cleaners 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 (2024–2029 for TSL 3 and 2028–2033 for all other TSLs), 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 air cleaners 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, the Attorney General determines the impact, if any, of any lessening of competition likely to result from a standard and to transmit such determination in writing to the Secretary within 60 days of the publication of a rule, together with an analysis of the nature and extent of the impact. To assist the Attorney General in making this determination, DOE will provide the DOJ with copies of the direct final rule and the TSD for review. DOE will also publish and respond to the DOJ's comments in the **Federal Register** in a separate document. DOE invites comment from the public regarding the competitive impacts that are likely to result from this direct final rule. In addition, stakeholders may also provide comments separately to DOJ regarding these potential impacts. See the **ADDRESSES** section of the NOPR published elsewhere in this issue of the **Federal Register** for information to send comments to DOJ.

6. Need of the Nation To Conserve Energy

Enhanced energy efficiency, where economically justified, improves the Nation's energy security, strengthens the economy, and reduces the environmental impacts (costs) of energy production. Reduced electricity demand due to energy conservation standards is also likely to reduce the cost of maintaining the reliability of the electricity system, particularly during peak-load periods. Chapter 15 in the 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 air cleaners is expected to yield environmental benefits in the form of reduced emissions of certain air pollutants and greenhouse gases. Table V.23 provides DOE's estimate of cumulative emissions reductions expected to result from the TSLs considered in this rulemaking. The emissions were calculated using the multipliers discussed in section IV.K of this document. DOE reports annual emissions reductions for each TSL in chapter 13 of the direct final rule TSD.

TABLE V.23—CUMULATIVE EMISSIONS REDUCTION FOR AIR CLEANERS SHIPPED FROM COMPLIANCE YEAR THROUGH 2057

	Trial standard level				
	1	2	3	4	5
Electric Power Sector Emissions					
CO_2 (*million metric tons*)	22.3	50.8	53.4	118.8	134.7
CH_4 (*thousand tons*)	1.6	3.7	3.9	8.6	9.8
N_2O (*thousand tons*)	0.2	0.5	0.5	1.2	1.4
SO_2 (*thousand tons*)	9.9	22.5	23.9	52.6	59.6
NO_X (*thousand tons*)	10.8	24.6	25.9	57.4	65.1
Hg (*tons*)	0.1	0.1	0.2	0.3	0.4
Upstream Emissions					
CO_2 (*million metric tons*)	1.8	4.1	4.3	9.6	10.9
CH_4 (*thousand tons*)	171.4	391.1	407.5	914.1	1,036.3
N_2O (*thousand tons*)	0.0	0.0	0.0	0.0	0.1
SO_2 (*thousand tons*)	0.1	0.3	0.3	0.7	0.7
NO_X (*thousand tons*)	27.4	62.6	65.2	146.3	165.8
Hg (*tons*)	0.0	0.0	0.0	0.0	0.0
Total FFC Emissions					
CO_2 (*million metric tons*)	24.1	55.0	57.7	128.5	145.7
CH_4 (*thousand tons*)	173.0	394.8	411.4	922.8	1,046.1
N_2O (*thousand tons*)	0.2	0.5	0.6	1.2	1.4
SO_2 (*thousand tons*)	10.0	22.8	24.2	53.2	60.4
NO_X (*thousand tons*)	38.2	87.2	91.2	203.7	231.0
Hg (*tons*)	0.1	0.1	0.2	0.3	0.4

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 air cleaners. Section IV.L of this document discusses the estimated SC–CO_2 values that DOE used. Table V.24 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.24—PRESENT VALUE OF CO_2 EMISSIONS REDUCTION FOR AIR CLEANERS SHIPPED FROM COMPLIANCE YEAR THROUGH 2057

TSL	SC–CO_2 Case Discount rate and statistics (billion 2021$)			
	5% Average	3% Average	2.5% Average	3% 95th percentile
1	0.2	0.9	1.5	2.8
2	0.5	2.1	3.4	6.4
3	0.5	2.3	3.6	6.9
4	1.1	5.0	7.8	15.0
5	1.3	5.6	8.9	17.0

As discussed in section IV.L.2 of this document, DOE estimated the climate benefits likely to result from the reduced emissions of methane and N_2O that DOE estimated for each of the considered TSLs for air cleaners. Table V.25 presents the value of the CH_4 emissions reduction at each TSL, and Table V.26 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.25—PRESENT VALUE OF METHANE EMISSIONS REDUCTION FOR AIR CLEANERS SHIPPED FROM COMPLIANCE YEAR THROUGH 2057

TSL	$SC–CH_4$ Case			
	Discount rate and statistics (billion 2021$)			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
1	0.1	0.2	0.3	0.6
2	0.2	0.5	0.7	1.3
3	0.2	0.5	0.7	1.4
4	0.4	1.1	1.6	3.0
5	0.4	1.3	1.8	3.4

TABLE V.26—PRESENT VALUE OF NITROUS OXIDE EMISSIONS REDUCTION FOR AIR CLEANERS SHIPPED FROM COMPLIANCE THROUGH 2057

TSL	$SC–N_2O$ Case			
	Discount rate and statistics (billion 2021$)			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
1	0.8	3.2	5.0	8.6
2	1.8	7.3	11.5	19.5
3	1.9	7.9	12.3	20.9
4	4.1	17.2	26.8	45.6
5	4.7	19.5	30.4	51.7

DOE is well aware that scientific and economic knowledge about the contribution of CO_2 and other GHG emissions to changes in the future global climate and the potential resulting damages to the global and U.S. economy continues to evolve rapidly. Thus, any value placed on reduced GHG emissions in this rulemaking is subject to change. That said, because of omitted damages, DOE agrees with the IWG that these estimates most likely underestimate the climate benefits of greenhouse gas reductions. 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 air cleaners. The dollar-per-ton values that DOE used are discussed in section IV.L of this document. Table V.27 presents the present value for NO_X emissions reduction for each TSL calculated using 7-percent and 3-percent discount rates, and Table V.28 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.27—PRESENT VALUE OF NO_X EMISSIONS REDUCTION FOR AIR CLEANERS SHIPPED FROM COMPLIANCE YEAR THROUGH 2057

TSL	7% discount rate	3% discount rate
	billion 2021$	
1	0.5	1.4
2	1.2	3.2
3	1.3	3.4
4	2.7	7.5
5	3.1	8.5

TABLE V.28—PRESENT VALUE OF SO_2 EMISSIONS REDUCTION FOR AIR CLEANERS SHIPPED FROM COMPLIANCE YEAR THROUGH 2057

TSL	7% discount rate	3% discount rate
	billion 2021$	
1	0.2	0.5
2	0.4	1.1
3	0.5	1.2
4	1.0	2.7
5	1.1	3.0

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

7. Other Factors

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

8. Summary of Economic Impacts

Table V.29 presents the NPV values that result from adding the monetized estimates of the potential economic, climate, and health 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 air cleaners and are measured for the lifetime of products shipped in 2024–2057. 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 air cleaners shipped in 2024–2057.

TABLE V.29—CONSUMER NPV COMBINED WITH PRESENT VALUE OF CLIMATE BENEFITS AND HEALTH BENEFITS

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Using 3% discount rate for Consumer NPV and Health Benefits (billion 2021$)					
5% Average SC–GHG case	7.6	17.8	19.0	3.3	8.8
3% Average SC–GHG case	8.5	19.8	21.1	7.9	14.0
2.5% Average SC–GHG case	9.1	21.2	22.7	11.3	17.8
3% 95th percentile SC–GHG case	10.7	24.9	26.6	19.9	27.6
Using 7% discount rate for Consumer NPV and Health Benefits (billion 2021$)					
5% Average SC–GHG case	3.1	7.3	8.2	1.8	3.9
3% Average SC–GHG case	4.0	9.3	10.3	6.4	9.2
2.5% Average SC–GHG case	4.6	10.7	11.8	9.8	13.0
3% 95th percentile SC–GHG case	6.3	14.4	15.8	18.4	22.8

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 establishing standards for air cleaners at each TSL, beginning with the maximum technologically feasible level, to determine whether that level was economically justified. Where the max-tech level was not justified, DOE then considered the next most efficient level and undertook the same evaluation until it reached the highest efficiency level that is both technologically feasible and economically justified and saves a significant amount of energy. DOE refers to this process as the ''walk-down'' analysis.

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

DOE also notes that the economics literature provides a wide-ranging discussion of how consumers trade off upfront costs and energy savings in the absence of government intervention. Much of this literature attempts to explain why consumers appear to undervalue energy efficiency improvements. There is evidence that consumers undervalue future energy savings as a result of (1) a lack of information; (2) a lack of sufficient salience of the long-term or aggregate benefits; (3) a lack of sufficient savings to warrant delaying or altering purchases; (4) excessive focus on the short term, in the form of inconsistent weighting of future energy cost savings relative to available returns on other investments; (5) computational or other difficulties associated with the evaluation of relevant tradeoffs; and (6) a divergence in incentives (for example, between renters and owners, or builders and purchasers). Having less than perfect foresight and a high degree of uncertainty about the future, consumers may trade off these types of investments at a higher than expected rate between current consumption and uncertain future energy cost savings.

In DOE's current regulatory analysis, potential changes in the benefits and costs of a regulation due to changes in consumer purchase decisions are included in two ways. First, if consumers forgo 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.[84]

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

[84] 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.

which these impacts are defined and estimated in the regulatory process.[85]

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 Air Cleaner Standards

Table V.30 and Table V.31 summarize the quantitative impacts estimated for each TSL for air cleaners. The national impacts are measured over the lifetime of air cleaners purchased in the analysis period that begins in the anticipated year of compliance with standards (2024–2057 for TSL3 and 2028–2057 for the other TSLs). The energy savings, emissions reductions, and value of emissions reductions refer to full-fuel-cycle results. DOE is exercising its own judgment in presenting monetized benefits in accordance with the applicable Executive orders and DOE would reach the same conclusion presented in this document 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.30—SUMMARY OF ANALYTICAL RESULTS FOR AIR CLEANER TSLS: NATIONAL IMPACTS

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Cumulative FFC National Energy Savings					
Quads	0.76	1.73	1.80	4.05	4.59
Cumulative FFC Emissions Reduction					
CO_2 (*million metric tons*)	24.1	55.0	57.7	128.5	145.7
CH_4 (*thousand tons*)	173.0	394.8	411.4	922.8	1,046.1
N_2O (*thousand tons*)	0.2	0.5	0.6	1.2	1.4
SO_2 (*thousand tons*)	10.0	22.8	24.2	53.2	60.4
NO_X (*thousand tons*)	38.2	87.2	91.2	203.7	231.0
Hg (*tons*)	0.1	0.1	0.2	0.3	0.4
Present Value of Benefits and Costs (*3% discount rate, billion 2021$*)					
Consumer Operating Cost Savings	5.6	13.2	14.1	(5.9)	(0.8)
Climate Benefits *	1.1	2.6	2.8	6.1	6.9
Health Benefits **	1.9	4.4	4.7	10.2	11.6
Total Benefits †	8.6	20.2	21.6	10.4	17.7
Consumer Incremental Product Costs	0.1	0.4	0.5	2.4	3.7
Consumer Net Benefits	5.4	12.8	13.7	(8.4)	(4.5)
Total Net Benefits	8.5	19.8	21.1	7.9	14.0
Present Value of Benefits and Costs (*7% discount rate, billion 2021$*)					
Consumer Operating Cost Savings	2.2	5.3	6.0	(2.3)	(0.2)
Climate Benefits *	1.1	2.6	2.8	6.1	6.9
Health Benefits **	0.7	1.6	1.8	3.7	4.2
Total Benefits †	4.1	9.5	10.6	7.5	10.9
Consumer Incremental Product Costs	0.1	0.2	0.2	1.1	1.7
Consumer Net Benefits	2.2	5.1	5.8	(3.4)	(1.9)
Total Net Benefits	4.0	9.3	10.3	6.4	9.2

Note: This table presents the costs and benefits associated with air cleaners shipped from the compliance year through 2057. These results include benefits to consumers which accrue after 2057 from the products shipped starting in the compliance year up through 2057.

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

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

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

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

TABLE V.31—SUMMARY OF ANALYTICAL RESULTS FOR AIR CLEANER TSLS: MANUFACTURER AND CONSUMER IMPACTS

Category	TSL 1	TSL 2	TSL 3		TSL 4	TSL 5
			Tier 1	Tier 2		
Manufacturer Impacts:						
Industry NPV (million 2021$) (No-new-standards case INPV = 1,565.94).	1,528 to 1,536.	1,504 to 1,528.	1,479 to 1,479.	1,499 to 1,525.	1,422 to 1,536.	1,394 to 1,574
Industry NPV (% change)	(2) to (2)	(4) to (2)	(2) to (2)	(4) to (3)	(9) to (2)	(11) to 1
Consumer Average LCC Savings (2021$):						
PC1: 10 ≤ $PM_{2.5}$ CADR < 100	$18	$12	$18	$12	($87)	($87)
PC2: 100 ≤ $PM_{2.5}$ CADR < 150	$38	$50	$38	$50	($60)	$11
PC3: $PM_{2.5}$ CADR ≥ 150	$105	$94	$105	$94	$29	$20
Shipment-Weighted Average *	$67	$62	$67	$62	($23)	($10)
Consumer Simple PBP (years):						
PC1: 10 ≤ $PM_{2.5}$ CADR < 100	0.9	1.4	0.9	1.4	NA	NA
PC2: 100 ≤ $PM_{2.5}$ CADR < 150	0.4	0.5	0.4	0.5	NA	1.6
PC3: $PM_{2.5}$ CADR ≥ 150	0.1	0.1	0.1	0.1	0.3	0.3
Shipment-Weighted Average *	0.4	0.5	0.4	0.5	NA	NA
Percent of Consumers that Experience a Net Cost:						
PC1: 10 ≤ $PM_{2.5}$ CADR < 100	0%	6%	0%	6%	88%	94%
PC2: 100 ≤ $PM_{2.5}$ CADR < 150	0%	0%	0%	0%	75%	54%
PC3: $PM_{2.5}$ CADR ≥ 150	0%	0%	0%	0%	50%	56%
Shipment-Weighted Average *	0%	1%	0%	1%	66%	65%

Parentheses indicate negative (-) values. The entry "NA" 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 2028.

DOE first considered TSL 5, which represents the max-tech efficiency levels for all the three product classes. Specifically, for all three product classes, DOE's expected design path for TSL 5 (which represents EL 4 for all product classes) incorporates cylindrical shaped filters and BLDC motors with an optimized motor-filter relationship. In particular, the cylindrical filter, which reduces the pressure drop across the filter because it allows for a larger surface area for the same volume of filter material, optimized with the size of the BLDC motor provides the improvement in efficiency at TSL 5 compared to TSL 4. TSL 5 would save an estimated 4.59 quads of energy, an amount DOE considers significant. Under TSL 5, the NPV of consumer benefit would be -$1.9 billion using a discount rate of 7 percent, and -$4.5 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 5 are 145.7 Mt of CO_2, 60.4 thousand tons of SO_2, 231.0 thousand tons of NO_X, 0.4 tons of Hg, 1,046.1 thousand tons of CH_4, and 1.4 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 $6.9 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 5 is $4.2 billion using a 7-percent discount rate and $11.6 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 $9.2 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 5 is $14.0 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, the average LCC impact is a loss of $87 for Product Class 1 (10 ≤ $PM_{2.5}$ CADR < 100), an average LCC savings of $11 for Product Class 2 (100 ≤ $PM_{2.5}$ CADR < 150), and an average LCC savings of $20 for Product Class 3 ($PM_{2.5}$ CADR ≥ 150). The simple payback period cannot be calculated for Product Class 1 due to the max-tech EL not being cost effective compared to the baseline EL, and is 1.6 years for Product Class 2 and 0.3 years for Product Class 3. The fraction of consumers experiencing a net LCC cost is 94 percent for Product Class 1, 54 percent for Product Class 2 and 56 percent for Product Class 3.

For the low-income consumer group, the average LCC impact is a loss of $97 for Product Class 1, an average LCC loss of $9 for Product Class 2, and an average LCC loss of $7 for Product Class 3. The simple payback period cannot be calculated for Product Class 1 due to a higher annual operating cost for the selected EL than the cost for baseline units, and is 2.7 years and 0.5 years for Product Class 2 and Product Class 3, respectively. The fraction of low-income consumers experiencing a net LCC cost is 95 percent for Product Class 1, 64 percent for Product Class 2 and 67 percent for Product Class 3.

At TSL 5, the projected change in INPV ranges from a decrease of $171.5 million to an increase of $8.1 million, which corresponds to a decrease of 11.0 percent and an increase of 0.5 percent, respectively. DOE estimates that industry may need to invest $145.2 million to comply with standards set at TSL 5.

At TSL 5, compliant models are typically designed to house a cylindrical filter, and the cabinets of these units are also typically cylindrical in shape. The move to cylindrical designs would require investment in new designs and new production tooling for most of the industry, as only 3% of units shipped meet TSL 5 today. Manufacturers would need to invest in both updated designs and updated cabinet tooling. The vast majority of product is made from injection molded plastic and DOE expect the need for new injection molding dies to drive conversion cost for the industry.

The Secretary concludes that at TSL 5 for air cleaners, the benefits of energy savings, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the economic burden on many consumers (negative LCC savings of Product Class 1, a majority of consumers with net costs for all three product classes, and negative NPV of consumer benefits), and the capital conversion costs and profit margin impacts that could result in reductions in INPV for manufacturers.

DOE next considered TSL 4, which represents the second highest efficiency levels. TSL 4 comprises EL 3 for all three product classes. Specifically, DOE's expected design path for TSL 4 incorporates many of the same technologies and design strategies as described for TSL 5. At TSL 4, all three product classes would incorporate cylindrical shaped filters and BLDC motors without an optimized motor-filter relationship. The cylindrical filter, which reduces the pressure drop across the filter because it allows for a larger surface area for the same volume of filter material, provides the improvement in efficiency at TSL 4 compared to TSL 3 which utilizes rectangular shaped filters and less efficient motor designs. TSL 4 would save an estimated 4.05 quads of energy, an amount DOE considers significant. Under TSL 4, the NPV of consumer benefit would be -$3.4 billion using a discount rate of 7 percent, and -$8.4 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 4 are 128.5 Mt of CO_2, 53.2 thousand tons of SO_2, 203.7 thousand tons of NO_X, 0.3 tons of Hg, 922.8 thousand tons of CH_4, and 1.2 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions (associated with the average SC–GHG at a 3-percent discount rate) at TSL 4 is $6.1 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 4 is $3.7 billion using a 7-percent discount rate and $10.2 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, health benefits from reduced SO_2 and NO_X emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 4 is $6.4 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 4 is $7.9 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 4, the average LCC impact is a loss of $87 for Product Class 1, an average LCC loss of $60 for Product Class 2 and an average savings of $29 for Product Class 3. The simple payback period cannot be calculated for Product Class 1 and Product Class 2 due to the higher annual operating cost compared to the baseline units, and is 0.3 years for Product Class 3. The fraction of consumers experiencing a net LCC cost is 88 percent for Product Class 1, 75 percent for Product Class 2 and 50 percent for Product Class 3.

For the low-income consumer group, the average LCC impact is an average loss of $95 for Product Class 1, an average LCC loss of $78 for Product Class 2 and an average savings of $2 for Product Class 3. The simple payback period cannot be calculated for Product Class 1 and Product Class 2 due to a higher annual operating cost for the selected EL than the cost for baseline units, and is 0.4 years for Product Class 3. The fraction of low-income consumers experiencing a net LCC cost is 89 percent for Product Class 1, 82 percent for Product Class 2 and 61 percent for Product Class 3.

At TSL 4, the projected change in INPV ranges from a decrease of $143.7 million to a decrease of $30.2 million, which correspond to decreases of 9.2 percent and 1.9 percent, respectively. Industry conversion costs could reach $136.6 million at this TSL.

At TSL 4, compliant models are typically designed to house a cylindrical filter, and the cabinets of these units are also typically cylindrical in shape—much like TSL 5. Again, the major driver of impacts to manufacturers is the move to cylindrical designs, requiring redesign of products and investment in new production tooling for most of the industry, as only 7% of sales meet TSL 4 today.

Based upon the previous considerations, the Secretary concludes that at TSL 4 for air cleaners, the benefits of energy savings, emission reductions, and the estimated monetary value of the health benefits and climate benefits from emissions reductions would be outweighed by negative LCC savings for Product Class 1 and Product Class 2, the high percentage of consumers with net costs for all product classes, negative NPV of consumer benefits, and the capital conversion costs and profit margin impacts that could result in reductions in INPV for manufacturers. Consequently, the Secretary has tentatively concluded that TSL 4 is not economically justified.

DOE then considered the recommended TSL (TSL3), which represents the Joint Proposal with EL 1 (Tier 1) going into effect in 2024 (compliance date December 31, 2023) and EL 2 (Tier 2) going into effect in 2026 (compliance date December 31, 2025). EL 1 comprises the lowest EL considered which aligns with the standards established by the States of Maryland, Nevada, and New Jersey, and the District of Columbia. EL 2 comprises the current ENERGY STAR V. 2.0 level and the standard adopted by the State of Washington. DOE's design path for TSL 3, which includes both EL 1 and EL 2 for all three product classes, includes rectangular shaped filters and either SPM or PSC motors. Specifically, for Product Class 1, the Tier 1 standard, which is represented by EL 1, includes a rectangular filter and SPM motor with an optimized motor-filter relationship while the Tier 2 standard, which is represented by EL 2, includes a rectangular filter and PSC motor, which is generally more efficient than an SPM motor. For Product Class 2 and Product Class 3, the Tier 1 standard, which is represented by EL 1, includes a rectangular filter and PSC motor while the Tier 2 standard, which is represented by EL 2, also includes a rectangular filter and PSC motor but with an optimized motor-filter relationship, which improves the efficiency of EL 2 over EL 1. TSL3 would save an estimated 1.80 quads of energy, an amount DOE considers significant. Under TSL 3, the NPV of consumer benefit would be $13.7 billion using a discount rate of 7 percent, and $5.8 billion using a discount rate of 3 percent.

The cumulative emissions reductions at the recommended TSL are 57.7 Mt of CO_2, 24.2 thousand tons of SO_2, 91.2 thousand tons of NO_X, 0.2 tons of Hg, 411.4 thousand tons of CH_4, and 0.6 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 $2.8 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at the recommended TSL is $1.8 billion using a 7-percent discount rate and $4.7 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 $10.3 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 3 is $21.1 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 with the two-tier approach, the average LCC impacts are average savings of $18 and $12 for Product Class 1, $38 and $50 for Product Class 2, and $105 and $94 for Product Class 3, for Tier 1 and Tier 2 respectively. The simple payback periods are below 1.4 years for the two tiers of Product Class 1, below 0.5 years for the two tiers of Product Class 2, and 0.1 for the two tiers of Product Class 3. The fraction of consumers experiencing a net LCC cost is below 6 percent for the two tiers of all three product classes.

For the low-income consumer group, the average LCC impact is a savings of $17 and $10 for the two tiers of Product Class 1, $34 and $44 for the two tiers of Product Class 2, and $85 and $76 for the two tiers of Product Class 3. The simple payback periods for the two-tier approach are 1.2 years for Tier 1 and 1.9 years for Tier 2 for Product Class 1, are 0.6 years and 0.7 years for Tier 1 and Tier 2 respectively for Product Class 2, and is 0.2 years for both tiers of Product Class 3. The fraction of low-income consumers experiencing a net LCC cost is 10 percent for Tier 2 of Product Class 1, and 0 percent for Tier 1 of Product Class 1 and all other tiers of the other product classes.

At the recommended TSL, the projected change in INPV ranges from a decrease of $66.7 million to a decrease of $40.7 million, which correspond to decreases of 4.3 percent and 2.6 percent, respectively. Industry conversion costs could reach $57.3 million at this TSL.

A sizeable portion of the market, approximately 40 percent, can currently meet the Tier 2 level. Additionally, a substantial portion of existing models can be updated to meet Tier 2 through optimization and improved components rather than a full product redesign. In particular, manufacturers may be able to leverage their existing cabinet designs, reducing the level of investment necessitated by the standard.

An even larger portion of the market, approximately 76 percent, can meet the Tier 1 level today. Efficiency improvements to meet Tier 1 are achievable by improving the motor or by optimizing the motor-filter relationship, typically by reducing the restriction of airflow (and therefore, the pressure drop across the filter) by increasing the surface area of the filter, reducing filter thickness, and/or increasing air inlet/outlet size. Manufacturer may be able to leverage their existing cabinet designs, reducing the level of investment necessitated by the standard.

After considering the analysis and weighing the benefits and burdens, the Secretary has concluded that at a standard set at the recommended TSL for air cleaners would be economically justified. At this TSL, the average LCC savings for all three product classes are positive. Only an estimated 6 percent of Product Class 1 consumers experience a net cost. No Product Class 2 and Product Class 3 consumers would experience net cost based on the estimates. The FFC national energy savings are significant and the NPV of consumer benefits is positive using both a 3-percent and 7-percent discount rate. At the recommended TSL, the NPV of consumer benefits, even measured at the more conservative discount rate of 7 percent, is over 84 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 $2.8 billion in climate benefits (associated with the average SC–GHG at a 3-percent discount rate), and $4.7 billion (using a 3-percent discount rate) or $1.8 billion (using a 7-percent discount rate) in health benefits—the rationale becomes stronger still.

As stated, DOE conducts the walk-down analysis to determine the TSL that represents the maximum improvement in energy efficiency that is technologically feasible and economically justified as required under EPCA. Although DOE has not conducted a comparative analysis to select the new energy conservation standards, DOE notes that as compared to TSL 4 and TSL 5, TSL 3 has positive LCC savings for all selected standards levels, a shorter payback period, smaller percentages of consumers experiencing a net cost, a lower maximum decrease in INPV, and lower manufacturer conversion costs.

Although DOE considered new standard levels for air cleaners by grouping the efficiency levels for each product class into TSLs, DOE analyzes and evaluates all possible ELs for each product class in its analysis. For all three product classes, the adopted standard levels represent units with rectangular filter shape with a PSC motor at EL 1 and an optimized motor-filter relationship at EL 2. Additionally, for all three product classes the adopted standard levels represent the maximum energy savings that does not result in a large percentage of consumers experiencing a net LCC cost. TSL 3 would also realize an additional 0.07 quads FFC energy savings compared to TSL 2, which selects the same standard levels but with a later compliance date. The efficiency levels at the specified standard levels result in positive LCC savings for all three 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 these levels are economically justified, as discussed for TSL 3 in the preceding paragraphs.

Therefore, based on the previous considerations, DOE adopts the energy conservation standards for air cleaners at the recommended TSL. The new energy conservation standards for air cleaners, which are expressed in IEF using $PM_{2.5}$ CADR/W, are shown in Table V.32.

TABLE V.32—NEW ENERGY CONSERVATION STANDARDS FOR AIR CLEANERS

Product class	IEF ($PM_{2.5}$ CADR/W)	
	Tier 1	Tier 2
PC1: $10 \leq PM_{2.5}$ CADR < 100	1.7	1.9
PC2: $100 \leq PM_{2.5}$ CADR < 150	1.9	2.4
PC3: $PM_{2.5}$ CADR ≥ 150	2.0	2.9

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 2021$) 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.33 shows the annualized values for air cleaners under the recommended TSL, expressed in 2021$. The results under the primary estimate are as follows.

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 adopted in this rule is $19.8 million per year in increased product costs, while the estimated annual benefits are $499 million in reduced product operating costs, $136 million in climate benefits, and $149 million in health benefits. In this case, the net benefit amounts to $764 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the standards is $23.4 million per year in increased equipment costs, while the estimated annual benefits are $690 million in reduced operating costs, $136 million in climate benefits, and $228 million in health benefits. In this case, the net benefit amounts to $1,030 million per year.

TABLE V.33 ANNUALIZED BENEFITS AND COSTS OF ADOPTED STANDARDS (RECOMMENDED TSL) FOR AIR CLEANERS

	Million (2021$/year)		
	Primary estimate	Low-net-benefits estimate	High-net-benefits estimate
3% discount rate			
Consumer Operating Cost Savings	689.7	623.7	773.4
Climate Benefits *	135.6	124.2	149.9
Health Benefits **	228.4	210.1	251.0
Total Benefits †	1,053.6	958.1	1,174.2
Consumer Incremental Product Costs‡	23.4	22.8	24.7
Net Benefits	1,030.2	935.3	1,149.5
7% discount rate			
Consumer Operating Cost Savings	498.8	459.8	546.9
Climate Benefits * (3% discount rate)	135.6	124.2	149.9
Health Benefits **	149.3	139.7	160.9
Total Benefit s†	783.7	723.7	857.7
Consumer Incremental Product Costs ‡	19.8	19.3	20.7
Net Benefits	763.9	704.4	837.0

Note: This table presents the costs and benefits associated with air cleaners shipped in 2024–2057. These results include benefits to consumers which accrue after 2057 from the products shipped in 2024–2057. The Primary, Low Net Benefits, and High Net Benefits Estimates utilize projections of energy prices from the *AEO2022* Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental equipment costs reflect a medium decline rate in the Primary Estimate, a low decline rate in the Low Net Benefits Estimate, and a high decline rate in the High Net Benefits Estimate. The methods used to derive projected price trends are explained in section IV.F.1of this document. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

* Climate benefits are calculated using four different estimates of the global SC–GHG (see section IV.L of this document). For presentational purposes of this table, the climate benefits associated with the average SC–GHG at a 3 percent discount rate are shown, but the Department does not have a single central SC–GHG point estimate, and it emphasizes the importance and value of considering the benefits calculated using all four sets of SC–GHG estimates. To monetize the benefits of reducing greenhouse gas emissions this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990* published in February 2021 by the Interagency Working Group on the Social Cost of Greenhouse Gases (IWG).

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

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

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

VI. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866 and 13563

Executive Order (''E.O.'') 12866, ''Regulatory Planning and Review,'' 58 FR 51735 (Oct. 4, 1993), as supplemented and reaffirmed by E.O. 13563, ''Improving Regulation and Regulatory Review,'' 76 FR 3821 (Jan. 21, 2011), 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 this 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 August 2022 Joint Proposal meets the necessary requirements under EPCA to issue this direct final rule for energy conservation standards for air cleaners under the procedures in 42 U.S.C. 6295(p)(4). DOE notes that the NOPR for energy conservation standards for air cleaners published elsewhere in this issue of the **Federal Register** contains an IRFA.

C. Review Under the Paperwork Reduction Act

Manufacturers of air cleaners 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 air cleaners, 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 air cleaners. (*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.

Certification data will be required for air cleaners; however, DOE is not adopting certification or reporting requirements for air cleaners in this direct final rule. Instead, DOE may consider proposals to establish certification requirements and reporting for air cleaners under a separate rulemaking regarding appliance and equipment certification. DOE will address changes to OMB Control Number 1910–1400 at that time, as necessary.

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

D. Review Under the National Environmental Policy Act of 1969

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. DOE has examined this rule and has determined that it would not have a substantial direct effect on the relationship between the National Government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of this rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297) Therefore, no further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of E.O. 12988, ''Civil Justice Reform,'' imposes on Federal agencies the general duty to adhere to the following requirements:

(1) eliminate drafting errors and ambiguity, (2) write regulations to minimize litigation, (3) provide a clear legal standard for affected conduct rather than a general standard, and (4) promote simplification and burden reduction. 61 FR 4729 (Feb. 7, 1996). Regarding the review required by section 3(a), section 3(b) of E.O. 12988 specifically requires that Executive agencies make every reasonable effort to ensure that the regulation (1) clearly specifies the preemptive effect, if any, (2) clearly specifies any effect on existing Federal law or regulation, (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction, (4) specifies the retroactive effect, if any, (5) adequately defines key terms, and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of 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.*

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

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

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

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

I. Review Under Executive Order 12630

Pursuant to E.O. 12630, ''Governmental Actions and Interference with Constitutionally Protected Property Rights,'' 53 FR 8859 (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.

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

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

K. Review Under Executive Order 13211

E.O. 13211, ''Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use,'' 66 FR 28355 (May 22, 2001), requires Federal agencies to prepare and submit to OIRA at OMB, a Statement of Energy Effects for any 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 energy conservation standards for air cleaners, 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.

L. Information Quality

On December 16, 2004, OMB, in consultation with the Office of Science and Technology Policy (''OSTP''), issued its Final Information Quality Bulletin for Peer Review (''the Bulletin''). 70 FR 2664 (Jan. 14, 2005). The Bulletin establishes that certain scientific information shall be peer reviewed by qualified specialists before it is disseminated by the Federal Government, including influential scientific information related to agency regulatory actions. The purpose of the Bulletin is to enhance the quality and credibility of the Government's scientific information. Under the Bulletin, the energy conservation standards rulemaking analyses are ''influential scientific information,'' which the Bulletin defines as ''scientific information the agency reasonably can determine will have, or does have, a clear and substantial impact on important public policies or private sector decisions.'' 70 FR 2664, 2667.

In response to OMB's Bulletin, DOE conducted formal peer reviews of the energy conservation standards development process and the analyses that are typically used and prepared a report describing that peer review.[86] Generation of this report involved a rigorous, formal, and documented evaluation using objective criteria and qualified and independent reviewers to make a judgment as to the technical/scientific/business merit, the actual or anticipated results, and the productivity and management effectiveness of programs and/or projects. Because available data, models, and technological understanding have changed since 2007, DOE has engaged with the National Academy of Sciences to review DOE's analytical methodologies to ascertain whether modifications are needed to improve the Department's analyses. DOE is in the process of evaluating the resulting report.[87]

AHAM AC–1–2020 is already approved at the location where it appears in the regulatory text.

M. 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 it has been determined that the rule is a ''major rule'' as defined by 5 U.S.C. 804(2).

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, and Small businesses.

Signing Authority

This document of the Department of Energy was signed on March 22, 2023, by Francisco Alejandro Moreno, Acting Assistant Secretary for Energy Efficiency and Renewable Energy, pursuant to delegated authority from the Secretary of Energy. That document with the original signature and date is maintained by DOE. For administrative purposes only, and in compliance with requirements of the Office of the Federal Register, the undersigned DOE Federal Register Liaison Officer has been authorized to sign and submit the document in electronic format for publication, as an official document of the Department of Energy. This administrative process in no way alters the legal effect of this document upon publication in the **Federal Register**.

Signed in Washington, DC, on March 24, 2023.

Treena V. Garrett,

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

For the reasons stated in the preamble, DOE amends part 430 of chapter II, subchapter D, of title 10 of the Code of Federal Regulations, as amended at 88 FR 14014 (March 6, 2023), 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 FF to subpart B of part 430 by revising section 5.1.2 to read as follows:

Appendix FF to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Air Cleaners

* * * * *

5. * * *

5.1.2. For determining compliance only with the standards specified in § 430.32(ee)(1), $PM_{2.5}$ CADR may alternately be calculated using the smoke CADR and dust CADR values determined according to Sections 5 and 6, respectively, of AHAM AC–1–2020, according to the following equation:

$$PM_{2.5}CADR = \sqrt{Smoke\ CADR\ (0.1 - 1\ \mu m) \times Dust\ CADR\ (0.5 - 3\ \mu m)}$$

* * * * *

■ 3. Amend § 430.32 by adding paragraph (ee) to read as follows:

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

* * * * *

(ee) *Air cleaners.* (1) Conventional room air cleaners as defined in § 430.2 with a $PM_{2.5}$ clean air delivery rate (CADR) between 10 and 600 (both inclusive) cubic feet per minute (cfm) and manufactured on or after December 31, 2023, and before December 31, 2025, shall have an integrated energy factor (IEF) in $PM_{2.5}$ CADR/W, as determined in § 430.23(hh)(4) that meets or exceeds the following values:

Product capacity	IEF ($PM_{2.5}$ CADR/W)
(i) 10 ≤$PM_{2.5}$ CADR <100	1.7
(ii) 100 ≤$PM_{2.5}$ CADR <150	1.9
(iii) $PM_{2.5}$ CADR ≥150	2.0

(2) Conventional room air cleaners as defined in § 430.2 with a $PM_{2.5}$ clean air delivery rate (CADR) between 10 and 600 (both inclusive) cubic feet per minute (cfm) and manufactured on or after December 31, 2025, shall have an integrated energy factor (IEF) in $PM_{2.5}$ CADR/W, as determined in § 430.23(hh)(4) that meets or exceeds the following values:

Product capacity	IEF ($PM_{2.5}$ CADR/W)
(i) 10 ≤$PM_{2.5}$ CADR <100	1.9
(ii) 100 ≤$PM_{2.5}$ CADR <150	2.4
(iii) $PM_{2.5}$ CADR ≥150	2.9

[FR Doc. 2023–06499 Filed 4–10–23; 8:45 am]

BILLING CODE 6450–01–P

[86] The 2007 ''Energy Conservation Standards Rulemaking Peer Review Report'' is available at the following website: *energy.gov/eere/buildings/downloads/energy-conservation-standards-rulemaking-peer-review-report-0* (last accessed July 19, 2022).

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