DEPARTMENT OF ENERGY

10 CFR Part 431

[EERE–2022–BT–STD–0015]

RIN 1904–AF34

Energy Conservation Program: Energy Conservation Standards for Air-Cooled Commercial Package Air Conditioners and Heat Pumps

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

ACTION: Direct final rule.

SUMMARY: The Energy Policy and Conservation Act, as amended (''EPCA''), prescribes energy conservation standards for various consumer products and certain commercial and industrial equipment, including air-cooled commercial package air conditioners and heat pumps with a rated cooling capacity greater than or equal to 65,000 Btu/h. In this direct final rule, DOE is adopting amended energy conservation standards, based on clear and convincing evidence, for air-cooled commercial package air conditioners and heat pumps with a rated cooling capacity greater than or equal to 65,000 Btu/h, which it has determined satisfy the relevant statutory criteria.

DATES: The effective date of this rule is September 17, 2024, unless adverse comment is received by September 9, 2024. 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 amended standards established for air-cooled commercial package air conditioners and heat pumps with a rated cooling capacity greater than or equal to 65,000 Btu/h in this direct final rule is required on and after January 1, 2029.

ADDRESSES: Interested persons are encouraged to submit comments using the Federal eRulemaking Portal at *www.regulations.gov* under docket number EERE–2022–BT–STD–0015. Follow the instructions for submitting comments. Alternatively, interested persons may submit comments, identified by docket number EERE–2022–BT–STD–0015, by any of the following methods:

Email: ApplianceStandardsQuestions@ee.doe.gov. Include the docket number EERE–2022–BT–STD–0015 in the subject line of the message.

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

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

No telefacsimiles (''faxes'') will be accepted.

Docket: 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-2022-BT-STD-0015.* The docket web page contains instructions on how to access all documents, including public comments, in the docket.

FOR FURTHER INFORMATION CONTACT:

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

Mr. Eric Stas, U.S. Department of Energy, Office of the General Counsel, GC–33, 1000 Independence Avenue SW, Washington, DC 20585–0121. Telephone: (202) 586–4798. Email: *Eric.Stas@hq.doe.gov.*

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.*

SUPPLEMENTARY INFORMATION:

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I. Synopsis of the Direct Final Rule

The Energy Policy and Conservation Act, Public Law 94–163, as amended (''EPCA''),[1] authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. (42 U.S.C. 6291–6317, as codified) Title III, Part C[2] of EPCA established the Energy Conservation Program for Certain Industrial Equipment. (42 U.S.C. 6311–6317) This covered equipment includes small, large, and very large commercial package air conditioning and heating equipment. (42 U.S.C. 6311(1)(B)–(D)) Such equipment includes as equipment categories air-cooled commercial unitary air conditioners with a rated cooling capacity greater than or equal to 65,000 Btu/h (''ACUACs'') and air-cooled commercial unitary heat pumps with a rated cooling capacity greater than or equal to 65,000 Btu/h (''ACUHPs''), which are the subject of this rulemaking.[3] The current energy conservation standards are found in the Code of Federal Regulations (''CFR'') at 10 CFR 431.97(b).

In accordance with the authority provided by 42 U.S.C. 6295(p)(4) and 42 U.S.C. 6316(b)(1), DOE is issuing this direct final rule amending the energy conservation standards for ACUACs and ACUHPs.[4] The amended standards levels outlined in this document reflect the culmination of a negotiated rulemaking that included the following notices and stakeholder comments thereon: May 2020 energy conservation standards request for information (''May 2020 ECS RFI'') (85 FR 27941 (May 12, 2020); May 2022 test procedure (''TP'')/ ECS RFI (87 FR 31743 (May 25, 2022)); and the 2022 Appliance Standards and Rulemaking Federal Advisory Committee (''ASRAC'') commercial unitary air conditioners and heat pumps working group negotiations, hereinafter referred to as ''the 2023 ECS Negotiations'' (87 FR 45703 (July 29, 2022). Participants in the 2023 ECS Negotiations included stakeholders representing manufacturers, energy-efficiency and environmental advocates, States, and electric utility companies. See section II.B.2 of this document for a detailed history of the current rulemaking.

The consensus reached by the ACUAC/HP ASRAC Working Group (hereinafter referred to as ''the ACUAC/HP Working Group'') on amended energy conservation standards (''ECS'') is outlined in the ASRAC Working Group Term Sheet (hereinafter referred to as ''the ACUAC/HP Working Group ECS Term Sheet''). (ASRAC Working Group Term Sheet, Docket No. EERE–2022–BT–STD–0015, No. 87) In accordance with the direct final rule provisions at 42 U.S.C. 6295(p)(4), DOE has determined that the recommendations contained in the ACUAC/HP Working Group ECS Term Sheet are compliant with 42 U.S.C. 6313(a)(6)(B). As required by EPCA, DOE is also simultaneously publishing a notice of proposed rulemaking (''NOPR'') that contains identical standards to those adopted in this direct final rule. Consistent with the statute, DOE is providing a 110-day public comment period on the direct final rule. (42 U.S.C. 6295(p)(4)(B); 42 U.S.C. 6316(b)(1))) If DOE determines that any adverse comments received provide a reasonable basis for withdrawal of the direct final rule under 42 U.S.C. 6313(a)(6)(B) or any other applicable law, DOE will withdraw the direct final rule and continue the rulemaking under the NOPR. (42 U.S.C. 6295(p)(4)(C); 42 U.S.C. 6316(b)(1)) See section II.A of this document for more details on DOE's statutory authority.

The amended standards that DOE is adopting in this direct final rule are the efficiency levels recommended in the ACUAC/HP Working Group ECS Term Sheet (shown in Table I.1) as measured according to DOE's amended test procedure for commercial unitary air conditioners and heat pumps codified at title 10 of the Code of Federal Regulations (''CFR''), part 431, subpart F, appendix A1 (''appendix A1'').

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

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

[3] While ACUACs and ACUHPs with rated cooling capacity less than 65,000 Btu/h are included in the broader category of commercial unitary air conditioners and heat pumps (''CUACs and CUHPs''), they are not addressed in this direct final rule. The standards for ACUACs and ACUHPs with rated cooling capacity less than 65,000 Btu/h have been addressed in a separate rulemaking (*see* Docket No. EERE–2022–BT–STD–0008). Accordingly, all references within this direct final rule to ACUACs and ACUHPs exclude equipment with rated cooling capacity less than 65,000 Btu/h.

[4] *See* 42 U.S.C. 6316(b) (applying 42 U.S.C. 6295(p)(4)) to energy conservation standard rulemakings involving a variety of industrial equipment, including ACUACs and ACUHPs.

The amended standards recommended in the Joint Agreement are represented as trial standard level (''TSL'') 3 in this document (hereinafter the ''Recommended TSL'') and are described in section V.A of this document. These standards apply to all equipment listed in Table I.1 and manufactured in, or imported into the United States starting on January 1, 2029.

Table I.1 Energy Conservation Standards for ACUACs and ACUHPs (Compliance Starting January 1, 2029)

Cooling Capacity	Subcategory	Supplementary Heating Type	Minimum Efficiency
≥65,000 Btu/h and <135,000 Btu/h	AC	Electric Resistance Heating or No Heating	IVEC = 14.3
		All Other Types of Heating	IVEC = 13.8
	HP	All Types of Heating or No Heating	IVEC = 13.4 IVHE = 6.2
≥135,000 Btu/h and <240,000 Btu/h	AC	Electric Resistance Heating or No Heating	IVEC = 13.8
		All Other Types of Heating	IVEC = 13.3
	HP	All Types of Heating or No Heating	IVEC = 13.1 IVHE = 6.0
≥240,000 Btu/h and <760,000 Btu/h	AC	Electric Resistance Heating or No Heating	IVEC = 12.9
		All Other Types of Heating	IVEC = 12.2
	HP	All Types of Heating or No Heating	IVEC = 12.1 IVHE = 5.8

A. Benefits and Costs to Consumers

Table I.2 summarizes DOE's evaluation of the economic impacts of the adopted standards on consumers of ACUACs and ACUHPs, as measured by the average life-cycle cost (''LCC'') savings and the simple payback period (''PBP'').[5] The average LCC savings are positive for all equipment classes, and the PBP is less than the average lifetime of the equipment, which is estimated to be 21–30 years, depending on equipment class (*see* sections IV.F and V.B.1 of this document).

Table I.2 Impacts of Adopted Energy Conservation Standards on Consumers of ACUACs

Equipment Class	Average LCC Savings (*2022$*)	Simple Payback Period (*years*)
Small (≥65,000 Btu/h and <135,000 Btu/h) CUACs	$1,380	5.9
Large (≥135,000 Btu/h and <240,000 Btu/h) CUACs	$2,488	3.5
Very Large (≥240,000 Btu/h and <760,000 Btu/h) CUACs	$6,431	1.1

Note: DOE did not conduct these analyses for ACUHPs for reasons discussed in section IV.C.3 of this document.

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 reference year through the end of the analysis period (2024–2058). Using a real discount rate of 5.9 percent, DOE estimates that the INPV for manufacturers of ACUACs and ACUHPs in the case without amended standards is $2,653.0 million in 2022$. Under the adopted standards, DOE estimates the change in INPV to range from −7.3 percent to −3.0 percent, which is approximately −$193.9 million to −$79.5 million. In order to bring this equipment into compliance with amended standards, it is estimated that industry will incur total conversion costs of $288.0 million.

DOE's analysis of the impacts of the adopted standards on manufacturers is

[5] 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 equipment (see section IV.C of this document).

described in sections IV.J and V.B.2 of this document.

C. National Benefits and Costs [6]

DOE's analyses indicate that the adopted energy conservation standards for ACUACs and ACUHPs would save a significant amount of energy. Relative to the case without amended standards, the lifetime energy savings for ACUACs and ACUHPs purchased in the 30-year period that begins in the anticipated year of compliance with the amended standards (2029–2058), amount to 5.5 quadrillion British thermal units (''Btu''), or quads.[7] This represents a savings of 10.0 percent relative to the energy use of this equipment in the case without amended standards (referred to as the ''no-new-standards case'').

The cumulative net present value (''NPV'') of total consumer benefits of the standards for ACUACs and ACUHPs ranges from $4.39 billion (at a 7-percent discount rate) to $15.30 billion (at a 3-percent discount rate). This NPV expresses the estimated total value of future operating-cost savings minus the estimated increased equipment and installation costs for ACUACs and ACUHPs purchased in 2029–2058.

In addition, the adopted standards for ACUACs and ACUHPs are projected to yield significant environmental benefits. DOE estimates that the adopted standards will result in cumulative emission reductions (over the same period as for energy savings) of 108.7 million metric tons (''Mt'') [8] of carbon dioxide (''CO_2''), 25.3 thousand tons of sulfur dioxide (''SO_2''), 185.1 thousand tons of nitrogen oxides (''NO_X''), 845.6 thousand tons of methane (''CH_4''), 0.8 thousand tons of nitrous oxide (''N_2O''), and 0.2 tons of mercury (''Hg'').[9] The estimated cumulative reduction in CO_2 emissions through 2030 amounts to 0.32 Mt, which is equivalent to the emissions resulting from the annual electricity use of more than 0.23 million 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''). DOE used interim SC–GHG values (in terms of benefit per ton of GHG avoided) developed by an Interagency Working Group on the Social Cost of Greenhouse Gases (''IWG'').[10] 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 $4.9 billion. DOE does not have a single central SC–GHG point estimate, and it emphasizes the value of considering the benefits calculated using all four sets of SC–GHG estimates. DOE is presenting monetized benefits of GHG emissions reductions in accordance with the applicable Executive Orders, and DOE would reach the same conclusion presented in this rule in the absence of the estimated benefits from reductions in GHG emissions.

DOE also estimated the monetized health benefits of SO_2 and NO_X emissions reductions associated with energy savings, using benefit-per-ton estimates from the U.S. Environmental Protection Agency,[11] as discussed in section IV.L of this document. DOE estimates the present value of the health benefits would be $3.0 billion using a 7-percent discount rate, and $8.8 billion using a 3-percent discount rate.[12] DOE is currently only monetizing health benefits from changes in ambient fine particulate matter (''$PM_{2.5}$'') concentrations from two precursors (SO_2 and NO_X), and from changes in ambient ozone from one precursor (for NO_X), 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 monetized benefits and costs expected to result from the amended standards for ACUACs and ACUHPs. 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.

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

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

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

[9] DOE calculated emissions reductions relative to the no-new-standards-case, which reflects key assumptions in the *Annual Energy Outlook 2023* (''*AEO 2023*''). *AEO 2023* reflects, to the extent possible, laws and regulations adopted through mid-November 2022, including the Inflation Reduction Act. See section IV.K of this document for further discussion of *AEO 2023* assumptions that affect air pollutant emissions.

[10] To monetize the benefits of reducing GHG emissions, this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990* published in February 2021 by the IWG. (''February 2021 SC–GHG TSD'') (available at: *www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf*) (last accessed Dec. 4, 2023).

[11] U.S. EPA, Estimating the Benefit per Ton of Reducing Directly Emitted $PM_{2.5}$, $PM_{2.5}$ Precursors and Ozone Precursors from 21 Sectors (available at: *www.epa.gov/benmap/estimating-benefit-ton-reducing-pm25-precursors-21-sectors*) (last accessed Dec. 4, 2023).

[12] 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 (''E.O.'') 12866.

Table I.3 Summary of Monetized Benefits and Costs of Adopted Energy Conservation Standards for ACUACs and ACUHPs (TSL 3)

	Billion $2022
3% discount rate	
Consumer Operating Cost Savings	23.89
Climate Benefits*	4.86
Health Benefits**	8.84
Total Benefits†	37.59
Consumer Incremental Equipment Costs‡	8.59
Net Benefits	29.00
Change in Producer Cash Flow (INPV)‡‡	(0.19) – (0.08)
7% discount rate	
Consumer Operating Cost Savings	8.94
Climate Benefits* (3% discount rate)	4.86
Health Benefits**	3.00
Total Benefits†	16.81
Consumer Incremental Equipment Costs‡	4.56
Net Benefits	12.25
Change in Producer Cash Flow (INPV)‡‡	(0.19) – (0.08)

Note: This table presents the costs and benefits associated with ACUACs and ACUHPs shipped during the period 2029-2058. These results include consumer, climate, and health benefits that accrue after 2058 from the equipment shipped during the period 2029-2058. Parentheses indicate negative values.

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

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

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

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

‡‡ Operating Cost Savings are calculated based on the life-cycle costs analysis and national impact analysis as discussed in detail below. *See* sections IV.F and IV.H of this document. DOE's national impacts analysis includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the equipment and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on

manufacturers (*i.e.*, the manufacturer impact analysis, or "MIA"). *See* section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. Change in INPV is calculated using the industry weighted-average cost of capital value of 5.9 percent that is estimated in the MIA (*see* chapter 12 of the direct final rule TSD for a complete description of the industry weighted-average cost of capital). For ACUACs and ACUHPs, the change in INPV ranges from -$193.9 million to -$79.5 million. DOE accounts for that range of likely impacts in analyzing whether a trial standard level is economically justified. *See* section V.C of this document. DOE is presenting the range of impacts to the INPV under two manufacturer markup scenarios: the Preservation of Gross Margin scenario, which is the manufacturer markup scenario used in the calculation of Consumer Operating Cost Savings in this table; and the Preservation of Operating Profit scenario, where DOE assumed manufacturers would not be able to increase per-unit operating profit in proportion to increases in manufacturer production costs. DOE includes the range of estimated INPV in the above table, drawing on the MIA explained further in section IV.J of this document, to provide additional context for assessing the estimated impacts of this direct final rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A-4 and E.O. 12866. If DOE were to include the INPV into the net benefit calculation for this direct final rule, the net benefits would range from $28.81 billion to $28.92 billion at a 3-percent discount rate and would range from $12.06 billion to $12.17 billion at a 7-percent discount rate.

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The benefits and costs of the considered 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 equipment purchase prices and installation costs, plus (3) the value of climate and health benefits of emission reductions, all annualized.[13]

The national operating cost savings are domestic private U.S. consumer monetary savings that occur as a result of purchasing the covered equipment and are measured for the lifetime of ACUACs and ACUHPs shipped in 2029–2058. The health benefits associated with reduced emissions achieved as a result of the adopted standards are also calculated based on the lifetime of ACUACs and ACUHPs shipped in 2029–2058. Total benefits for both the 3-percent and 7-percent cases are presented using the average GHG social costs with 3-percent discount rate.[14] Estimates of SC–GHG values are presented for all four discount rates in section V.B of this document.

Table I.4 presents the total estimated monetized benefits and costs associated with the adopted standard, expressed in terms of annualized values. The results under the primary estimate are as follows.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the adopted standards is $493.2 million per year in increased equipment costs, while the estimated annual benefits are $1,371.6 million in reduced equipment operating costs, $279.2 million in climate benefits, and $507.9 million in health benefits. In this case, the net benefit would amount to $1.7 billion per year.

Using a 7-percent discount rate for consumer benefits and costs and health benefits from reduced NOx and SO_2 emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the standards adopted in this rule is $481.3 million per year in increased equipment costs, while the estimated annual benefits are $944.7 million in reduced equipment operating costs, $279.2 million in climate benefits, and $317.2 million in health benefits. In this case, the net benefit amounts to $1.1 billion per year.

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[13] To convert the time-series of costs and benefits into annualized values, DOE calculated a present value in 2024, the year used for discounting the NPV of total consumer costs and savings. For the benefits, DOE calculated a present value associated with each year's shipments in the year in which the shipments occur (*e.g.,* 2030), and then discounted the present value from each year to 2024. 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.

[14] As discussed in section IV.L.1 of this document, DOE agrees with the IWG that using consumption-based discount rates (*e.g.,* 3 percent) is appropriate when discounting the value of climate impacts. Combining climate effects discounted at an appropriate consumption-based discount rate with other costs and benefits discounted at a capital-based rate (*e.g.,* 7 percent) is reasonable because of the different nature of the types of benefits being measured.

Table I.4 Annualized Benefits and Costs of Adopted Standards for ACUACs and ACUHPs (TSL 3)

	Million 2022$/year		
	Primary Estimate	Low-Net-Benefits Estimate	High-Net-Benefits Estimate
3% discount rate			
Consumer Operating Cost Savings	1,371.6	1,332.2	1,403.0
Climate Benefits*	279.282.8	279.282.8	279.282.8
Health Benefits**	507.9	507.9	507.9
Total Benefits†	2,158.7	2,119.2	2,190.0
Consumer Incremental Equipment Costs‡	493.2	529.3	415.2
Net Benefits	1,665.5	1,590.0	1,774.9
Change in Producer Cashflow (INPV)‡‡	(13) – (5)		
7% discount rate			
Consumer Operating Cost Savings	944.7	918.8	966.6
Climate Benefits* (3% discount rate)	279.2	279.2	279.2
Health Benefits**	317.1	317.1	317.1
Total Benefits†	1,541.0	1,515.1	1,562.9
Consumer Incremental Equipment Costs‡	481.3	511.6	414.3
Net Benefits	1,059.7	1,003.5	1,148.7
Change in Producer Cashflow (INPV)‡‡	(13) – (5)		

Note: This table presents the costs and benefits associated with ACUACs and ACUHPs shipped in 2029-2058. These results include consumer, climate, and health benefits that accrue after 2058 from the products shipped in 2029-2058. The Primary, Low-Net-Benefits, and High-Net-Benefits Estimates utilize projections of energy prices from the *AEO2023* Reference case, Low-Economic-Growth case, and High-Economic-Growth case, respectively. In addition, incremental equipment costs reflect a constant rate in the Primary Estimate, an increasing rate in the Low-Net-Benefits Estimate, and a decreasing rate in the High-Net-Benefits Estimate. The methods used to derive projected price trends are explained in sections IV.F.1 and IV.H.3 of this document. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding. Parentheses indicate negative values.

* 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 DOE does not have a single central SC-GHG point estimate, and it emphasizes the value of considering the benefits calculated using all four sets of SC-GHG estimates. To monetize the benefits of reducing GHG emissions, this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990* published in February 2021 by the IWG.

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

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

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

‡‡ Operating Cost Savings are calculated based on the life-cycle costs analysis and national impact analysis as discussed in detail below. See sections IV.F and IV.H of this document. DOE's national impacts analysis includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to

manufacture the equipment and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (*i.e.*, the manufacturer impact analysis, or "MIA"). See section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. The annualized change in INPV is calculated using the industry weighted-average cost of capital value of 5.9 percent that is estimated in the MIA (*see* chapter 12 of the direct final rule TSD for a complete description of the industry weighted average cost of capital). For ACUACs and ACUHPs, the annualized change in INPV ranges from -$13 million to -$5 million. DOE accounts for that range of likely impacts in analyzing whether a trial standard level is economically justified. *See* section V.C of this document. DOE is presenting the range of impacts to the INPV under two manufacturer markup scenarios: the Preservation of Gross Margin scenario, which is the manufacturer markup scenario used in the calculation of Consumer Operating Cost Savings in this table; and the Preservation of Operating Profit scenario, where DOE assumed manufacturers would not be able to increase per-unit operating profit in proportion to increases in manufacturer production costs. DOE includes the range of estimated annualized change in INPV in the above table, drawing on the MIA explained further in section IV.J of this document, to provide additional context for assessing the estimated impacts of this direct final rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A-4 and E.O. 12866. If DOE were to include the INPV into the annualized net benefit calculation for this direct final rule, the annualized net benefits would range from $1,652 million to $1,660 million at a 3-percent discount rate and would range from $1,046 million to $1,054 million at a 7-percent discount rate.

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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 ACUAC/ACUHP Working Group statement containing recommendations with respect to energy conservation standards for ACUACs and ACUHPs 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).[15] 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. 6313(a)(6)(B), which contains criteria for adopting a uniform national standard more stringent than the levels contained in the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (''ASHRAE'') Standard 90.1, as amended,[16] for the equipment considered in this document. Specifically, the Secretary has determined, supported by clear and convincing evidence, 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 emissions reduction benefits, and a 3-percent discount rate case for GHG social costs, the estimated cost of the standards for ACUACs and ACUHPs is $481.3 million per year in increased equipment costs, while the estimated annual benefits are $944.7 million in reduced equipment operating costs, $279.2 million in climate benefits, and $317.2 million in health benefits. The net benefit amounts to $1.1 billion per year. DOE notes that the net benefits are substantial even in the absence of climate benefits,[17] and DOE would adopt the same standards in the absence of such benefits.

The significance of energy savings offered by a new or amended energy conservation standard cannot be determined without knowledge of the specific circumstances surrounding a given rulemaking.[18] For example, some covered products and equipment have most of their energy consumption occur during periods of peak energy demand. The impacts of these products on the energy infrastructure can be more pronounced than products with relatively constant demand. Accordingly, DOE evaluates the significance of energy savings on a case-by-case basis.

As previously mentioned, the standards are projected to result in estimated national energy savings of 5.5 quads (FFC), the equivalent of the primary annual energy use of 59.1 million homes. In addition, they are projected to reduce CO_2 emissions by 108.7 Mt. Based on these findings, DOE has determined the energy savings from the standard levels adopted in this direct final rule are ''significant'' within the meaning of 42 U.S.C. 6313(a)(6)(A)(ii)(II). A more detailed discussion of the basis for these conclusions is contained in the remainder of this document and the accompanying TSD.

Under the authority provided by 42 U.S.C. 6295(p)(4), DOE is issuing this direct final rule amending the energy conservation standards for ACUACs and ACUHPs. Consistent with this authority, DOE is also publishing elsewhere in this issue of the **Federal Register** a NOPR proposing standards that are identical to those contained in this direct final rule. (*See* 42 U.S.C. 6295(p)(4)(A)(i); 42 U.S.C. 6316(b)(1))

[15] *See* 42 U.S.C. 6316(b) (applying 42 U.S.C. 6295(p)(4) to energy conservation standard rulemakings involving a variety of industrial equipment, including ACUACs and ACUHPs.

[16] As discussed in section II.B.2, ASHRAE 90.1–2019 updated the minimum efficiency levels for ACUACs and ACUHPs to align with those adopted by DOE in the January 2016 Direct Final Rule—*i.e.,* ASHRAE 90.1–2019 includes minimum efficiency levels that are aligned with the current Federal energy conservation standards. The most recent version of ASHRAE Standard 90.1, ASHRAE 90.1–2022, includes the same minimum efficiency levels for ACUACs and ACUHPs as ASHRAE 90.1–2019.

[17] The information on climate benefits is provided in compliance with Executive Order 12866.

[18] 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).

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 energy conservation standards for ACUACs and ACUHPs.

A. Authority

EPCA, Public Law 94–163, as amended, authorizes DOE to regulate the energy efficiency of certain consumer products and industrial equipment. Title III, Part C of EPCA, added by Public Law 95–619, Title IV, section 441(a) (42 U.S.C. 6311–6317, as codified), established the Energy Conservation Program for Certain Industrial Equipment, which sets forth a variety of provisions designed to improve energy efficiency. This equipment includes ACUACs and ACUHPs, which are a category of small, large, and very large commercial package air conditioning and heating equipment and the subject of this rulemaking. (42 U.S.C. 6311(1)(B)–(D)) EPCA prescribed initial standards for this equipment. (42 U.S.C. 6313(a)(1)–(2))

Pursuant to EPCA, DOE must amend the energy conservation standards for certain types of commercial and industrial equipment, including the equipment at issue in this document, whenever ASHRAE amends the standard levels or design requirements prescribed in ASHRAE Standard 90.1, ''Energy Standard for Buildings Except Low-Rise Residential Buildings'' (''ASHRAE Standard 90.1''). DOE must adopt the amended ASHRAE Standard 90.1 levels for these equipment (hereafter ''ASHRAE equipment''), unless the Secretary of Energy (''the Secretary'') determines by rule published in the **Federal Register** and supported by clear and convincing evidence that adoption of a more-stringent uniform national standard would result in significant additional conservation of energy and is technologically feasible and economically justified. (42 U.S.C. 6313(a)(6)(A)–(B))

In addition, EPCA contains a review requirement for this same equipment (the six-year-lookback review), which requires DOE to consider the need for amended standards every six years. To adopt more-stringent standards under that provision, DOE must once again have clear and convincing evidence to show that such standards would be technologically feasible and economically justified and would save a significant additional amount of energy. (42 U.S.C. 6313(a)(6)(C)); *see id.* 6313(a)(6)(A)(ii)(II) & (a)(6)(B)(i))

In deciding whether a more-stringent standard is economically justified, under either the provisions of 42 U.S.C. 6313(a)(6)(A) or 42 U.S.C. 6313(a)(6)(C), DOE must determine whether the benefits of the standard exceed its burdens. DOE must make this determination after receiving comments on the proposed standard, and by considering, to the maximum extent practicable, the following seven factors:

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

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

(3) The total projected amount of energy savings likely to result directly from the standard;

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

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

(6) The need for national energy conservation; and

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

(42 U.S.C. 6313(a)(6)(B)(ii)(I)–(VII))

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

Federal energy efficiency requirements for covered equipment established under EPCA generally supersede State laws and regulations concerning energy conservation testing, labeling, and standards. (42 U.S.C. 6316(a) and (b); 42 U.S.C. 6297) DOE may, however, grant waivers of Federal preemption in limited instances for particular State laws or regulations, in accordance with the procedures and other provisions set forth under EPCA. (42 U.S.C. 6316(b)(2)(D))

Under 42 U.S.C. 6314, EPCA sets forth the criteria and procedures DOE is required to follow when prescribing or amending test procedures for covered equipment. EPCA requires that any test procedure prescribed or amended under this section must be reasonably designed to produce test results which reflect energy efficiency, energy use, or estimated annual operating cost of covered equipment during a representative average use cycle and requires that the test procedure not be unduly burdensome to conduct. (42 U.S.C. 6314(a)(2)) Manufacturers of covered equipment must use the Federal test procedures as the basis for: (1) certifying to DOE that their equipment complies with the applicable energy conservation standards adopted pursuant to EPCA (42 U.S.C. 6316(b); 42 U.S.C. 6296), and (2) making representations about the efficiency of that equipment (42 U.S.C. 6314(d)). Similarly, DOE uses these test procedures to determine whether the equipment complies with relevant standards promulgated under EPCA. The current DOE test procedure for ACUACs and ACUHPs appear at title 10 of the Code of Federal Regulations (''CFR''), part 431, subpart F, appendix A.

EPCA also contains what is known as an ''anti-backsliding'' provision, which prevents the Secretary from prescribing any amended standard that either increases the maximum allowable energy use or decreases the minimum required energy efficiency of a covered product. (42 U.S.C. 6313(a)(6)(B)(iii)(I)) Also, the Secretary may not prescribe an amended or new standard if interested persons have established by a preponderance of the evidence that the standard is likely to result in the unavailability in the United States in any covered equipment type (or class) of performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as those generally available in the United States. (42 U.S.C. 6313(a)(6)(B)(iii)(II)(aa))

Finally, the Energy Independence and Security Act of 2007 (''EISA 2007''), Public Law 110–140, amended EPCA, in relevant part, to grant DOE authority to issue a final rule (*i.e.,* a ''direct final rule'' or ''DFR'') establishing an energy conservation standard upon receipt of a statement submitted jointly by interested persons that are fairly representative of relevant points of view (including representatives of manufacturers of covered products, States, and efficiency advocates), as determined by the Secretary, that contains recommendations with respect to an energy or water conservation standard that are in accordance with the provisions of 42 U.S.C. 6295(o) or 42 U.S.C. 6313(a)(6)(B), as applicable. (42 U.S.C. 6295(p)(4); 42 U.S.C. 6316(b)(1)) Pursuant to 42 U.S.C. 6295(p)(4), the Secretary must also determine whether a jointly submitted recommendation for an energy or water conservation standard satisfies 42 U.S.C. 6295(o) or 42 U.S.C. 6313(a)(6)(B), as applicable.

The direct final rule must be published simultaneously with a NOPR that proposes an energy or water conservation standard that is identical to the standard established in the direct final rule, and DOE must provide a public comment period of at least 110 days on this proposal. (42 U.S.C. 6295(p)(4)(A)–(B); 42 U.S.C. 6316(b)(1)) While DOE typically provides a comment period of 60 days on proposed energy conservation standards, for a NOPR accompanying a direct final rule, DOE provides a comment period of the same length as the comment period on the direct final rule—*i.e.* 110 days. Based on the comments received during this period, the direct final rule will either become effective, or DOE will withdraw it not later than 120 days after its issuance if: (1) one or more adverse comments is received, and (2) DOE determines that those comments, when viewed in light of the rulemaking record related to the direct final rule, may provide a reasonable basis for withdrawal of the direct final rule under 42 U.S.C. 6295(o), 42 U.S.C. 6313(a)(6)(B), or any other applicable law. (42 U.S.C. 6295(p)(4)(C); 42 U.S.C. 6316(b)(1)) 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 at the same time as 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 noted that it may issue standards recommended by interested persons that are fairly representative of relative points of view as a direct final rule when the recommended standards are in accordance with 42 U.S.C. 6295(o) or 42 U.S.C. 6313(a)(6)(B), as applicable. 86 FR 70892, 70912 (Dec. 13, 2021). But the direct final rule provision in EPCA does not impose additional requirements applicable to other standards rulemakings, which is consistent with the unique circumstances of rules issued as consensus agreements under DOE's direct final rule authority. *Id.* DOE's discretion remains bounded by its statutory mandate to adopt a standard that results in significant conservation of energy and is technologically feasible and economically justified—a requirement found in 42 U.S.C. 6313(a)(6)(B). As such, DOE's review and analysis of the Joint Agreement is limited to whether the recommended standards satisfy the criteria in 42 U.S.C. 6313(a)(6)(B).

Additionally, DOE notes that the direct final rule authority in EPCA is permissive. If DOE determines that recommended standards satisfy the applicable criteria, the Department ''may issue a final rule.'' (42 U.S.C. 6295(p)(4)(A)(i)) This discretion is particularly relevant for ASHRAE equipment where the applicable statutory criteria require that an amended standard be technologically feasible and economically justified and result in significant conservation of energy. (42 U.S.C. 6313(a)(6)(A)(ii)(II)) This is in contrast to the applicable criteria for covered products and non-ASHRAE equipment, where, in addition to requiring significant conservation of energy, an amended standard must also represent the maximum improvement in energy efficiency that is technologically feasible and economically justified. Thus, there may be situations where the recommended standards for ASHRAE equipment satisfy the criteria in 42 U.S.C. 6313(a)(6)(B), but do not represent that maximum improvement in energy efficiency that is technologically feasible and economically justified. In those situations, DOE has discretion on whether to proceed with a direct final rule or propose its own, more-stringent standard. In order to inform that decision, DOE conducts its typical walk-down analysis when evaluating all direct final rules, including those for ASHRAE equipment. Under that approach, DOE starts from the most stringent possible standard (''max-tech'') and ''walks-down'' through the TSLs until arriving at the first TSL that meets all of the statutory criteria.

B. Background

1. Current Standards

In a direct final rule published in the **Federal Register** on January 15, 2016 (''January 2016 Direct Final Rule''), DOE prescribed the current energy conservation standards for ACUACs and ACUHPs manufactured on and after January 1, 2023. 81 FR 2420. These standards are set forth in DOE's regulations at 10 CFR 431.97(b) and are repeated in Table II.1.

Table II.1 Federal Energy Conservation Standards for ACUACs and ACUHPs

Equipment Type	Cooling Capacity	Subcategory	Supplementary Heating Type	Minimum Efficiency
Small Commercial Packaged Air Conditioning and Heating Equipment (Air-Cooled)	≥65,000 Btu/h and <135,000 Btu/h	AC	Electric Resistance Heating or No Heating	IEER = 14.8
			All Other Types of Heating	IEER = 14.6
		HP	Electric Resistance Heating or No Heating	IEER = 14.1 COP = 3.4
			All Other Types of Heating	IEER = 13.9 COP = 3.4
Large Commercial Packaged Air Conditioning and Heating Equipment (Air-Cooled)	≥135,000 Btu/h and <240,000 Btu/h	AC	Electric Resistance Heating or No Heating	IEER = 14.2
			All Other Types of Heating	IEER = 14.0
		HP	Electric Resistance Heating or No Heating	IEER = 13.5 COP = 3.3
			All Other Types of Heating	IEER = 13.3 COP = 3.3
Very Large Commercial Packaged Air Conditioning and Heating Equipment (Air-Cooled)	≥240,000 Btu/h and <760,000 Btu/h	AC	Electric Resistance Heating or No Heating	IEER = 13.2
			All Other Types of Heating	IEER = 13.0
		HP	Electric Resistance Heating or No Heating	IEER = 12.5 COP = 3.2
			All Other Types of Heating	IEER = 12.3 COP = 3.2

2. History of Standards Rulemaking for ACUACs and ACUHPs

Since publication of the January 2016 Direct Final Rule, ASHRAE published an updated version of ASHRAE Standard 90.1 (''ASHRAE 90.1–2019''), which updated the minimum efficiency levels for ACUACs and ACUHPs to align with those adopted by DOE in the January 2016 Direct Final Rule (*i.e.,* specifying two tiers of minimum levels for ACUACs and ACUHPs, with a January 1, 2023 compliance date for the second tier). ASHRAE published another version of ASHRAE Standard 90.1 in January 2023 (''ASHRAE 90.1–2022''), which includes the same minimum efficiency levels for ACUACs and ACUHPs as those included in ASHRAE Standard 90.1–2019.

On May 12, 2020, DOE began its six-year-lookback review with for ACUACs and ACUHPs by publishing in the **Federal Register** the May 2020 ECS RFI.[19] 85 FR 27941. The May 2020 ECS RFI sought information to help DOE inform its decisions, consistent with its obligations under EPCA. DOE received multiple comments from interested stakeholders in response to the May 2020 ECS RFI, which prompted DOE to publish the May 2022 TP/ECS RFI in the **Federal Register** on May 25, 2022, to investigate additional aspects of the ACUAC and ACUHP TP and standards. 87 FR 31743. In the latter document, DOE identified several issues that it determined would benefit from further comment. DOE discussed these topics (including any comments received in response to the May 2020 ECS RFI that are related to these topics) in the May 2022 TP/ECS RFI. Once again, DOE received a number of written comments from interested parties related to standards for CUACs and CUHPs in response to the May 2020 ECS RFI and the May 2022 TP/ECS RFI. DOE considered these comments in preparation of this direct final rule. Table II.2 and Table II.3 list the stakeholders whose comments were related to standards for ACUACs and ACUHPs and have been considered in this rulemaking. Relevant comments, and DOE's responses, are provided in the appropriate sections of this document.

[19] The May 2020 ECS RFI also addressed commercial warm air furnaces, a separate type of covered equipment which was subsequently handled in a different rulemaking proceeding (*see* Docket No. EERE–2019–BT–STD–0042 in *www.regulations.gov*).

Table II.2 List of Commenters with Written Submissions in Response to the May 2020 ECS RFI Relevant to ACUAC and ACUHP Standards (Excluding Double-Duct Systems)

Commenter(s)	Abbreviation	Commenter Type
Air-Conditioning, Heating, and Refrigeration Institute	AHRI	Manufacturer Trade Association
Appliance Standards Awareness Project, American Council for an Energy Efficient Economy, California Energy Commission, Natural Resources Defense Council, and Northeast Energy Efficiency Partnerships	ASAP, ACEEE, *et al.*	Efficiency Advocacy Organizations, State Agency
California Investor-Owned Utilities	CA IOUs	Utilities
Carrier Corporation	Carrier	Manufacturer
Goodman Manufacturing Company, L.P.	Goodman	Manufacturer
Institute for Policy Integrity at NYU School of Law	Policy Integrity	Other Stakeholder
Lennox International Inc.	Lennox	Manufacturer
Northwest Energy Efficiency Alliance	NEEA	Efficiency Advocacy Organization
Portland General Electric Company	PGE	Utility
Trane Technologies	Trane	Manufacturer
United CoolAir Corporation	UCA	Manufacturer

Table II.3 List of Commenters with Written Submissions in Response to the May 2022 TP/ECS RFI Relevant to ACUAC and ACUHP Standards

Commenter(s)	Abbreviation	Commenter Type
Air-Conditioning, Heating, and Refrigeration Institute	AHRI	Manufacturer Trade Association
Appliance Standards Awareness Project and American Council for an Energy-Efficient Economy	ASAP and ACEEE	Efficiency Advocacy Organizations
California Investor-Owned Utilities	CA IOUs	Utilities
Carrier Corporation	Carrier	Manufacturer
Lennox International Inc.	Lennox	Manufacturer
New York State Energy Research and Development Authority	NYSERDA	State Agency
Northwest Energy Efficiency Alliance	NEEA	Efficiency Advocacy Organization

A parenthetical reference at the end of a comment quotation or paraphrase provides the location of the item in the public record.[20] For comments received in response to the May 2020 ECS RFI and May 2022 TP/ECS RFI (which are contained within two different dockets [21]), parenthetical references in this direct final rule include the full docket number (rather than just the document number).

On July 29, 2022, DOE published in the **Federal Register** a notice of intent to establish a working group for commercial unitary air conditioners and heat pumps to negotiate proposed test procedures and amended energy conservation standards for this equipment (''July 2022 Notice of Intent''). 87 FR 45703. The ACUAC/HP Working Group was established under ASRAC in accordance with the Federal Advisory Committee Act (''FACA'') (5 U.S.C. App 2) and the Negotiated Rulemaking Act (''NRA'') (5 U.S.C. 561–

[20] The parenthetical reference provides a reference for information located in the relevant docket for this rulemaking, which is maintained at *www.regulations.gov.* The references are arranged as follows: (commenter name, comment docket ID number, page of that document).

[21] Comments submitted in response to the May 2020 ECS RFI are available in Docket No. EERE–2019–BT–STD–0042. Comments submitted in response to the May 2022 TP/ECS RFI are available in Docket No. EERE–2022–BT–STD–0015.

570, Pub. L. 104–320). The purpose of the ACUAC/HP Working Group was to discuss, and if possible, reach consensus on recommended amendments to the test procedures and energy conservation standards for ACUACs and ACUHPs. The ACUAC/HP Working Group consisted of 14 voting members, including DOE. (*See* appendix A, Working Group Members, Document No. 65 in Docket No. EERE–2022–BT–STD–0015) On December 15, 2022, the ACUAC/HP Working Group signed a Term Sheet (''ACUAC/HP Working Group TP Term Sheet'') of recommendations regarding ACUAC and ACUHP test procedures, including two new efficiency metrics: integrated ventilation, economizing, and cooling (''IVEC'') and integrated ventilation and heating efficiency (''IVHE''). (*See Id.*)

The ACUAC/HP Working Group met five times to discuss energy conservation standards for ACUACs and ACUHPs. These meetings took place on February 22–23, March 21–22, April 12–13, April 26–27, and May 1, 2023. As a result of these efforts, the ACUAC/HP Working Group successfully reached consensus on recommended energy conservation standards in terms of the new IVEC and IVHE metrics for CUACs and CUHPs. On May 1, 2023, the ACUAC/HP Working Group signed the ACUAC/HP Working Group ECS Term Sheet outlining its recommendations which ASRAC approved on October 17, 2023. These recommendations are discussed further in section II.B.3 of this direct final rule.[22]

3. 2022–2023 ASRAC ACUAC/HP Working Group Recommended Standard Levels

This section summarizes the standard levels recommended in the Term Sheet submitted by the ACUAC/HP Working Group for ACUAC/HP energy conservation standards and the subsequent procedural steps taken by DOE. Recommendation #1 of the ACUAC/HP Working Group ECS Term Sheet recommends standard levels for ACUACs and ACUHPs with a recommended compliance date of January 1, 2029. (ASRAC Term Sheet, No. 87 at p. 2) These recommended standard levels are presented in Table II.4. Recommendation #2 of the ACUAC/HP Working Group ECS Term Sheet recommends revising existing certification requirements to support the new metrics and standards presented in Table II.4, specifically requesting that manufacturers be required to certify the following information publicly to DOE for each basic model: (1) crankcase heat wattage for each compressor stage, and (2) 5 °F heating capacity and COP, if applicable. DOE will address recommendation #2 regarding certification in a separate rulemaking.

Table II.4 Energy Conservation Standards for ACUACs and ACUHPs Recommended in the ACUAC/HP Working Group ECS Term Sheet

Cooling Capacity	Subcategory	Supplementary Heating Type	Minimum Efficiency
≥65,000 Btu/h and <135,000 Btu/h	AC	Electric Resistance Heating or No Heating	IVEC = 14.3
		All Other Types of Heating	IVEC = 13.8
	HP	All Types of Heating or No Heating	IVEC = 13.4 IVHE = 6.2
≥135,000 Btu/h and <240,000 Btu/h	AC	Electric Resistance Heating or No Heating	IVEC = 13.8
		All Other Types of Heating	IVEC = 13.3
	HP	All Types of Heating or No Heating	IVEC = 13.1 IVHE = 6.0
≥240,000 Btu/h and <760,000 Btu/h	AC	Electric Resistance Heating or No Heating	IVEC = 12.9
		All Other Types of Heating	IVEC = 12.2
	HP	All Types of Heating or No Heating	IVEC = 12.1 IVHE = 5.8

After carefully considering the consensus recommendations for amending the energy conservation standards for ACUACs and ACUHPs submitted by the ACUAC/HP Working Group and adopted by ASRAC, DOE has determined that these recommendations are in accordance with the statutory requirements of 42 U.S.C. 6295(p)(4) and 42 U.S.C. 6316(b)(1) for the issuance of a direct final rule. The following paragraphs explain DOE's rationale in making this determination.

First, with respect to the requirement that recommended energy conservation standards be submitted by interested persons that are fairly representative of relevant points of view, DOE notes that the ACUAC/HP Working Group ECS Term Sheet was signed and submitted by a broad cross-section of interests, including the manufacturers who produce the subject equipment. To satisfy this requirement, DOE has generally found that the group submitting a joint statement must, where appropriate, include larger concerns and small businesses in the regulated industry/manufacturer community, energy advocates, energy utilities, consumers, and States. However, the Department has explained that 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 additional parties must be part of a joint statement beyond the required ''manufacturers of covered products, States, and efficiency advocates'' specifically called out by EPCA at 42 U.S.C. 6295(p)(4)(A). In this case, in addition to manufacturers, the ACUAC/HP Working Group ECS Term Sheet also included environmental and energy-efficiency advocacy organizations, and electric utility companies. Although States were not direct signatories to the ACUAC/HP Working Group ECS Term Sheet, the ASRAC Committee approving

[22] The ACUAC/HP Working Group ECS Term Sheet is available at *www.regulations.gov/document/EERE-2022-BT-STD-0015-0087.*

the ACUAC/HP Working Group's recommendations included at least two members representing States—one representing the State of New York and one representing the State of California. As a result, DOE has determined that these recommendations were submitted by interested persons who are fairly representative of relevant points of view on this matter, including those specifically identified by Congress: manufacturers of covered equipment, States, and efficiency advocates. (42 U.S.C. 6295(p)(4)(A); 42 U.S.C. 6316(b)(1))

Pursuant to 42 U.S.C. 6295(p)(4), the Secretary must also determine whether a jointly-submitted recommendation for an energy or water conservation standard satisfies 42 U.S.C. 6295(o) or 42 U.S.C. 6313(a)(6)(B), as applicable. In making this determination, DOE conducted an analysis to evaluate whether the potential energy conservation standards under consideration achieve significant energy savings and are technologically feasible and economically justified. The evaluation is similar to the comprehensive approach that DOE typically conducts whenever it considers potential new or amended energy conservation standards for a given type of product or equipment. DOE applies the same principles to any consensus recommendations it may receive to satisfy its statutory obligations. Upon review, the Secretary determined that the ACUAC/HP Working Group ECS Term Sheet comports with the standard-setting criteria set forth under 42 U.S.C. 6313(a)(6)(B). Accordingly, the consensus-recommended efficiency levels were included as the recommended TSL for ACUACs and ACUHPs (*see* section V.A of this document for description of all of the considered TSLs). The details regarding how the consensus-recommended TSL complies with the standard-setting criteria are discussed and demonstrated in the relevant sections throughout this document.

In sum, the Secretary has determined that the relevant criteria under 42 U.S.C. 6295(p)(4) and 42 U.S.C. 6316(b)(1) have been satisfied, such that it is appropriate to adopt the consensus-recommended amended energy conservation standards for ACUACs and ACUHPs through this direct final rule based on the clear and convincing evidence discussed throughout this final rule. Also, in accordance with the provisions described in section II.A of this document, DOE is simultaneously publishing a NOPR proposing that the identical standard levels contained in this direct final rule be adopted.

III. General Discussion

A. General Comments

In response to the May 2020 ECS RFI, DOE received multiple comments from stakeholders generally expressing support for DOE evaluating and amending standards for ACUACs and ACUHPs. (ASAP, ACEEE, *et al.,* EERE–2019–BT–STD–0042–0023 at p. 1; CA IOUs EERE–2019–BT–STD–0042–0020 at p. 1; NEEA, EERE–2019–BT–STD–0042–0024 at p. 9; PGE, EERE–2019–BT–STD–0042–0009, pp. 1–2) ASAP, ACEEE, *et al.* stated that very large energy savings could result from amended standards for ACUACs and ACUHPs, citing the max-tech efficiency levels analyzed in the January 2016 Direct Final Rule as well as the range of efficiencies in the current market. (ASAP, ACEEE, *et al.,* EERE–2019–BT–STD–0042–0023 at pp. 1–2) PGE also asserted that standards for ACUACs should be substantially higher than standards for ACUHPs to incentivize increased adoption of ACUHPs by commercial consumers, particularly in dual season climates where the commenter claimed that ACUHPs deliver higher efficiency, reduce peak loads, and reduce greenhouse gas emissions. (PGE, EERE–2019–BT–STD–0042–0009 at pp. 1–2)

In response to PGE's assertion that standards for ACUACs should be substantially higher than standards for ACUHPs, DOE notes that at the recommended TSL, the IVEC values are marginally higher for ACUACs with all other types of heat than for ACUHPs, as mentioned in section IV.C.2.a, and are unlikely on their own to incentivize increased adoption of ACUHPs, as discussed in section IV.G.4. At this time, DOE does not have evidence or information that would justify adopting higher standards for ACUACs than ACUHPs by a larger margin than recommended by the ACUAC/HP Working Group.

DOE also received comments in response to the May 2020 ECS RFI from several other stakeholders generally expressing views that DOE should not amend the existing energy conservation standards for ACUACs and ACUHPs. (AHRI, EERE–2019–BT–STD–0042–0014 at p. 3; Carrier, EERE–2019–BT–STD–0042–0013 at pp. 8, 18–19; Lennox, EERE–2019–BT–STD–0042–0015 at p. 1; Trane, EERE–2019–BT–STD–0042–0016 at p. 2) More specifically, AHRI, Carrier, Lennox, and Trane argued that standards should not be amended because of the burdens manufacturers already face, including regulatory changes such as refrigerant regulations, new efficiency metrics and standards for central air conditioners and heat pumps, and pending test procedure and standard updates for variable refrigerant flow equipment. (AHRI, EERE–2019–BT–STD–0042–0014 at p. 2; Carrier, EERE–2019–BT–STD–0042–0013 at pp. 18–19; Lennox, EERE–2019–BT–STD–0042–0015 at pp. 3–4, 8; Trane, EERE–2019–BT–STD–0042–0016 at p. 2) Commenters also asserted that the impacts associated with the 2023 standards could not be assessed at the time of submitting their comments because the standards had yet to take effect, and therefore, considering new standards prior to 2023 would be premature. (AHRI, EERE–2019–BT–STD–0042–0014 at p. 3; Carrier, EERE–2019–BT–STD–0042–0013 at p. 8, Lennox, EERE–2019–BT–STD–0042–0015 at pp. 2–3; Trane, EERE–2019–BT–STD–0042–0016 at p. 2) Lennox also asserted that future market uncertainties are compounded by the COVID19 pandemic. (Lennox, EERE–2019–BT–STD–0042–0015 at p. 2)

DOE acknowledges that at the time of the May 2020 ECS RFI, compliance was not yet required for the second tier of energy conservation standards adopted in the January 2016 Direct Final Rule, which had a compliance date of January 1, 2023. However, the ACUAC/HP Working Group meetings to negotiate recommended energy conservation standard levels and the subsequent agreement outlined in the ACUAC/HP Working Group ECS Term Sheet occurred after January 1, 2023. Further, the analyses of amended energy conservation standards conducted by DOE as part of the 2023 ECS Negotiations were based on the ACUAC/HP market after the 2023 compliance date. DOE notes that despite the concerns raised regarding cumulative regulatory burden and impacts to the market due to the COVID 19 pandemic, Carrier, Lennox, and Trane (as members of the ACUAC/HP Working Group) voted in favor of the recommended standard levels. Additionally, AHRI subsequently supported efforts for a negotiated rulemaking to amend standards in comments received in response to the May 2022 TP/ECS RFI, demonstrating AHRI's position on this issue changed. (AHRI, EERE–2022–BT–STD–0015–0008 at p. 1) Therefore, DOE surmises that those commenters' original positions on this topic changed since the time of the May 2020 ECS RFI.

In response to the May 2020 ECS RFI, AHRI asserted that among ACUACs and ACUHPs, the only equipment category for which DOE is statutorily required to review amended standards under the six-year-lookback rulemaking is double-duct systems, based on the fact that the 2023 standards adopted in the January 2016 Direct Final Rule had not yet come into effect. (AHRI, EERE–2019–BT–STD–0042–0014 at p. 3) DOE disagrees with AHRI's reading of the statute. The six-year-lookback provision does not reference compliance dates. (*See* 42 U.S.C. 6313(a)(6)(C)(1)) The plain language of EPCA requires DOE to evaluate amended standards for ACUACs and ACUHPs ''every 6 years'' regardless of compliance dates of any amended standards from previous rulemakings. (*Id.*) In this rulemaking, DOE has evaluated the potential for amended standards for ACUACs and ACUHPs (except for double-duct systems, as discussed in section III.B of this document) pursuant to its statutory obligations.

In response to the May 2022 TP/ECS RFI, Lennox highlighted the preparations manufacturers are undergoing to implement the 2023 energy conservation standards, as well as the pending transition to lower global warming potential (''GWP'') refrigerants in 2025. (Lennox, EERE–2022–BT–STD–0015–0009 at p. 2) Lennox recommended that DOE exercise caution with energy conservation standard amendments for ACUAC and ACUHP equipment because manufacturers need time to assess the impacts of an amended test procedure before DOE assesses amending energy conservations standards. (*Id.*) Specifically, Lennox recommended a 180-day period for manufacturers to assess the test procedure before the DOE moves forward with energy conservation standards based on the provisions of 10 CFR part 430, subpart C, appendix A. (*Id.* at pp. 5–6)

As discussed previously, DOE notes that at the time of the May 2022 TP/ECS RFI, compliance was not yet required with the second tier of energy conservation standards adopted in the January 2016 Direct Final Rule. However, the ACUAC/HP Working Group meetings and subsequent ACUAC/HP Working Group ECS Term Sheet agreement occurred after compliance became required with the most recent standards (January 1, 2023), and the analyses of amended energy conservation standards conducted by DOE as part of the 2023 ECS Negotiations were based on the ACUAC/HP market after the 2023 compliance date. DOE notes that after the agreement on the ACUAC/HP Working Group TP Term Sheet, industry members in the ACUAC/HP Working Group conducted simulations to approximate where many models currently on the market would fall in terms of the new IVEC and IVHE metrics. These simulations were shared with a DOE contractor and were used in the 2023 ECS Negotiations. DOE also notes that Lennox was a member of the ACUAC/HP Working Group and agreed to the ACUAC/HP Working Group ECS Term Sheet; therefore, DOE surmises that Lennox's original position on this topic changed since the time of the May 2022 TP/ECS RFI.

B. Scope of Coverage

This direct final rule applies to ACUACs and ACUHPs with a rated cooling capacity greater than or equal to 65,000 Btu/h (excluding double-duct air conditioners and heat pumps), which is the scope of equipment addressed in the 2023 ECS Negotiations.

In the May 2020 ECS RFI, DOE requested comment on several topics related to double-duct systems. 85 FR 27941, 27943–27953 (May 12, 2020). DOE received comments regarding double-duct systems from multiple stakeholders in response to the May 2020 ECS RFI. (Carrier, EERE–2019–BT–STD–0042–0013, pp. 2, 8, 10; AHRI, EERE–2019–BT–STD–0042–0014 at pp. 3–8, 11; UCA, EERE–2019–BT–STD–0042–0008, Attachment 2) Double-duct systems are a sub-category of ACUACs and ACUHPs with a separate definition (10 CFR 431.92), metrics, and efficiency requirements (10 CFR 431.97).

As noted, the scope of proposed standards in the ACUAC/HP Working Group ECS Term Sheet was determined through the 2023 ECS Negotiations and excludes double-duct air conditioners and heat pumps. Therefore, comments regarding energy conservation standards for double-duct systems are outside the scope of consideration for this rulemaking. Topics related to energy conservation standards for double-duct systems will be addressed in a separate rulemaking process.

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

C. Test Procedure and Metrics

EPCA sets forth generally applicable criteria and procedures for DOE's adoption and amendment of test procedures. (42 U.S.C. 6314) Manufacturers of covered equipment must use these test procedures to certify to DOE that their equipment complies with applicable energy conservation standards (42 U.S.C. 6316(b)(1); 42 U.S.C. 6296) and when making representations about the efficiency of their equipment (42 U.S.C. 6314(d)). Similarly, DOE uses these test procedures to determine whether the equipment complies with the relevant standards promulgated under EPCA. (42 U.S.C. 6314(d)) DOE's current energy conservation standards are expressed in terms of IEER for the cooling efficiency of ACUACs and ACUHPs, and in terms of COP for the heating efficiency of ACUHPs. (*See* 10 CFR 431.97(b))

As previously mentioned, the ACUAC/HP Working Group met several times and put forth the ACUAC/HP Working Group TP Term Sheet of recommendations regarding ACUAC and ACUHP test procedures, including new metrics IVEC and IVHE. DOE recently adopted the IVEC and IVHE metrics in a final rule amending the test procedure for ACUACs and ACUHPs.[23] The newly adopted DOE test procedure for ACUACs and ACUHPs appears at 10 CFR part 431, subpart F, appendix A1 (appendix A1). This direct final rule adopts amended energy conservation standards for ACUACs and ACUHPs denominated in terms of the new IVEC and IVHE metrics.

DOE notes that a change in metrics (*i.e.,* from IEER to IVEC and from COP to IVHE) necessitates an initial DOE determination that the new requirement would not result in backsliding when compared to the current standards. (*See* 42 U.S.C 6313(a)(6)(B)(iii)(I)) The translation of the current standards to IVEC and IVHE baselines is discussed further in section IV.C.2 of this document.

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. *See generally* 10 CFR 431.4; 10 CFR part 430, subpart C, appendix A, sections 6(b)(3)(i) and 7(b)(1) (''appendix A'').

After DOE has determined that particular technology options are

[23] The final rule amending the test procedure can be found at *www.regulations.gov* under docket number EERE–2023–BT–TP–0014.

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 equipment utility or availability; (3) adverse impacts on health or safety and (4) unique-pathway proprietary technologies. Section IV.B of this document discusses the results of the screening analysis for ACUACs and ACUHPs, 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 technical support document (''TSD'').

2. Maximum Technologically Feasible Levels

When DOE adopts a new or amended standard for a type or class of covered equipment, it determines the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible for such equipment. Accordingly, in the engineering analysis, DOE determined the maximum technologically feasible (''max-tech'') improvements in energy efficiency for ACUACs and ACUHPs, 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 direct final rule 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 ACUACs and ACUHPs purchased in the 30-year period that begins in the year of compliance with the amended standards (2029–2058).[24] The savings are measured over the entire lifetime of the subject equipment 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 equipment would likely evolve in the absence of amended energy conservation standards.

DOE used its national impact analysis (''NIA'') computer models to estimate national energy savings (''NES'') from potential amended standards for ACUACs and ACUHPs. The NIA computer model (described in section IV.H of this document) calculates energy savings in terms of site energy, which is the energy directly consumed by equipment 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.[25] DOE's approach is based on the calculation of an FFC multiplier for each of the energy types used by covered products or equipment. For more information on FFC energy savings, see section IV.H.2 of this document.

2. Significance of Savings

To adopt any new or amended standards for covered equipment more stringent than those set forth in ASHRAE Standard 90.1 or the existing Federal standard (as applicable in the context of the specific rulemaking), DOE must have clear and convincing evidence that such action would result in significant additional energy savings. (*See* 42 U.S.C. 6313(a)(6)(C)(i); 42 U.S.C. 6313(a)(6)(A)(ii)(II)) [26]

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. For example, some covered products and equipment have most of their energy consumption occur during periods of peak energy demand. The impacts of this equipment on the energy infrastructure can be more pronounced than equipment 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 5.59 quads, the equivalent of the primary annual energy use of 146 million homes. Based on the amount of FFC savings, the corresponding reduction in emissions, and the need to confront the global climate crisis, DOE has determined (based on the methodology described in section IV of this document and the analytical results presented in section V.B.3.a of this document) that there is clear and convincing evidence that the energy savings from the standard levels adopted in this direct final rule are ''significant'' within the meaning of 42 U.S.C. 6313(a)(6)(A)(ii)(II).

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. 6313(a)(6)(B)(ii)(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

EPCA requires DOE to consider the economic impact of a potential standard on manufacturers and the consumers of the equipment subject to the standard. (42 U.S.C. 6313(a)(6)(B)(ii)(I) and (C)(i)) In determining the impacts of potential new or amended standards on manufacturers, DOE conducts an MIA, as discussed in section IV.J of this document. DOE first uses an annual cash-flow approach to determine the quantitative impacts. This step includes both a short-term assessment—based on the cost and capital requirements during the period between when a regulation is issued and when entities must comply with the regulation—and a long-term assessment over a 30-year period. The industry-wide impacts analyzed

[24] Each TSL is composed of specific efficiency levels for each equipment class. The TSLs considered for this direct final rule are described in section V.A of this document. DOE also presents a sensitivity analysis that considers impacts for equipment shipped in a nine-year period.

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

[26] In setting a more-stringent standard for ASHRAE equipment, DOE must have ''clear and convincing evidence'' that doing so ''would result in significant additional conservation of energy'' in addition to being technologically feasible and economically justified. (42 U.S.C. 6313(a)(6)(A)(ii)(II)) This language indicates that Congress had intended for DOE to ensure that, in addition to the savings from the ASHRAE standards, DOE's standards would yield additional energy savings that are significant. In DOE's view, this statutory provision shares the requirement with the statutory provision applicable to covered products and non-ASHRAE equipment that ''significant conservation of energy'' must be present (42 U.S.C. 6295(o)(3)(B))—and supported with ''clear and convincing evidence''—to permit DOE to set a more-stringent requirement than ASHRAE.

include: (1) INPV, which values the industry on the basis of expected future cash flows; (2) cash flows by year; (3) changes in revenue and income; and (4) other measures of impact, as appropriate. Second, DOE analyzes and reports the impacts on different types of manufacturers, including impacts on small manufacturers. Third, DOE considers the impact of standards on domestic manufacturer employment and manufacturing capacity, as well as the potential for standards to result in plant closures and loss of capital investment. Finally, DOE takes into account cumulative impacts of various DOE regulations and other regulatory requirements on manufacturers.

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

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

EPCA requires DOE to consider the savings in operating costs throughout the estimated average life of the covered equipment in the type (or class) compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered equipment that are likely to result from a standard. (42 U.S.C. 6313(a)(6)(B)(ii)(II)) DOE conducts this comparison in its LCC and PBP analysis.

The LCC is the sum of the purchase price of a piece of equipment (including its installation) and the operating cost (including energy, maintenance, and repair expenditures) discounted over the lifetime of the equipment. The LCC analysis requires a variety of inputs, such as equipment prices, equipment energy consumption, energy prices, maintenance and repair costs, equipment lifetime, and discount rates appropriate for consumers. To account for uncertainty and variability in specific inputs, such as equipment 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 more-efficient equipment through lower operating costs. DOE calculates the PBP by dividing the change in purchase cost due to a more-stringent standard by the change in annual operating cost for the year that standards are assumed to take effect.

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

c. Energy Savings

Although significant additional 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. 6313(a)(6)(B)(ii)(III)) As discussed in section IV.H of this document, DOE uses the NIA computer models to project national energy savings.

d. Lessening of Utility or Performance of Equipment

In establishing equipment 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 equipment. (42 U.S.C. 6313(a)(6)(B)(ii)(IV)) Based on data available to DOE, the standards adopted in this document would not reduce the utility or performance of the equipment 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 of the United States (''Attorney General''), that is likely to result from a standard. (42 U.S.C. 6313(a)(6)(B)(ii)(V)) To assist the Department of Justice (''DOJ'') in making such a determination, DOE will transmit a copy of this direct final rule and the accompanying TSD to the Attorney General for review, with a request that the DOJ provide its determination on this issue. DOE will consider DOJ's comments on the rule contained in its assessment letter 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 document.

f. Need for National Energy Conservation

DOE also considers the need for national energy and water conservation in determining whether a new or amended standard is economically justified. (42 U.S.C. 6313(a)(6)(B)(ii)(VI)) The energy savings from the adopted standards are likely to provide improvements to the security and reliability of the Nation's energy system. Reductions in the demand for electricity also may result in reduced costs for maintaining the reliability of the Nation's electricity system. DOE conducts a utility impact analysis to estimate how standards may affect the Nation's needed power generation capacity, as discussed in section IV.M of this document.

DOE maintains that environmental and public health benefits associated with the more efficient use of energy are important to take into account when considering the need for national energy conservation. The adopted standards are likely to result in environmental benefits in the form of reduced emissions of air pollutants and GHGs associated with energy production and use. As part of the analysis of the need for national energy and water conservation, DOE conducts an emissions analysis to estimate how potential standards may affect these emissions, as discussed in section IV.K of this document, and the estimated emissions impacts are reported in section V.B.6 of this document.[27] DOE also estimates the economic value of emissions reductions resulting from the considered TSLs, as discussed in section IV.L of this document. DOE emphasizes that the SC–GHG analysis presented in this direct final rule and accompanying TSD was performed in support of the cost-benefit analyses required by Executive Order (''E.O.'') 12866, and is provided to inform the public of the impacts of emissions reductions resulting from this rule. However, the SC–GHG estimates were not factored into DOE's EPCA analysis of the need for national energy and water conservation. DOE would reach the same conclusion presented in this

[27] As discussed in section IV.L of this document, for the purpose of complying with the requirements of E.O. 12866, DOE also estimates the economic value of emissions reductions resulting from the considered TSLs. DOE calculates this estimate using a measure of the social cost (''SC'') of each pollutant (*e.g.,* SC–CO_2). Although this estimate is calculated for the purpose of complying with E.O. 12866, the Seventh Circuit Court of Appeals confirmed in 2016 that DOE's consideration of the social cost of carbon in energy conservation standards rulemakings is permissible under EPCA. *Zero Zone* v. *United States DOE,* 832 F.3d 654, 677 (7th Cir. 2016).

rule in the absence of the estimated benefits from reductions in GHG emissions.

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. 6313(a)(6)(B)(ii)(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.''

IV. Methodology and Discussion of Related Comments

This section addresses the analyses DOE has performed for this rulemaking with regard to ACUACs and ACUHPs. Separate subsections address each component of DOE's analyses. Comments on the methodology and DOE's responses are presented in each section.

DOE used several analytical tools to estimate the impact of the standards considered in this document on consumers and manufacturers. The first tool is a spreadsheet that calculates the LCC savings and PBP of potential amended or new energy conservation standards. The national impacts analysis uses a second spreadsheet set that provides shipments projections and calculates national energy savings and net present value of total consumer costs and savings expected to result from potential energy conservation standards. DOE uses the third spreadsheet tool, the Government Regulatory Impact Model (''GRIM''), to assess manufacturer impacts of potential standards. These three spreadsheet tools are available on the DOE website for this rulemaking: *www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=75.* 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 (*i.e., AEO 2023*).

A. Market and Technology Assessment

DOE develops information in the market and technology assessment that provides an overall picture of the market for the equipment concerned, including the purpose of the equipment, the industry structure, manufacturers, market characteristics, and technologies used in the equipment. 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 equipment classes; (2) manufacturers and industry structure; (3) existing efficiency programs; (4) market and industry trends, and (5) technologies or design options that could improve the energy efficiency of ACUACs and ACUHPs. 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. Equipment Classes

When evaluating and establishing energy conservation standards, DOE divides covered equipment into equipment classes by the type of energy used, capacity, or other performance-related feature that would justify a different standard. (42 U.S.C. 6313(a)(6)(B)(iii)(II))

DOE currently defines separate energy conservation standards for twelve ACUAC and ACUHP equipment classes (excluding double-duct systems), determined according to the following performance-related features that provide utility to the consumer: rated cooling capacity, equipment subcategory (air conditioner versus heat pump), and supplementary heating type. Table IV.1 lists the current ACUAC and ACUHP equipment classes. (*See also* 10 CFR 431.97(b))

Table IV.1 Current ACUAC and ACUHP Equipment Classes

Equipment Type	Cooling Capacity	Sub-Category	Heating Type
Small Commercial Packaged Air-Conditioning and Heating Equipment (Air-Cooled)	≥65,000 Btu/h and <135,000 Btu/h	AC	Electric Resistance Heating or No Heating
			All Other Types of Heating
		HP	Electric Resistance Heating or No Heating
			All Other Types of Heating
Large Commercial Packaged Air-Conditioning and Heating Equipment (Air-Cooled)	≥135,000 Btu/h and <240,000 Btu/h	AC	Electric Resistance Heating or No Heating
			All Other Types of Heating
		HP	Electric Resistance Heating or No Heating
			All Other Types of Heating
Very Large Commercial Packaged Air-Conditioning and Heating Equipment (Air-Cooled)	≥240,000 Btu/h and <760,000 Btu/h	AC	Electric Resistance Heating or No Heating
			All Other Types of Heating
		HP	Electric Resistance Heating or No Heating
			All Other Types of Heating

In response to the May 2020 ECS RFI, DOE received multiple comments from stakeholders regarding the equipment classes for ACUACs and ACUHPs. Several stakeholders recommended that DOE evaluate the capacity ranges that separate the current ACUAC and ACUHP equipment classes, and that DOE consider splitting the existing very large equipment classes (*i.e.,* 240,000 to 760,000 Btu/h) into separate equipment classes because of the potential for increasing stringency of standards (*i.e.,* more models with efficiency significantly above the 2023 standards) for ACUACs and ACUHPs with capacities at the lower end of the very large capacity range, as compared to the capacity range of very-large equipment as a whole. (ASAP, ACEEE, *et al.,* EERE–2019–BT–STD–0042–0023 at pp. 2–3; CA IOUs, EERE–2019–BT–STD–0042–0020 at p. 6; NEEA, EERE–2019–BT–STD–0042–0024 at pp. 3–5) NEEA specifically recommended splitting the very large equipment class into two classes: one greater than or equal to 240,000 Btu/h and less than 384,000 Btu/h, and the other greater than or equal to 384,000 Btu/h and less than 760,000 Btu/h. (NEEA, EERE–2019–BT–STD–0042–0024 at pp. 3–4) The CA IOUs specifically recommended splitting the very large equipment class into two classes: one greater than or equal to 240,000 Btu/h and less than 400,000 Btu/h, and the other greater than or equal to 400,000 Btu/h and less than 760,000 Btu/h. (CA IOUs, EERE–2019–BT–STD–0042–0020 at p. 6)

In response, DOE notes that the stakeholders that recommended splitting the existing very large equipment classes (ASAP, NEEA, and CA IOUs) had representatives that were members of the ACUAC/HP Working Group and agreed to the recommendations in the ACUAC/HP Working Group ECS Term Sheet, which maintained the existing equipment class capacity boundaries based upon the capacities in the EPCA definitions of small, large, and very large commercial package air conditioning and heating equipment. Consequently, DOE concludes that the recommended energy conservation standards and equipment classes presented in the ACUAC/HP Working Group ECS Term Sheet represent those stakeholders' latest recommendations on equipment classes.

Additionally, the ACUAC/HP Working Group ECS Term Sheet combines all ACUHPs within each capacity range into single equipment classes regardless of supplementary heating type, which is different from DOE's existing equipment class structure (which includes separate equipment classes in each capacity range for: (1) ACUHPs with electric resistance or no heating; and (2)

ACUHPs with all other types of heating). DOE is adopting amended energy conservation standards in terms of the nine equipment classes recommended in the ACUAC/HP Working Group ECS Term Sheet, presented in Table IV.2.

Table IV.2 Adopted ACUAC and ACUHP Equipment Classes

Equipment Type	Cooling Capacity	Sub-Category	Supplemental Heating Type
Small Commercial Packaged Air-Conditioning and Heating Equipment (Air-Cooled)	≥65,000 Btu/h and <135,000 Btu/h	AC	Electric Resistance Heating or No Heating
			All Other Types of Heating
		HP	All Types of Heating
Large Commercial Packaged Air-Conditioning and Heating Equipment (Air-Cooled)	≥135,000 Btu/h and <240,000 Btu/h	AC	Electric Resistance Heating or No Heating
			All Other Types of Heating
		HP	All Types of Heating
Very Large Commercial Packaged Air-Conditioning and Heating Equipment (Air-Cooled)	≥240,000 Btu/h and <760,000 Btu/h	AC	Electric Resistance Heating or No Heating
			All Other Types of Heating
		HP	All Types of Heating

2. Market Post-2023

In the May 2020 ECS RFI, DOE sought comment on whether currently available models of ACUACs and ACUHPs (excluding double-duct systems) with efficiency ratings that meet or exceed the 2023 standard levels are representative of the designs and characteristics of models that would be expected to be on the market after the 2023 compliance date. 85 FR 27941, 27948 (May 12, 2020).

AHRI, Carrier, and Trane asserted that the ACUAC and ACUHP markets at the time of the May 2020 ECS RFI are not representative of the models that would be expected to be on the market after the 2023 standards take effect. (AHRI, EERE–2019–BT–STD–0042–0014 at pp. 3, 5–6; Carrier, EERE–2019–BT–STD–0042–0013 at p. 7; Trane, EERE–2019–BT–STD–0042–0016 at p. 6) More specifically, AHRI commented that it is impossible to forecast the market impact of the 2023 standards on ACUACs and ACUHPs, and also asserted that State refrigerant regulations that drive the industry to use A2L refrigerants will require components such as compressors to be redesigned to accommodate new refrigerants. (AHRI, EERE–2019–BT–STD–0042–0014 at pp. 3, 5–6) Goodman also stated that alternative refrigerants would impact future product design and characteristics (*e.g.,* requiring factory-installed refrigerant detection sensors depending on the charge amounts of an alternate refrigerant). (Goodman, EERE–2019–BT–STD–0042–0017 at p. 3) Carrier stated the then-current models available on the market that meet the 2023 standards will not be the same products that are offered in 2023 because manufacturers will be working to optimize efficiencies, lower cost, and implement new entry level products. Carrier added that the upcoming 2023 standards will also create a need to further optimize higher-efficiency equipment. Carrier asserted that most products being sold are currently at the minimum efficiency levels, which leads to an inability to properly evaluate the economic impact of moving the markets from the current standards to 2023 standards. (Carrier, EERE–2019–BT–STD–0042–0013 at p. 7) Trane stated that it would be redesigning all of its ACUAC and ACUHP model lines in response to the 2023 standards. (Trane, EERE–2019–BT–STD–0042–0016 at p. 6)

Lennox commented that the market impacts of the 2023 standards are unknown because of uncertainties in assessing the evolving market, including uncertainties in future shipments, the economic impact on manufacturers and consumers, and the total projected energy savings. (Lennox, EERE–2019–BT–STD–0042–0015 at pp. 2–3) However, Lennox also commented that the ACUAC and ACUHP models on the market are representative of designs and characteristics of models that would be expected to be on the market after the 2023 compliance date. (*Id.* at p. 5) Lennox additionally mentioned that the 2023 standards would cause a phase out of single-speed technology and constant airflow fans. (*Id.*)

DOE notes that at the time these comments were received, compliance was not yet required with the current standards. Compliance was required with the current standards beginning January 1, 2023. DOE analyzed the market after January 1, 2023 for its analyses for the 2023 ECS Negotiations and for this direct final rule such that the comments received in 2020 on this matter are now moot. DOE's analysis of the market efficiency distribution to develop IEER efficiency levels is discussed in section of this direct final rule.

3. Technology Options

As part of the market and technology assessment, DOE identifies technologies that manufacturers could use to improve ACUAC and ACUHP energy efficiency. Chapter 3 of the direct final rule TSD includes the detailed list and descriptions of all technology options identified for this equipment.

In the May 2020 ECS RFI, DOE listed 19 technology options determined to improve the efficiency of ACUACs and ACUHPs, as measured by the DOE test procedure, that were presented in the

January 2016 Direct Final Rule. 85 FR 27941, 27946 (May 12, 2020). DOE requested comment on the technology options considered in the development of the January 2016 Direct Final Rule, their applicability to the current market, and the range of performance characteristics for each technology option. *Id.* DOE also sought feedback on other technology options that it should consider for inclusion in its analysis. *Id.*

DOE also sought comment on any changes in market adoption, costs, and concerns with incorporating the technologies identified into equipment that may have occurred since the January 2016 Direct Final Rule. *Id.* DOE also requested feedback on how manufacturers would incorporate the technology options from the January 2016 Direct Final Rule to increase energy efficiency in ACUACs and ACUHPs beyond the current levels. *Id.* at 85 FR 27949. This request included information on the order in which manufacturers would incorporate the different technologies to incrementally improve the efficiencies of equipment. *Id.* DOE also requested feedback on whether the increased energy efficiency would lead to other design changes that would not occur otherwise. *Id.* DOE was also interested in information regarding any potential impact of design options on a manufacturer's ability to incorporate additional functions or attributes in response to consumer demand. *Id.*

DOE also requested comment on whether certain design options may not be applicable to (or incompatible with) specific equipment classes. *Id.*

Several stakeholders stated that, in general, the technology options listed in the May 2020 ECS RFI are appropriate and have not seen any significant changes since the analysis was conducted for the January 2016 Direct Final Rule. (AHRI, EERE–2019–BT–STD–0042–0014 at p. 4; Lennox, EERE–2019–BT–STD–0042–0015 at p. 5; Trane, EERE–2019–BT–STD–0042–0016 at p. 3)

Carrier stated that high-efficiency, multi-stage, and variable-speed compressors, the size of heat exchangers, and more-efficient condenser fan blades and motors can increase efficiency. Carrier also stated that microchannel heat exchangers and expansion valves do not affect efficiency, and that electro-hydrodynamic enhancement has a very minor effect on efficiency.[28] (Carrier, EERE–2019–BT–STD–0042–0013 at p. 4) Carrier stated that it anticipates that the identified technology options would impact practicability to manufacture, install, and service, with potential impacts including larger/heavier chassis, roof curb changes, and modified electrical service to accommodate high-efficiency components. (Carrier, EERE–2019–BT–STD–0042–0013 at pp. 5–6) AHRI stated that there may be limited availability of electro-hydrodynamic enhancements (without elaborating on why) and that direct-drive fan systems at some voltages may not be available. (AHRI, EERE–2019–BT–STD–0042–0014 at p. 4)

NEEA recommended that DOE consider the presence of economizers, fan speed control, multi-stage compressors, electronically-commutated motors (''ECMs''), and fan efficiency. (NEEA, EERE–2019–BT–STD–0042–0024 at p. 7)

Trane stated that achieving the 2023 standard levels will take a combination of compressor technology and advanced heat exchanger design. Trane also stated that secondarily, indoor and outdoor fan technologies would be employed to reach the 2023 standard levels. (Trane, EERE–2019–BT–STD–0042–0016 at p. 8) Carrier stated that the technology options identified are currently being used to reach max-tech efficiency and that more of the advanced features would be used to meet the 2023 standards. (Carrier, EERE–2019–BT–STD–0042–0013 at p. 11) Carrier also asserted that additional features or advancements at the time of their comments would create undue burden in terms of cost and increased equipment size, resulting in a lack of marketability for ACUACs and ACUHPs. (*Id.*)

AHRI suggested that DOE contact manufacturers directly to solicit feedback on: (1) how manufacturers would incorporate the identified technology options to increase energy efficiency of ACUACs and ACUHPs and (2) whether certain design options may not be applicable to specific equipment classes. (AHRI, EERE–2019–BT–STD–0042–0014 at p. 7)

In response to the May 2020 ECS RFI, the CA IOUs and ASAP, ACEEE, *et al.* suggested that DOE consider additional alternative refrigerants as a technology option. (CA IOUs, EERE–2019–BT–STD–0042–0020 at p. 5; ASAP, ACEEE, *et al.,* EERE–2019–BT–STD–0042–0023 at pp. 3–4) ASAP, ACEEE, *et al.* stated that alternative refrigerants, including R–452B, R–454B, and R–32, can improve efficiency by at least 5 percent relative to the current refrigerant R–410A, citing testing conducted by Oak Ridge National Laboratory (''ORNL'') in partnership with Trane.[29] (ASAP, ACEEE, *et al.,* EERE–2019–BT–STD–0042–0023 at pp. 1, 3–4) In response to the May 2022 TP/ECS RFI, ASAP and ACEEE again recommended DOE consider low-GWP refrigerants as a design option. (ASAP and ACEEE, EERE–2022–BT–STD–0015–0011 at p. 3)

AHRI commented that considering alternative refrigerants as a technology option is not appropriate and would be unduly burdensome for manufacturers, recommending screening out alternative refrigerants on the bases of technological feasibility and practicability to manufacture, install, and service. (AHRI, EERE–2019–BT–STD–0042–0014 at pp. 4–5) Carrier suggested that alternate refrigerants should not be the basis of an energy efficiency increase. (Carrier, EERE–2019–BT–STD–0042–0013 at p. 7)

As discussed in section IV.C.1 of this document, DOE conducted its engineering analysis by selecting and analyzing currently-available models using their rated efficiency in terms of IEER to characterize the energy use and manufacturing production costs at each efficiency level. As a result, DOE analyzed equipment designs, including expansion devices, indoor and outdoor coils, and fans/motors, consistent with currently available models and the design of the equipment as whole. Therefore, DOE has concluded that the technology options in this direct final rule accurately reflect the efficiency improvement and incremental manufacturing costs associated with these designs.

Comments received in response to the May 2020 ECS RFI were received three years prior to the compliance date of the current standards and the 2023 ECS Negotiations. Since that time, the market has updated to comply with the new standards, and DOE conducted interviews with manufacturers to solicit feedback on all aspects of its engineering analysis, including technology options used to increase efficiency of ACUACs and ACUHPs. Certain technology options were also discussed among the ACUAC/HP Working Group during the 2023 ECS Negotiations. (EERE–2022–BT–STD–0015–0088 at pp. 60–64; EERE–2022–BT–STD–0015–0089 at pp. 17–24) Therefore, DOE surmises that the positions of commenters on certain technology options may have changed since the time of the drafting of some of the comments received.

[28] Carrier used the term electro-hydromatic enhancement, but DOE assumes Carrier was referring to electro-hydrodynamic enhancement.

[29] Available at: *www.energy.gov/sites/prod/files/2017/04/f34/10_32226f_Shen_031417-1430.pdf.*

Regarding economizers, while the IVEC metric accounts for the benefit of economizer cooling and the energy consumed during economizing via calculations, the metric does not include testing with economizer operation due to test burden and repeatability concerns. As such, the IVEC metric does not allow for differentiation in terms of IVEC efficiency between: (1) systems installed with economizers versus not installed with economizers, and (2) different types of economizers offered. Therefore, DOE did not consider economizers as a technology option for this rulemaking.

There are no models currently on the market that include low-GWP refrigerants. Therefore, at this time, DOE does not have sufficient information to consider low-GWP refrigerants as a technology option for improving efficiency. As such, DOE did not consider low-GWP refrigerants as a technology option in its analysis. Section IV.C.4 of this document includes discussion of the impact of low-GWP refrigerants on efficiency and cost of ACUACs and ACUHPs.

Regarding electro-hydrodynamic enhancement, DOE did not identify any prototypes or models currently on the market that incorporate this technology to improve efficiency.

After consideration of the comments received, assessment of technology options used to improve efficiency in models currently on the market, and additional information provided during manufacturer interviews, DOE considered the technology options presented in Table IV.3 as part of this rulemaking.

Table IV.3 ACUAC/HP Technology Options

Compressor
Multiple Compressor Staging
Variable-Speed or Multiple-Tandem Compressors
Heat Exchangers
Larger Heat Exchangers
Microchannel Heat Exchangers
Condenser Fans and Fan Motors
More-Efficient Fan Blades
Higher Efficiency and Variable-Speed Fans/Motors
Evaporator Fans and Fan Motors
More-Efficient Fan Blades
Higher Efficiency and Variable-Speed Fans/Motors
Direct-Drive Fans
Expansion Valves
Thermostatic Expansion Valve
Electronic Expansion Valve

A detailed discussion of each technology option identified is contained in chapter 3 of the direct final rule TSD.

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

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

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

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

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

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

1. Screened-Out Technologies

In the January 2016 Direct Final Rule, DOE screened-out three technology options: electro-hydrodynamic enhanced heat transfer (due to technological feasibility and practicability to manufacture/install/service), alternative refrigerants (due to technological feasibility), and sub-coolers (due to technological feasibility). 81 FR 2420, 2449 (Jan. 15, 2016).

In the May 2020 ECS RFI, DOE presented the three technology options that were screened out in the January 2016 Direct Final Rule and the criteria for screening them out. DOE sought feedback on whether the technology options that were screened out in the January 2016 Direct Final Rule should continue to be screened out. DOE also sought comment on what impact the screening criteria would have on consideration of the technology options that were considered (*i.e.,* not screened out) in the January 2016 Direct Final Rule. 85 FR 27941, 27947 (May 12, 2020).

Trane agreed with the screening analysis conducted for the January 2016 Direct Final Rule. (Trane, EERE–2019–BT–STD–0042–0016 at p. 5)

Carrier also agreed with continuing to screen out the technology options that were screened out in the January 2016 Direct Final Rule. (Carrier, EERE–2019–BT–STD–0042–0013 at p. 6) Carrier further recommended that an additional screening criterion be added to address cost of a technology option. (Carrier, EERE–2019–BT–STD–0042–0013 at p. 6)

As discussed in section IV.A.3 of this document, DOE is not considering alternative refrigerants and electro-hydrodynamic enhanced heat transfer as technology options, and, thus, the need to screen them in or out is not relevant. With respect to the third previously-screened out technology option, DOE is aware of at least one model line on the market that uses sub-coolers for increased efficiency. DOE does not find that the third previously-screened out technology meets any of the criteria for being screened out.

In response to Carrier's comment recommending an additional screening criterion be added to address cost of a technology option, the added cost of a technology option is considered in the cost-efficiency analysis and the downstream economic analyses that evaluate the impacts to consumers and the Nation as a whole. Additionally, the product and capital conversion costs manufacturers must bear in order to implement certain technologies are considered in the manufacturer impact analysis, discussed further in section IV.J of this document.

DOE did not find that any of the other technology options it identified met the criteria to be screened-out in this rulemaking.

2. Remaining Technologies

Through a review of each technology, DOE concludes that all of the identified technologies listed in section IV.A.3 of this document 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 any technology options for this rulemaking.

DOE determined that these technology options are technologically feasible because they are being used or have previously been used in commercially-available equipment 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; do not result in adverse impacts on consumer utility, equipment availability, health, or safety; and do not involve a proprietary technology that is a unique pathway to meeting a given efficiency level). For additional details, see chapter 4 of the direct final rule TSD.

C. Engineering Analysis

The purpose of the engineering analysis is to establish the relationship between the efficiency and cost of ACUACs and ACUHPs. There are two elements to consider in the engineering analysis: (1) the selection of efficiency levels to analyze (*i.e.,* the ''efficiency analysis'') and (2) the determination of equipment cost at each efficiency level (*i.e.,* the ''cost analysis''). In determining the performance of higher-efficiency equipment, DOE considers technologies and design option combinations not eliminated by the screening analysis. For each equipment class, DOE estimates the baseline cost, as well as the incremental cost for the equipment at efficiency levels above the baseline. The output of the engineering analysis is a set of cost-efficiency ''curves'' that are used in downstream analyses (*i.e.,* the LCC and PBP analyses and the NIA).

1. Efficiency Levels in Terms of Existing Metrics

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 equipment (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 equipment 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 an efficiency-level approach, analyzing three specific capacities—90,000 Btu/h (7.5-tons), 180,000 Btu/h (15-tons), and 360,000 Btu/h (30-tons)—that served as representative units for the three equipment capacity ranges—''small'' (≥65,000 to <135,000 Btu/h), ''large'' (≥135,000 to <240,000 Btu/h), and ''very large'' (≥240,000 to <760,000 Btu/h). DOE selected these representative capacities consistent with the analysis conducted for the January 2016 Direct Final Rule after concluding based on assessment of the current market (and receiving no contrary feedback during the 2023 ECS Negotiation meetings) that these capacities continue to be representative of models on the market in their respective capacity ranges. To develop cost-efficiency curves, DOE used the current cooling efficiency metric (IEER) and later translated each efficiency level to the new cooling efficiency metric (IVEC) because there were no publicly-available data for existing models on the market in terms of the new metric; therefore, the cost to produce these models could not be linked directly to efficiency in terms of IVEC. Selection of the efficiency levels in terms of the current efficiency metrics is discussed in sections IV.C.1.a and IV.C.1.b of this document. Further discussion on the translation from IEER to IVEC can be found in section IV.C.2.a of this document. The selection of heating efficiency levels in terms of the new heating efficiency metric (IVHE) is discussed in section IV.C.2.b of this document.

Based on DOE's review of equipment available on the market and feedback received during manufacturer interviews, DOE understands that the majority of ACUAC models with electric resistance heating or no heating are designed on the same basic platform and cabinet size as the equivalent ACUAC models with all other types of heating and comparable ACUHP models. Because these models typically have similar designs, DOE estimated that implementing the same efficiency-improving design options would result in the same or similar energy savings for comparable equipment classes. As discussed further in section IV.C.2.a of this document, ACUACs with all other types of heating typically are paired with furnaces that impose additional pressure drop that must be overcome by the indoor fan, thus increasing measured indoor fan power, so for otherwise comparable models, efficiencies in terms of IEER are lower for ACUACs with all other types of heating than ACUACs with electric resistance heating or no heating. Therefore, in order to develop equivalently stringent efficiency levels for all ACUACs, DOE first developed higher efficiency levels specifically for ACUACs with electric resistance heating or no heating. As discussed, these efficiency levels were developed in terms of IEER, and were subsequently translated to the new IVEC metric. DOE then translated these IVEC efficiency levels for ACUACs with electric resistance heating or no heating into IVEC efficiency levels for ACUACs with all other types of heating by using furnace pressure drops from product literature to calculate additional indoor fan power consumed and ultimately IVEC decrements to represent the reduction in IVEC as a result of furnace pressure drop. The calculated decrements closely aligned with the decrements proposed in the ACUAC/HP Working Group ECS Term Sheet. As further discussed in section IV.C.2 of this document, DOE did not analyze lower IVEC efficiency levels for ACUHPs as compared to ACUACs.

a. Baseline Efficiency

For each equipment class, DOE generally selects a baseline model as a reference point for each class, and measures changes resulting from potential energy conservation standards against the baseline. The baseline model in each equipment class represents the characteristics of equipment typical of that class (*e.g.,* capacity, physical size). Generally, a baseline model is one that just meets current energy conservation standards, or, if no standards are in place, the baseline is typically the most common or least efficient unit on the market.

In the May 2020 ECS RFI, DOE requested feedback on whether the 2023 energy conservation standards for ACUACs and ACUHPs are appropriate baseline efficiency levels for DOE to apply each equipment class in evaluating whether to amend energy conservation standards for this equipment. 85 FR 27941, 27948 (May 12, 2020). AHRI, Lennox, and Goodman stated that the 2023 standards would be the correct baseline efficiency to be used in a future DOE analysis. (AHRI, EERE–2019–BT–STD–0042–0014 at p. 6; Lennox, EERE–2019–BT–STD–0042–0015 at p. 6; Goodman, EERE–2019–BT–STD–0042–0017 at p. 3)

Consistent with stakeholder feedback, DOE used the current energy conservation standards as the baseline efficiency level in terms of IEER and COP for each equipment class. The baseline efficiency levels in terms of IEER and COP considered in this direct final rule are presented in Table IV.4. As discussed further in section IV.A.1 of this document, consistent with the ACUAC/HP Working Group ECS Term Sheet, DOE is combining ACUHPs with all types of heating into a single equipment class for each capacity range. Therefore, for the baseline for ACUHP equipment classes, DOE used the current IEER standard for ACUHPs with all other types of heating.

Table IV.4 Baseline Efficiency Levels in Terms of IEER and COP

Equipment	Cooling Capacity	Sub-Category	Supplemental Heating Type	IEER	COP
Small ACUACs and ACUHPs	≥65,000 Btu/h and <135,000 Btu/h	AC	Electric Resistance Heating or No Heating	14.8	-
			All Other Types of Heating	14.6	-
		HP	All Types of Heating	13.9	3.4
Large ACUACs and ACUHPs	≥135,000 Btu/h and <240,000 Btu/h	AC	Electric Resistance Heating or No Heating	14.2	-
			All Other Types of Heating	14.0	-
		HP	All Types of Heating	13.3	3.3
Very Large ACUACs and ACUHPs	≥240,000 Btu/h and <760,000 Btu/h	AC	Electric Resistance Heating or No Heating	13.2	-
			All Other Types of Heating	13.0	-
		HP	All Types of Heating	12.3	3.2

b. Higher Efficiency Levels

For each equipment class, DOE analyzes several efficiency levels above baseline. The maximum available efficiency level is the highest efficiency model currently available on the market. DOE also defines a ''max-tech'' efficiency level to represent the maximum possible efficiency for a given equipment class.

In the May 2020 ECS RFI, DOE requested comment on what efficiency levels should be considered as max-tech levels for ACUACs and ACUHPs for the evaluation of whether amended standards are warranted. 85 FR 27941, 27949 (May 12, 2020).

The CA IOUs and ASAP, ACEEE, *et al.* suggested DOE should analyze max-tech efficiency levels higher than what were analyzed in the January 2016 Direct Final Rule and consider max-tech efficiency levels that reflect incorporation of all possible technology options. (CA IOUs, EERE–2019–BT–STD–0042–0020 at pp. 6–7; ASAP, ACEEE, *et al.,* EERE–2019–BT–STD–0042–0023 at pp. 1–2, 4) The CA IOUs recommended DOE consider the technology development timeline of emerging technologies in determining max-tech levels, specifically technology options currently in the lab-scale prototype stage. (CA IOUs, EERE–2019–BT–STD–0042–0020 at pp. 6–7)

AHRI, Goodman, and Lennox recommended DOE only consider commercially-available technologies in determining max-tech efficiency levels, specifically those that are used in equipment certified to DOE's Compliance Certification Database (''CCD''). (AHRI, EERE–2019–BT–STD–0042–0014 at p. 6; Goodman, EERE–2019–BT–STD–0042–0017 at p. 3; Lennox, EERE–2019–BT–STD–0042–0015 at p. 6) Lennox additionally commented that the max-tech levels for ACUACs and ACUHPs have increased by up to eight percent since the January 2016 Direct Final Rule, driven by manufacturers having optimized designs for the part-load IEER metric, which is more representative of consumer use than the prior EER full-load metric, not the advancement of technologies that are employed by this equipment. (Lennox, EERE–2019–BT–STD–0042–0015 at p. 6)

Trane stated that the analysis for the January 2016 Direct Final Rule is still relevant and that it supported the process used then for considering max-tech efficiency levels (including manufacturer interviews). (Trane, EERE–2019–BT–STD–0042–0016 at p. 7)

Carrier specified what it argued are the max-tech levels for ACUACs and ACUHPs should be in terms of IEER and COP based on certifications to the AHRI Directory at the time of its comment submission. (Carrier, EERE–2019–BT–STD–0042–0013 at pp. 9–10)

Consistent with feedback from stakeholders, DOE identified incremental efficiency levels based on a review of currently available models on the market, taking into consideration the efficiency levels analyzed for the January 2016 Direct Final Rule. DOE relied on certified IEER data from DOE's CCD and the AHRI Directory, focusing on models that had sufficient information in public product literature to develop costs. Review of the market showed that many of the model lines analyzed for the January 2016 Direct Final Rule are still on the market today; therefore, DOE concluded that many of the efficiency levels analyzed for the January 2016 Direct Final Rule were still appropriate to consider for this rulemaking. DOE started with the efficiency levels used for the January 2016 Direct Final Rule analysis that were above the current IEER standards (*i.e.,* standards with compliance date of January 1, 2023), adjusting IEER values of some efficiency levels as appropriate based on current market efficiency distributions. DOE also added efficiency levels, as needed, to better represent the range of certified IEER ratings for ACUAC models with electric resistance heating or no heating currently available on the market. This included adjusted max-tech levels for some classes that have models on the market with higher rated IEER than the max-tech levels analyzed for the January 2016 Direct Final Rule, consistent with suggestions by stakeholders.

Regarding the CA IOU's comment that DOE consider emerging technologies in determining max-tech levels, as discussed, DOE developed max-tech levels for the engineering analysis based on model designs currently on the market. DOE concluded that it lacked sufficient cost and efficiency information to analyze higher efficiency levels than currently on the market. DOE notes that the max-tech levels presented in this DFR reflect those presented in the 2023 ECS Negotiations, and the CA IOUs were a member of the ACUAC/HP Working Group and did not object to the analyzed max-tech levels in the 2023 ECS Negotiations.

In response to the May 2020 ECS RFI, Carrier also recommended that DOE analyze max-tech efficiency separately for equipment that uses alternate refrigerants once available on the market, as it believes that safety code compliance will require additional components and testing that may restrict the use of certain design options. (Carrier, EERE–2019–BT–STD–0042–0013 at p. 10)

In response, DOE did not analyze max-tech levels for equipment with alternative refrigerants separately for this rulemaking because DOE is not aware of any models on the market at this time that include refrigerants with GWP below the limit of 700 GWP adopted by the Environmental Protection Agency (''EPA'').[30] Section IV.C.4 of this direct final rule includes further discussion on consideration of lower-GWP refrigerants in the engineering analysis.

The higher efficiency levels for ACUACs with electric resistance heating or no heating in terms of IEER considered in this direct final rule are presented in Table IV.5.

[30] On October 24, 2023, the EPA published a final rule in the **Federal Register** restricting the use of certain higher-GWP hydrofluorocarbons (''HFCs'') in aerosols, foams, and refrigeration, air conditioning, and heat pump products and equipment (''October 2023 EPA Final Rule''). This final rule restricts refrigerants with a GWP higher than 700 in residential and light commercial air conditioning and heat pump systems installed on and after January 1, 2025. 88 FR 73098. On December 26, 2023, EPA published an interim final rule and request for comment in the **Federal Register** amending a provision of the October 2023 EPA Final Rule allowing one additional year, until January 1, 2026, for the installation of new residential and light commercial air conditioning and heat pump systems using components manufactured or imported prior to January 1, 2025. 88 FR 88825.

Table IV.5 Incremental Efficiency Levels in Terms of IEER

Equipment Class	Efficiency Levels in Terms of IEER						
	EL1	EL2	EL3	EL4	EL5	EL6	EL7
Small ACUACs with electric resistance heating or no heating – ≥65,000 Btu/h and <135,000 Btu/h Cooling Capacity	15.4	15.8	17.0	18.0	19.9	21.0	22.4
Large ACUACs with electric resistance heating or no heating – ≥135,000 Btu/h and <240,000 Btu/h Cooling Capacity	14.6	15.0	17.5	20.1	-	-	-
Very Large ACUACs with electric resistance heating or no heating – ≥240,000 Btu/h and <760,000 Btu/h Cooling Capacity	13.5	15.5	18.5	-	-	-	-

2. Efficiency Levels in Terms of New Metrics

a. IVEC

DOE considered the efficiency levels in terms of IVEC presented in Table IV.6 for this direct final rule. The development of these efficiency levels for each equipment class is discussed in the following subsections.

Table IV.6 Direct Final Rule Efficiency Levels in Terms of IVEC

Equipment	Subcategory	Supplemental Heating Type	Efficiency Levels in Terms of IVEC							
			Baseline	EL1	EL2	EL3	EL4	EL5	EL6	EL7
Small ACUACs and ACUHPs – ≥65,000 Btu/h and <135,000 Btu/h Cooling Capacity	AC	Electric Resistance Heating or No Heating	10.6	11.6	12.5	13.1	14.3	14.9	16.4	18.7
		All Other Types of Heating	10.1	11.1	12.0	12.6	13.8	14.4	15.9	18.2
	HP	All Types of Heating	10.1	11.1	12.0	12.6	13.4	14.4	15.9	18.2
Large ACUACs and ACUHPs – ≥135,000 Btu/h and <240,000 Btu/h Cooling Capacity	AC	Electric Resistance Heating or No Heating	12.0	12.9	13.8	15.7	19.5	-	-	-
		All Other Types of Heating	11.5	12.4	13.3	15.2	19.0	-	-	-
	HP	All Types of Heating	11.5	12.4	13.1	15.2	19.0	-	-	-
Very Large ACUACs and ACUHPs – ≥240,000 Btu/h and <760,000 Btu/h Cooling Capacity	AC	Electric Resistance Heating or No Heating	12.0	12.9	15.2	18.3	-	-	-	-
		All Other Types of Heating	11.3	12.2	14.5	17.6	-	-	-	-
	HP	All Types of Heating	11.3	12.1	14.5	17.6	-	-	-	-

ACUACs with Electric Resistance Heating or No Heating

As discussed in section II.B.3 of this document, the ACUAC/HP Working Group recommended the current cooling performance energy efficiency descriptor, IEER, be replaced with the newly-developed IVEC metric. While the cost-efficiency curves were developed in terms of the existing cooling efficiency metric (IEER), DOE translated the IEER values at each efficiency level to IVEC values for use in the other analyses in this direct final rule, and to allow consideration of potential amended energy conservation standard levels in terms of the IVEC metric.

With this change in cooling efficiency metric, DOE must ensure that a new IVEC-based standard would not result in backsliding of energy efficiency levels when compared to the current IEER standards. (42 U.S.C 6313(a)(6)(B)(iii)(I)) To this end, DOE translated the identified IEER baseline levels (as discussed in section IV.C.1.a of this document) to IVEC baseline levels.

During the course of the 2023 ECS Negotiations, industry members in the ACUAC/HP Working Group provided a DOE contractor with a confidential, anonymized dataset that included simulated IEER and IVEC values for more than 100 models currently available on the market. In this dataset, for each equipment class, there is a range of IVEC values near the IEER baseline. DOE calculated a weighted-average IVEC baseline based on the values in this industry-provided dataset to use as the IVEC baseline for analysis for each equipment class for ACUACs with electric resistance heating or no heating. Further discussion of DOE's analysis of baseline IVEC levels is included in chapter 5 of the direct final rule TSD.

DOE also translated the higher efficiency levels in terms of IEER to IVEC based on the performance correlations it developed (discussed further in section IV.C.3 of this document) (*i.e.,* DOE used the performance correlations to calculate an IVEC value for each IEER efficiency level). Further discussion of DOE's analysis of higher IVEC levels is included in chapter 5 of the direct final rule TSD.

ACUACs with All Other Types of Heating

ACUACs with all other types of heating typically are paired with furnaces that impose additional pressure drop that must be overcome by the indoor fan, thus increasing measured indoor fan power. Therefore, the current IEER standards have lower minimum efficiency for ACUACs with all other types of heating as compared to ACUACs with electric resistance heating or no heating, and DOE considered a similar furnace decrement for IVEC efficiency levels (*i.e.,* difference in IVEC levels between comparable classes to reflect presence of a furnace). The recommended standard levels in the ACUAC/HP Working Group ECS Term Sheet include a furnace decrement of 0.5 for IVEC levels for small and large ACUACs and a furnace decrement of 0.7 for IVEC levels for very large ACUACs. DOE conducted an analysis of furnace pressure drops based on public literature for ACUAC models and used estimates of furnace pressure drop to calculate a furnace IVEC decrement for small, large, and very large ACUACs. DOE's calculated furnace IVEC decrements are similar to the decrements of 0.5, 0.5, and 0.7 included in the ACUAC/HP Working Group ECS Term Sheet for small, large, and very large ACUACs, respectively. Therefore, with these decrements confirmed, DOE used the furnace IVEC decrements from the ACUAC/HP Working Group ECS Term Sheet more broadly to develop IVEC efficiency levels for ACUACs with all other types of heating across all considered efficiency levels for the subject equipment. In other words, for each IVEC efficiency level for ACUACs with electric resistance heating or no heating, DOE subtracted the corresponding furnace IVEC decrement from the ACUAC/HP Working Group ECS Term Sheet to determine the corresponding IVEC efficiency level for ACUACs with all other types of heating. Further discussion of DOE's analysis of furnace IVEC decrements is included in chapter 5 of the direct final rule TSD.

ACUHPs

For the IVEC values of ACUHPs, DOE conducted an analysis to understand the potential decrement in IVEC efficiency ratings between ACUACs and ACUHPs. Using the January 2016 Direct Final Rule IEER decrements between ACUACs and ACUHPs (81 FR 2420, 2456 (Jan. 15, 2016)), DOE determined IEER values at each efficiency level for ACUHPs. The performance correlations developed for each efficiency level of ACUACs were then adjusted to decrease IEER to reflect the lower ACUHP IEER values. Changes made to the performance correlations reflect the design and operating differences between otherwise identical ACUACs and ACUHPs. For example, compressor performance may be lower in a heat pump than an air conditioner due to the reversing valve imposing pressure drop on the suction line (*i.e.,* heat pumps may have reduced capacity at a similar power input). Compressor performance may also be lower in a heat pump than an air conditioner due to circuiting not being fully optimized for cooling operation (*i.e.,* heat pumps may have reduced capacity with a higher power input in this case). Additionally, a heat pump is more likely to require a tube and fin condenser coil instead of a microchannel heat exchanger, which could increase high-side pressure (resulting in a capacity reduction at increased power input) or increase condenser fan power. DOE then calculated IVEC values based on these adjusted correlations for ACUHPs at each efficiency level, and the Department found no significant difference in IVEC between ACUACs and ACUHPs with the same supplemental heating type at each efficiency level using its performance correlations, in contrast to the decrement used when analyzing IEER efficiency levels for the January 2016 Direct Final Rule.

DOE understands the lack of decrement found in IVEC between ACUACs and ACUHPs to be for two reasons: (1) the design differences in ACUHPs that reduce IEER affect vapor compression system performance, and IVEC weights this performance less than IEER for several reasons (*e.g.,* because IVEC also includes economizer-only cooling operation, higher external static pressure requirements, and crankcase heater energy consumption; and (2) the reduction in vapor compression system performance for an ACUHP mentioned previously is counterbalanced by an increase in IVEC due to the metric including fewer hours of off-mode operation (*i.e.,* crankcase heater energy consumption) for ACUHPs than are included in IVEC for ACUACs.[31] Further discussion of DOE's analysis of ACUHP IVEC decrements is included in chapter 5 of the direct final rule TSD.

Given the finding of no IVEC decrement between ACUACs and ACUHPs of the same supplementary heating type, for all efficiency levels except for the levels recommended in the ACUAC/HP Working Group ECS Term Sheet (discussed later in this sub-section), DOE did not analyze lower IVEC efficiency levels for ACUHPs as compared to ACUACs. Because the standard levels recommended in the ACUAC/HP Working Group ECS Term Sheet combine ACUHPs into equipment classes that depend only on cooling capacity, regardless of supplemental heating type, DOE analyzed ACUHPs without separate classes for different

[31] The IVEC metric includes all annual crankcase heater operation, which includes ventilation mode and unoccupied no-load hours for ACUACs and ACUHPs. For ACUACs, the IVEC metric also includes crankcase heater operation during the heating season, because ACUAC compressors do not provide mechanical heating, whereas ACUHP compressors do provide mechanical heating. Specifically, for ACUACs, IVEC includes 4,202 hours of crankcase heater operation during ventilation mode, unoccupied no-load hours, and heating season hours. For ACUHPs, IVEC includes 338 hours of crankcase heater operation during ventilation mode and unoccupied no-load hours.

supplementary heating types at all efficiency levels. Therefore, for all efficiency levels (including the baseline) except for the levels recommended in the ACUAC/HP Working Group ECS Term Sheet (discussed later in this sub-section), the IVEC efficiency levels for ACUHPs are the same as the efficiency levels for ACUACs with all other types of heating.

Despite the finding of no IVEC decrement for ACUHPs as compared to ACUACs, the ACUAC/HP Working Group ECS Term Sheet includes marginally lower recommended standards for ACUHPs than ACUACs with all other types of heat. Therefore, at the recommended efficiency level for each ACUHP equipment class, DOE analyzed the IVEC value recommended by the ACUAC/HP Working Group for that class, instead of using the corresponding IVEC level for ACUACs with all other types of heating.

As previously discussed, the additional pressure drop of a furnace and indoor fan energy required to overcome that pressure drop results in lower IVEC for otherwise identical models with furnaces. This pressure drop is the reason that DOE's current standards apply a decrement such that ACUHPs with all other types of heating and have lower IEER standards than ACUHPs with electric resistance heating or no heating. Based on review of models currently on the market and feedback from manufacturer interviews, DOE understands that most manufacturers offer ACUHPs with and without furnaces (*i.e.,* considered in either the ''all other types of heating'' class or the ''electric resistance heating or no heating'' class), and ACUHP models with furnaces are typically otherwise identical to ACUHP models without the furnace. Therefore, DOE understands that manufacturers do not design separate baseline ACUHP models to precisely meet the IEER standards for both ''electric resistance heating or no heating'' and ''all other types of heating''; rather, they design a single ACUHP model such that it meets the applicable standard with or without a furnace present. If the presence of a furnace for an ACUHP model impacts the IEER rating for a model by an amount that differs from the decrement present in the IEER standards, using a single ACUHP design to meet both standards inherently means that one model will have an IEER value above the applicable standard, but DOE understands that manufacturers do not undertake the product development effort to design separate slightly less efficient ACUHP models to take advantage of this small IEER gap. Based on feedback from manufacturer interviews, DOE expects this to continue in the future, even in the context of more-stringent standards.

Therefore, considering ACUHP equipment classes including models of all supplementary heating types (which is the equipment class structure recommended in the ACUAC/HP Working Group ECS Term Sheet), DOE assumed that manufacturers would design ACUHPs to meet the applicable IVEC efficiency level with a furnace present; by removing the furnace, the otherwise identical ACUHP models with electric resistance or no heating would naturally achieve a higher IVEC. Therefore, in the analyses following the engineering analysis, DOE assumed that all ACUHP IVEC efficiency levels would be met by ACUHPs with furnaces, and that ACUHPs without furnaces (but otherwise identical to the models with furnaces) would have higher IVEC values. Therefore, to determine the IVEC values achieved by ACUHPs without furnaces, DOE added the previously discussed furnace decrements to the ACUHP efficiency levels (which nominally apply to all ACUHPs regardless of supplementary heating type). As a result, DOE concluded that combining ACUHP equipment classes for all types of heating into single equipment classes for each capacity range would generally result in the same market dynamics and energy savings as having ACUHP equipment classes separated by supplementary heating type (*i.e.,* with the IVEC standard levels for ACUHPs with electric resistance or no heating being higher than the IVEC standard levels for ACUHPs with all other types of heating, with the difference being equal to the previously discussed furnace IVEC decrements). In other words, when comparing IVEC efficiency levels between ACUACs and ACUHPs, DOE's analysis for this direct final rule considers the ACUHP levels to be comparable to the levels for ACUACs with all other types of heating (because the ACUHP levels would need to be met by ACUHP models with furnaces), rather than the ACUHP levels being comparable to the levels for ACUACs with electric resistance or no heating.

b. IVHE

The ACUAC/HP Working Group also recommended the current heating performance energy efficiency descriptor, COP, be replaced with the newly-developed IVHE metric. With this change in heating efficiency metric, DOE must ensure that a new IVHE-based standard would not result in backsliding of energy efficiency levels when compared to the current COP standards. (42 U.S.C 6313(a)(6)(B)(iii)(I)) To this end, DOE first established a baseline at the current energy conservation standard in terms of COP for each of the ACUHP equipment classes, and then translated the COP baseline for each class to an IVHE baseline. As discussed previously, DOE used the current COP energy conservations standards as the COP baseline for all ACUHP equipment classes.

During the 2023 ECS Negotiations and in confidential interviews conducted with manufacturers, two industry members in the ACUAC/HP Working Group provided a DOE contractor with simulated COP and IVHE values. DOE used this data set, as well as DOE's own test data, to determine an IVHE baseline for each ACUHP equipment class. Specifically, DOE identified an IVHE baseline representative of models with simulated COP at or near the current applicable COP standard level for each ACUHP equipment class.

Although, as mentioned, two industry members in the ACUAC/HP Working Group provided DOE contractors with simulated COP and IVHE values, this dataset was significantly smaller than the previously discussed IVEC dataset. Therefore, DOE has concluded that it lacks sufficient IVHE data to identify IVHE efficiency levels more stringent than the levels recommended in the ACUAC/HP Working Group ECS Term Sheet. In particular, many ACUHP models currently on the market with multiple stages of mechanical cooling offer only one stage of mechanical heating. DOE recognizes that the IVHE metric (which includes part-load operation) will incentivize development of multiple stages of mechanical heating in ACUHPs. However, at this time, there are limited IVHE data available for ACUHP models with multiple stages of mechanical heating; therefore, it is unclear which IVHE levels above the recommended IVHE levels are attainable across the range of capacities. Consequently, for all efficiency levels above the recommended efficiency levels, DOE assigned the recommended IVHE levels—*i.e.,* for all IVEC levels above the recommended IVEC levels for ACUHPs, DOE did not analyze an increase in IVHE levels above the recommended IVHE levels.

For efficiency levels between the IVHE baseline and the recommended IVHE levels, DOE used its own test data and confidential data provided by certain industry members to identify incremental IVHE levels corresponding to the incremental IVEC levels.

Commercial buildings where ACUHPs are currently installed tend to be dominated by cooling hours as compared to heating hours (*e.g.,* there are 4,220 hours with a cooling demand in the IVEC metric and only 1,745 hours with a heating demand in the IVHE metric). Further, as discussed, at this time, there are limited IVHE data available to quantify IVHE improvements from design options that impact only heating efficiency. Therefore, the evaluation of amended energy conservation standards for ACUHPs is focused on the analysis of higher cooling efficiency. While many design options employed to achieve higher cooling efficiency levels could inherently result in higher heating efficiency, DOE did not analyze design options that improve only heating efficiency.

DOE considered the efficiency levels in terms of IVHE presented in Table IV.7 for this direct final rule.

Table IV.7 ACUHP Efficiency Levels in Terms of IVHE

Equipment Class	Efficiency Levels in Terms of IVHE							
	Baseline	EL1	EL2	EL3	EL4	EL5	EL6	EL7
Small ACUHPs – ≥65,000 Btu/h and <135,000 Btu/h Cooling Capacity	6.0	6.1	6.1	6.1	6.2	6.2	6.2	6.2
Large ACUHPs – ≥135,000 Btu/h and <240,000 Btu/h Cooling Capacity	5.6	5.8	6.0	6.0	6.0	-	-	-
Very Large ACUHPs – ≥240,000 Btu/h and <760,000 Btu/h Cooling Capacity	5.3	5.8	5.8	5.8	-	-	-	-

3. Energy Modeling

As done for the January 2016 Direct Final Rule (*see* 81 FR 2420, 2458–2459 (Jan. 15, 2016)), DOE developed component wattage profiles and performance correlations for each efficiency level in this rulemaking (discussed further in section IV.E of this document). This served two purposes. First, and as discussed in section IV.E of this document, these component wattage profiles and performance correlations developed for this direct final rule were used in the energy use analysis, along with hourly building cooling loads and generalized building samples, to estimate the energy savings associated with each efficiency level. Second, as discussed in section IV.C.2.a of this document, the developed performance correlations, along with industry data, were used to develop IVEC values that translated the IEER efficiency levels to the IVEC metric.

As previously mentioned in section IV.C.1.b of this document, many of the efficiency levels analyzed for the January 2016 Direct Final Rule were still appropriate to consider for this rulemaking. For this rulemaking, DOE repurposed component wattage profiles and performance correlations from the January 2016 Direct Final Rule analysis for some of those efficiency levels also included in the January 2016 Direct Final Rule. Some IEER efficiency levels for this direct final rule have an IEER value that is close to but not exactly the same as an IEER efficiency level analyzed in the January 2016 Direct Final Rule. In those cases, DOE adjusted the calculations used to develop the component wattage profiles and performance correlations for that efficiency level from the January 2016 Direct Final Rule analysis so that the resulting IEER would match the IEER value of the new target IEER efficiency level.

For new efficiency levels added in the analysis for this direct final rule that are not close to an IEER efficiency level from the January 2016 Direct Final Rule, DOE selected currently-available models with rated IEER close to the IEER efficiency level to use as the basis for new component wattage profiles and performance correlations. DOE used publicly-available product literature for the selected models to collect relevant compressor, evaporator fan, condenser fan, and capacity data. This information was used to create component wattage profiles and performance correlations as a function of temperature for the new efficiency levels.

These component wattage profiles and performance correlations were then used to calculate an IVEC value for each efficiency level. As discussed in section IV.C.2.a of this document, the IVEC values resulting from these component wattage profiles and performance correlations were used to develop the incremental IVEC efficiency levels corresponding to each incremental IEER efficiency level. More details regarding the methodology for creating the component wattage profiles and performance correlations for each efficiency level and equipment class are presented in chapter 5 of the direct final rule TSD.

DOE did not conduct similar energy modeling for ACUHP representative units since ACUHP shipments represent a very small portion of industry shipments compared to ACUACs shipments (10 percent versus 90 percent). Further, as discussed, in section IV.C.2.a of this document, DOE found no IVEC decrement between ACUACs and ACUHPs of the same supplementary heating type, and, therefore, DOE did not analyze lower IVEC efficiency levels for ACUHPs as compared to ACUACs for all efficiency levels, except for the levels recommended in the ACUAC/HP Working Group ECS Term Sheet. In addition, because ACUHPs represent a small portion of shipments, DOE noted, based on equipment teardowns and an extensive review of equipment literature, that manufacturers generally use the same basic design/platform for equivalent ACUAC and ACUHP models. DOE also considered the same design changes for the ACUHP equipment classes that were considered for the ACUAC equipment classes within a given capacity range. For these reasons, DOE focused energy modeling on ACUAC equipment. Although not considered in the LCC and PBP analyses, DOE did analyze ACUHP equipment in the NIA. From this analysis, DOE believes the energy modeling conducted for ACUAC equipment provides a good estimate of ACUHP cooling performance and provides the necessary information to estimate the magnitude of the national energy savings from increases in ACUHP equipment efficiency.

4. Impact of Low-GWP Refrigerants

On October 24, 2023, EPA published in the **Federal Register** regulations to restrict the use of HFC refrigerants in specific sectors or subsectors (''October 2023 EPA Final Rule''). 88 FR 73098. This includes establishing a GWP limit of 700 for refrigerants used in light commercial air conditioning and heat pump systems (which includes ACUACs and ACUHPs) installed January 1, 2025 or later. *Id.* at 88 FR 73206, 73208. On December 26, 2023, EPA published an interim final rule and request for comment in the **Federal Register** amending a provision of the October 2023 EPA Final Rule allowing one additional year, until January 1, 2026, for the installation of new residential and light commercial air conditioning and heat pump systems using components manufactured or imported prior to January 1, 2025. 88 FR 88825. ACUACs and ACUHPs available on the market today use R–410A, which has a GWP that exceeds this 700 GWP limit. This will require manufacturers to shift away from the use of R–410A to low-GWP refrigerants.

In response to the May 2020 ECS RFI, multiple stakeholders commented regarding the transition to low-GWP refrigerants and their impacts on ACUACs and ACUHPs, which was well before EPA took final regulatory action.

On this topic, the CA IOUs recommended that DOE work closely with the California Air Resources Board, ASHRAE Standing Standard Project Committee 15—Safety Standard for Refrigeration Systems, and AHRI's Low-GWP Alternative Refrigeration Evaluation Program to ensure that equipment meeting low-GWP requirements can meet any new efficiency standard. (CA IOUs, EERE–2019–BT–STD–0042–0020 at p. 5)

NEEA recommended that DOE consider the impact of alternate refrigerants on ACUAC efficiency, including the technical feasibility and economic implications of meeting new and amended standard levels with alternate refrigerants. (NEEA, EERE–2019–BT–STD–0042–0024 at p. 9)

AHRI stated that changes to the engineering analysis would be needed if conducting an analysis at present due to the transition to alternative refrigerants. AHRI stated that the combined costs to add sensors, controls, and other components for new refrigerants, including the cost of these refrigerants, will increase the overall cost of the subject equipment by 10–15 percent over minimum designs of 2018. (AHRI, EERE–2019–BT–STD–0042–0014 at p. 7)

Trane stated that systems that use A2L refrigerants will need more controls and sensors for safety reasons, which it predicted will impact the adoption of the new technologies negatively. (Trane, EERE–2019–BT–STD–0042–0016 at pp. 4–5) Trane also recommended that DOE consider in its analysis the effect of new low-GWP refrigerants on cost, design, and size of units. (Trane, EERE–2019–BT–STD–0042–0016 at p. 7) AHRI, Carrier, and Trane also collectively mentioned the Federal authority to regulate refrigerants and the timing of adoption of State building and safety codes to support mildly flammable (A2L) refrigerants. (AHRI, EERE–2019–BT–STD–0042–0014 at p. 5; Carrier, EERE–2019–BT–STD–0042–0013 at p. 7; Trane, EERE–2019–BT–STD–0042–0016 at p. 4)

In the May 2022 TP/ECS RFI, DOE requested data on the impact of low-GWP refrigerants as replacements for R–410A on: (1) the cooling and heating capacities and compressor power of ACUACs and ACUHPs at various temperature conditions, including, but not limited to, the temperatures currently included in the IEER metric; and (2) the size and design of heat exchangers and compressors used in ACUACs and ACUHPs. 87 FR 31743, 31753 (May 25, 2022). DOE also sought feedback and any additional data on the cost of implementing low-GWP refrigerants in ACUACs and ACUHPs beyond the comments received in response to the May 2020 ECS RFI. *Id.*

In response to DOE's request for data on the impact of low-GWP refrigerants on capacities, compressor power, and design of heat exchangers and compressors in the May 2022 TP/ECS RFI, Carrier stated that replacement refrigerants require optimization and compressor displacement changes which could also impact performance results, if not properly compensated for. Carrier provided data for a pure cycle analysis where equal compressor isentropic efficiency, heat exchanger efficiency, and system operating conditions were assumed. The analysis presented by Carrier indicates that new low-GWP refrigerant alternatives R–32 and R–454B do not result in a significant impact on measured EER, IEER, and COP at 47 °F and 17 °F. (Carrier, EERE–2022–BT–STD–0015–0010 Attachment 1 at p. 17) Carrier further commented that the required displacement changes with the alternative refrigerants it analyzed, so compressor optimization is required. Carrier also stated the mass flow rates changed with the alternative refrigerants it analyzed, so coil redesign may be required. (*Id.*)

Lennox stated that implementing low-GWP refrigerants will require extensive product redesign from both a performance and safety standard perspective for ACUACs and ACUHPs. (Lennox, EERE–2022–BT–STD–0015–0009 at pp. 5–6)

With respect to the cost of implementing low-GWP refrigerants in ACUACs and ACUHPs, AHRI stated that refrigerant charge generally increases with increasing efficiency. AHRI added that transporting factory-charged systems with A2L refrigerants would be more expensive than shipping existing systems charged with non-flammable refrigerants. AHRI further commented that the Department of Transportation has not approved special permits allowing systems with larger charge amounts to ship in the same manner as those containing non-flammable refrigerants. AHRI indicated that without special permits, the expectation is that systems over the charge size threshold of 12 kilograms would need to be shipped as HAZMAT, which would be more costly. (AHRI, EERE–2022–BT–STD–0015–0008 at p. 6)

Carrier stated that the likely replacement for R–410A will be A2L refrigerants with low-flame spread per ASHRAE Standard 34, ''Designation and Safety Classification of Refrigerants.'' (Carrier, EERE–2022–BT–STD–0015–0010 Attachment 1 at p. 17) Carrier further stated that per UL 60335–2–40 4th edition, ''Household and Similar Electrical Appliances—Safety—Part 2–40: Particular Requirements for Electrical Heat Pumps, Air-Conditioners, and Dehumidifiers,'' and ASHRAE 15–2022, ''Safety Standard for Refrigeration Systems,'' additional changes would be required for A2L mitigation, including addition of a refrigerant sensor, additional labeling, testing, and certification. (*Id.*) Carrier commented that it is currently conducting design work and system optimization for the anticipated 2025 implementation date, but that it has not determined final details on cost impacts. (*Id.*) Carrier also stated that there is variability in refrigerant prices due to supply chain issues and it anticipates that the start of the American Innovation and Manufacturing (''AIM'') Act regulations would increase those prices. (*Id.*)

NEEA recommended that the analysis consider the effects on efficiency of the likely and approved refrigerant options for ACUACs available domestically and internationally. NEEA specifically recommended that DOE address the technical feasibility and economic implications of meeting amended standard levels with equipment that uses different refrigerants, similar to the analysis DOE conducted for the 2016 beverage vending machine energy conservation standards rulemaking (81 FR 1028 (Jan. 8, 2016)). (NEEA, EERE–2022–BT–STD–0015–0013 at p. 8)

More generally in response to the May 2022 TP/ECS RFI, NYSERDA recommended that in evaluating amended energy conservation standards, DOE should be mindful of the transition to low-GWP refrigerants that will be more common, even if not required, by 2029. (NYSERDA, EERE–2022–BT–STD–0015–0007 at p. 3)

In response, DOE notes that these comments were received prior to the 2023 ECS Negotiations, and in particular, comments received in response to the May 2020 ECS RFI were received three years prior to the 2023 ECS Negotiations. Therefore, manufacturers' understanding of the impacts of low-GWP refrigerants may have changed since the time of the drafting of some of the comments received. DOE conducted multiple rounds of manufacturer interviews to support the analyses for this direct final rule. In the first round of manufacturer interviews, DOE sought feedback on its engineering analysis, and the Department particularly sought input on the potential impacts of low-GWP refrigerants. DOE understands that manufacturers are currently still in the process of developing models that use low-GWP refrigerants and consequently there are currently no market efficiency data available for models using low-GWP refrigerants. However, based on feedback received to this point during the course of the rulemaking (including manufacturer interviews and Carrier's comment providing preliminary testing data), DOE has concluded that implementation of low-GWP refrigerants such as R–32 and R–454B is unlikely to result in a significant impact on measured efficiency of ACUACs and ACUHPs. Therefore, DOE conducted its engineering analysis for this direct final rule using efficiency data for models currently on the market that use R–410A.

With respect to suggestions that DOE consider the impact of cost of equipment using A2L refrigerants, DOE acknowledges that design changes to implement A2L refrigerants could impact the cost of equipment and that models using A2L refrigerants may require additional controls or sensors to detect leaks and additional labeling. However, DOE's research and feedback from manufacturer interviews suggests that based on information available at this time, these cost differences are not likely to have a significant impact on the marginal cost to improve efficiency (*i.e.,* the costs to implement these changes will likely be similar at each efficiency level). DOE concludes that the switch to A2L refrigerants will not make a significant difference to the incremental costs of higher efficiency levels as compared to R–410A. Similarly, to the extent that shipping costs may increase in some cases for equipment shipped with A2L refrigerants, DOE does not expect these shipping costs are likely to have a significant impact on the marginal costs to consumers. Therefore, DOE conducted its cost analysis, including shipping costs, considering models currently on the market that use R–410A.

5. Cost Analysis

a. MPC Estimates

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 equipment, and the availability and timeliness of purchasing the equipment on the market. The cost approaches are summarized as follows:

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

• *Catalog teardowns:* In lieu of physically deconstructing equipment, 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 equipment.

• *Price surveys:* If neither a physical nor catalog teardown is feasible (*e.g.,* for tightly integrated products such as fluorescent lamps, which are infeasible to disassemble and for which parts diagrams are unavailable), cost-prohibitive, or 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 May 2020 ECS RFI, DOE sought input on the increase in manufacturer production cost (''MPC'') associated with incorporating particular design options and/or with reaching efficiency levels above the baseline. 85 FR 27941, 27949 (May 12. 2020). Specifically, DOE was interested in whether and how the costs estimated in the January 2016 Direct Final Rule have changed since the time of that analysis. *Id.* 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. *Id.*

Regarding feedback on MPC associated with each design option and how costs estimated in the January 2016 Direct Final Rule have changed, AHRI commented that the work done to quantify MPCs was generally accurate at the time of the analysis. Regarding the list of design options to improve efficiency, AHRI asserted that ACUAC progression to larger heat exchangers was not properly characterized in the January 2016 Direct Final Rule and that increases to outdoor and indoor fan efficiency were missing. (AHRI, EERE–2019–BT–STD–0042–0014 at p. 7)

DOE notes that AHRI's comment was received three years ago and prior to the 2023 ECS Negotiations. As discussed, as part of the analyses supporting the 2023 ECS Negotiations, DOE contractors conducted engineering interviews with manufacturers (all of which are AHRI members) and analyzed the market after the January 1, 2023 compliance date. During these discussions, DOE contractors received feedback on design options used in higher efficiency equipment (including heat exchangers, indoor fans, and outdoor fans), and the MPCs developed for this direct final rule analysis reflect the feedback received in those confidential interviews. Additionally, the cost-efficiency curves were developed based on ACUAC and ACUHP models available on the market at the time of the 2023 ECS Negotiations. To the extent that available models included larger heat exchangers and increases to outdoor and indoor fan efficiency, the improvement in efficiency and corresponding cost for these design options are reflected in the cost-efficiency curves presented in this direct final rule. Further, the cost-efficiency curves were presented during multiple meetings during the 2023 ECS Negotiations [32] and ACUAC/HP Working Group members had ample opportunity to provide feedback.

In the present case, DOE conducted the cost analysis using a combination of physical teardowns and catalog

[32] See *www.regulations.gov/document/EERE-2022-BT-STD-0015-0077* and *www.regulations.gov/document/EERE-2022-BT-STD-0015-0080* for presentations during the 2023 ECS Negotiations with cost efficiency curves.

teardowns of models to assess how manufacturing costs change with increased equipment efficiency. The resulting bill of materials (''BOM'') provides the basis for the MPC estimates. For each equipment class, DOE initially estimated the MPCs for models using physical and catalog teardowns for each manufacturer that included sufficient information in their equipment literature to conduct the cost estimation analysis. As discussed in section IV.C.1 of this document, DOE specifically focused its analysis on 7.5-ton, 15-ton, and 30-ton ACUAC models with electric resistance heating or no heating.

To collect additional information regarding design options and costs associated with equipment at different efficiency levels, DOE provided design details and cost estimates, broken out by production factors (materials, labor, depreciation, and overhead) and also by major subassemblies (*e.g.,* indoor/outdoor heat exchangers and fan assemblies, controls, sealed system) and components (*e.g.,* compressors, fan motors), for each model analyzed in its physical and catalog teardowns to the manufacturers of the models. DOE refined its analysis based on all data and feedback provided by manufacturers in confidential manufacturer interviews.

As previously discussed, DOE did not consider any design changes specific to improving heating efficiency, and the cost-efficiency analysis was focused on cooling mode operation. Further, as discussed, because market efficiency data in terms of the new IVEC metric are not available beyond the limited dataset provided to DOE contractors during the Negotiations, the cost-efficiency analysis was conducted based on IEER, and then IVEC values were developed to translate the IEER efficiency levels to IVEC.

DOE analyzed costs (using physical teardowns and catalog teardowns) across the full range of manufacturers and equipment offerings for which DOE identified sufficient data to conduct the manufacturing cost estimation analysis. Therefore, DOE's cost estimates reflect the various design pathways that each manufacturer uses to increase efficiency in their current model offerings. The following paragraphs provide additional detail on DOE's methodology for developing MPC estimates, and further detail is included in chapter 5 of the direct final rule TSD. Generally, the methodology used for this direct final rule is consistent with the methodology used in the January 2016 Direct Final Rule analysis. 81 FR 2420, 2464 (Jan. 15, 2016).

For small and large equipment classes (represented by 7.5-ton and 15-ton capacities, respectively), DOE developed cost-efficiency curves (*i.e.,* relationship between rated IEER and MPC estimate) for each manufacturer individually, and then aggregated the manufacturer-specific cost curves into an industry-average cost-efficiency curve. For efficiency levels for which there were no analyzed models from a given manufacturer with rated IEER values that exactly match the efficiency level, DOE's primary method to determine the MPCs for those efficiency levels for that manufacturer was to interpolate or extrapolate results. For example, to determine the MPC at 7.5-ton Efficiency Level 1 (15.4 IEER) for one manufacturer, DOE interpolated between the results for models rated at 14.8 IEER and 15.6 IEER. For cases in which a manufacturer does not offer a model near a given efficiency level at the representative capacity but offers models at that efficiency level at a similar capacity, DOE estimated the costs of similar capacity models at the target efficiency level and then scaled those costs up or down to reflect the capacity difference and estimate what the cost would be for that model to achieve that efficiency level at the representative capacity. For example, to determine the MPC at 7.5-ton Efficiency Level 5 (19.9 IEER) for one manufacturer, DOE scaled down the cost of an 8.5-ton model with a rated IEER of 19.9 to reflect DOE's estimate of the cost of a 7.5-ton model with comparable efficiency, by developing a cost per efficiency times capacity relationship for that specific model line. There were certain efficiency levels for which some manufacturers did not offer models at or near the target efficiency level, even including capacities slightly different than the representative capacity. For these levels (for example, the 15-ton Efficiency Level 4 (20.1 IEER)), DOE calculated the relative percentage increase in cost relative to baseline for a manufacturer with a commercially-available model at that level, and then applied that percentage increase to the baseline cost for the other manufacturers to estimate MPCs at that level for each manufacturer.

For the very large equipment class represented by 30-ton representative units, DOE identified fewer manufacturers offering equipment in this capacity range. After collecting information for all models with sufficient data available to develop cost estimates, DOE concluded that there are insufficient models available to develop separate cost curves for each manufacturer and then combine into an industry-average cost-efficiency curve as was done for the small and large equipment classes. Therefore, DOE developed a single industry-wide cost curve for very large equipment including models from all identified manufacturers. Additionally, DOE's review of equipment available on the market showed that there are two platform types of equipment for 30-ton models (and the very large equipment class more broadly): (1) models with smaller cabinets for light commercial applications, and (2) models with larger cabinets for industrial-type applications. DOE concluded that there are insufficient models with the larger cabinet size spanning the range of efficiency levels being considered (both at the low and high ends of the efficiency range) to develop cost estimates based on the larger cabinet size. Therefore, DOE developed incremental MPCs based on the smaller cabinet platform.

As discussed, DOE's cost analysis focused on ACUAC models with electric resistance heating or no heating. In the economic analyses for this rulemaking, the MPCs developed for ACUACs with electric resistance heating or no heating were applied for all ACUACs, including ACUACs with all other types of heating. As previously discussed, DOE has found that ACUACs with electric resistance heating or no heating model lines and ACUACs with all other types of heating model lines generally differ only in the type of supplemental heating and are otherwise identical; therefore, the incremental MPCs for ACUACs with electric resistance heating or no heating and ACUACs with all other types of heating would be the same. In other words, the cost to achieve higher efficiencies would not be impacted by the presence of a furnace. DOE also developed a baseline cost differential between a baseline ACUAC model with electric resistance heating or no heating as compared to a baseline ACUHP model, reflecting the cost differentials of heat pump technology. Consistent with the analysis from the January 2016 Direct Final Rule and feedback received during manufacturer interviews, DOE applied the incremental MPC adders determined for ACUACs with electric resistance or no heating to develop cost curves for ACUHPs. In other words, while there is an absolute cost differential associated with heat pump technology, DOE assumed that this cost differential remained constant across all efficiency levels (*e.g.,* the cost to achieve higher efficiencies would not be impacted by the presence of a reversing valve). The one exception to this approach was developing costs for the recommended efficiency levels for ACUHPs, because as discussed in section IV.C.2.a of this document, the IVEC values at those efficiency levels for ACUHP equipment classes were slightly different than the IVECs for the comparable efficiency levels for the ACUACs with all other types of heating., For these recommended ACUHP IVEC levels, DOE used interpolation to adjust the MPC estimates for the corresponding ACUAC levels to reflect the slight difference in IVEC levels between ACUACS and ACUHPS. As discussed in section IV.C.2 of this document, DOE translated the cost-efficiency relationships based on IEER to IVEC and IVHE. Further discussion of DOE's methodology for developing MPC estimates is included in chapter 5 of the direct final rule TSD.

b. MSP Estimates, Manufacturer Markup, and Shipping Costs

To account for manufacturers' non-production costs and profit margin, DOE applies a multiplier (the manufacturer markup) to the MPC. The resulting manufacturer selling price (''MSP'') is the price at which the manufacturer distributes a unit into commerce. DOE developed an average manufacturer markup by examining the annual Securities and Exchange Commission (''SEC'') 10–K reports [33] filed by publicly-traded manufacturers primarily engaged in commercial package air conditioning and heating equipment manufacturing and whose combined product range includes ACUACs and ACUHPs.

In the May 2020 ECS RFI, DOE requested feedback on whether manufacturer mark-ups determined in the January 2016 Direct Final Rule are still appropriate for ACUACs and ACUHPs. 85 FR 27941, 27950 (May 12, 2020). In response, AHRI stated that its members found that the manufacturer markups from the January 2016 Direct Final Rule are still appropriate for ACUACs. (AHRI, EERE–2019–BT–STD–0042–0014 at p. 8) AHRI stated that manufacturer markups for ACUHPs are up to 10 percent higher than those determined in the January 2016 Direct Final Rule. (*Id.*)

DOE incorporated AHRI's feedback into its current analysis, estimating manufacturer markups of 1.30 for small ACUACs, 1.32 for small ACUHPs, 1.34 for large ACUACs, 1.36 for large ACUHPs, 1.41 for very large ACUACs, and 1.43 for very large ACUHPs. These markups were applied to MPC estimates to develop MSP estimates. See section IV.J.2.d of this document and chapter 12 of the direct final rule TSD for additional discussion on manufacturer markups.

Because the design options associated with certain incremental efficiency level involved increases in cabinet sizes, DOE also estimated the incremental shipping cost at each efficiency level separate from the MSP. More specifically, DOE estimated the per-unit shipping costs based on the cabinet dimensions at each efficiency level, assuming the use of a typical 53-foot flatbed trailer. For shipping of HVAC equipment, the size threshold of a trailer is typically met before the weight threshold. DOE used the same approach used for estimating the cost-efficiency relationship, evaluating shipping costs for each manufacturer individually then averaging the results for the small and large equipment classes, and (for the reasons described for MPC estimates in section IV.C.5.a of this document) a single industry-wide shipping cost relationship for the very large equipment class including models from all identified manufacturers. Further discussion of DOE's methodology for developing shipping cost estimates is included in chapter 5 of the direct final rule TSD.

6. Cost-Efficiency Results

The results of the engineering analysis are reported as cost-efficiency data (or ''curves'') in the form of IVEC versus MSP plus shipping cost (in dollars), which form the basis for subsequent analyses. As previously mentioned, DOE's cost analysis focused on ACUACs with electric resistance heating or no heating, which were also used to represent the MPCs of ACUACs with all other types of heating. The incremental MPC estimates for these classes were applied to ACUHPs. The total MPC, shipping cost, and MSP plus shipping cost for each efficiency level for the ACUAC equipment classes are listed in Table IV.8 through Table IV.10. The total MPC, shipping cost, and MSP plus shipping cost for each efficiency level for the ACUHP equipment classes (which, as discussed, are based on the same incremental MPC estimates as for ACUAC equipment classes) can be found in chapter 5 of the direct final rule TSD.

Table IV.8 Manufacturer Production Costs and Manufacturer Selling Price Plus Shipping Costs for Small ACUACs

Efficiency Level	Total MPC	Shipping Cost	MSP Plus Shipping Cost
Baseline	$4,138.28	$715.43	$6,095.19
EL 1	$4,283.90	$715.43	$6,284.50
EL 2	$4,370.83	$715.43	$6,397.51
EL 3	$4,472.63	$715.43	$6,529.85
EL 4*	$4,670.41	$715.43	$6,786.96
EL 5	$4,978.23	$822.74	$7,294.44
EL 6	$5,258.34	$822.74	$7,658.58
EL 7	$5,566.03	$822.74	$8,058.59

* Recommended efficiency level

[33] U.S. Securities and Exchange Commission, Annual 10–K Reports (Various Years) (available at: *www.sec.gov/edgar/searchedgar/companysearch.html*) (last accessed Oct. 3, 2023).

Table IV.9 Manufacturer Production Costs and Manufacturer Selling Price Plus Shipping Costs for Large ACUACs

Efficiency Level	Total MPC	Shipping Cost	MSP Plus Shipping Cost
Baseline	$7,376.61	$1,032.90	$10,917.56
EL 1	$7,533.13	$1,056.38	$11,150.77
EL 2*	$7,689.65	$1,079.85	$11,383.98
EL 3	$8,421.29	$1,189.40	$12,473.93
EL 4	$9,260.56	$1,228.53	$13,637.67

* Recommended efficiency level

Table IV.10 Manufacturer Production Costs and Manufacturer Selling Price Plus Shipping Costs for Very Large ACUACs

Efficiency Level	Total MPC	Shipping Cost	MSP Plus Shipping Cost
Baseline	$14,383.32	$1,565.00	$21,845.48
EL 1*	$14,522.06	$1,565.00	$22,041.11
EL 2	$16,316.97	$1,565.00	$24,571.92
EL 3	$19,754.59	$2,347.50	$30,201.47

* Recommended efficiency level

See chapter 5 of the direct final rule TSD for additional detail on the engineering analysis.

D. Markups Analysis

The markups analysis develops appropriate markups (*e.g.,* manufacturer markups, retailer markups, distributor markups, contractor markups) in the distribution chain and sales taxes to convert the MPC/MSP estimates derived in the engineering analysis to consumer prices, which are then used in the LCC and PBP analysis. The markups are multiplicative factors applied to MPCs and MSPs. At each step in the distribution channel, companies mark up the price of the equipment to cover business costs and profit margin. Before developing markups, DOE defines key market participants and identifies distribution channels.

In response to the May 2020 ECS RFI, AHRI commented that it is researching distribution channels; however, it had no feedback at the time the comment was written. (AHRI, EERE–2019–BT–STD–0042–0014 at p. 8) Carrier commented that it has not observed large shifts in the distribution channels, as the industry for the subject equipment remains mature in the U.S. (Carrier, EERE–2019–BT–STD–0042–0013 at p. 12)

However, AHRI disagreed with DOE's use of incremental markups, citing an analysis by Everett Shorey from 2014, and recommended that DOE revert to using the baseline markup for both baseline and incremental costs. (AHRI, EERE–2019–BT–STD–0042–0014 at p. 8)

DOE responded thoroughly to the Shorey report in the previous direct final rule. *See* 81 FR 2420, 2468 (Jan. 15, 2016). In summary, DOE's incremental markup approach assumes that an increase in profitability, which is implied by keeping a fixed markup when the product price goes up, is unlikely to be viable over time in reasonably competitive markets. DOE recognizes that actors in the distribution chains are likely to seek to maintain the same markup on appliances in response to changes in manufacturer sales prices after an amendment to energy conservation standards. However, DOE believes that retail pricing is likely to adjust over time as those actors are forces to readjust their markups to reach a medium-term equilibrium in which per-unit profit is relatively unchanged before and after standards are implemented.

DOE acknowledges that markup practices in response to amended standards are complex and vary across business conditions. However, DOE's analysis necessarily only considers changes in appliance offerings that occur in response to amended standards. DOE continues to maintain that its assumption that standards do not facilitate a sustainable increase in profitability is reasonable.

PGE commented that ACUACs are purchased in larger volume by distributors, with larger discounts from manufacturers, and thereby resulting in lower prices to contractors. PGE stated that raising the minimum efficiency ratings for ACUACs will have a lesser negative wholesale pricing impact due to this volume. (PGE, EERE–2019–BT–STD–0042–0009 at p. 2)

DOE reviewed the distribution channels and overall markups from the January 2016 Direct Final Rule at the February 9, 2023 public meeting webinar for this rulemaking (*see* presentation slides, EERE–2022–BT–STD–0015–0073 at pp. 20–23), with updated overall markups presented at the March 21–22, 2023 ACUAC/HP Working Group meeting (*see* presentation slides, EERE–2022–BT–STD–0015–0080 at pp. 30–33). There was no stakeholder discussion regarding the distribution channels or markups at these meetings. For this reason, DOE continues to use the distribution channels from the January 2016 Direct Final Rule, as well as the same overall methodology, but with updated inputs.

1. Distribution Channels

For ACUACs and ACUHPs, the main parties in the distribution channel are: (1) manufacturers; (2) wholesalers; (3) small or large mechanical contractors, and (4) consumers. See chapter 6 and appendix 6A of the direct final rule TSD for a more detailed discussion about parties in the distribution chain.

For the direct final rule, DOE characterized three distribution channels to describe how the ACUAC and ACUHP equipment passes from the manufacturer to the commercial consumer. The first of these channels, the replacement distribution channel, estimated to represent 66.0 percent of shipments, was characterized as follows:

Manufacturer → Wholesaler → Small or Large Mechanical Contractor → Consumer

The second channel, the new construction distribution channel, estimated to represent 16.5 percent of shipments, was characterized as follows:

Manufacturer → Wholesaler → Small or Large Mechanical Contractor → General Contractor → Consumer

In the third distribution channel, which applies to both the replacement and new construction markets, estimated to represent 17.5 percent of shipments, the manufacturer sells the equipment directly to the customer through a national account:

Manufacturer → Consumer (National Account)

2. Markups and Sales Tax

DOE developed baseline and incremental markups for each actor in the distribution channels. Baseline markups are applied to the price of equipment with baseline efficiency, while incremental markups are applied to the difference in price between baseline and higher-efficiency models (the incremental cost increase). The incremental markup is typically less than the baseline markup and is designed to maintain similar per-unit operating profit before and after new or amended standards.[34]

Following the same approach applied in the January 2016 Direct Final Rule, DOE relied on several sources to estimate average baseline and incremental markups, including: (1) the 2017 Annual Wholesale Trade Survey for ''Hardware and Plumbing and Heating Equipment and Supplies Merchant Wholesaler'' [35] to develop wholesaler markups, and (2) U.S. Census Bureau's 2017 Economic Census data [36] for the commercial and institutional building construction industry to develop mechanical and general contractor markups. In addition, DOE used the 2005 Air Conditioning Contractors of America's (''ACCA'') financial analysis for the heating, ventilation, air conditioning, and refrigeration (''HVACR'') contracting industry [37] to disaggregate the mechanical contractor markups into small and large, replacement and new construction markets.

In addition to the markups, DOE derived State and local taxes from data provided by the Sales Tax Clearinghouse.[38] These data represent weighted-average taxes that include county and city rates. DOE derived population-weighted average tax values for each of the regions from the Energy Information Administration's 2018 Commercial Building Energy Consumption Survey (''CBECS 2018'') [39] considered in the analysis.

Chapter 6 of the direct final rule TSD provides details on DOE's development of markups for ACUACs and ACUHPs.

E. Energy Use Analysis

The purpose of the energy use analysis is to determine the annual energy consumption of ACUACs at different efficiencies for a representative sample of U.S. commercial buildings, and to assess the energy savings potential of increased equipment efficiency. DOE did not analyze ACUHP energy use because, for the reasons explained in section IV.C.3 of this document, the energy modeling in the engineering analysis was performed only for ACUAC equipment.

The energy use analysis estimates the range of energy use of ACUACs 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.

Chapter 7 of the direct final rule TSDs provides details on DOE's energy use analysis for ACUACs. DOE developed engineering correlation data and energy consumption estimates only for the ACUAC equipment classes that have electric resistance heating or no heating. For equipment classes with all other types of heating, DOE assumed that the incremental change in efficiency, and hence, energy savings and energy cost savings, would be similar to the values calculated for the equipment classes with electric resistance heating or no heating.

1. System-level Calculations

DOE based the energy use estimates for all equipment classes on three sets of input data:

(1) The engineering analysis provided data that were used to calculate the equipment net capacity, compressor, and condenser power consumption as a function of outdoor air temperature (''OAT''), the indoor fan power as a function of external static pressure (''ESP''), and controls power (constant), for each equipment stage at each efficiency level. The compressor, condenser, indoor fan, and controls are referred to as the ''system components'' in the discussion that follows. The ''net capacity'' is defined as the maximum-stage system capacity minus the heat generated by the indoor fan. DOE assumed that the ESPs appropriate to each equipment class were those agreed upon in the ACUAC/HP Working Group TP Term Sheet, plus an increment of 0.1 to account for the economizer pressure drop (also included in the ACUAC/HP Working Group TP Term Sheet).

(2) Hourly A/C system data were generated using Energy Plus for 11 commercial building prototypes, 4 building vintages, and 16 climate zones; as each building prototype includes multiple systems serving multiple zones, the total number of simulated systems in the 11 commercial building prototypes is 48. Given 4 vintages and 16 climates, this leads to a total of 3,072 individual systems. DOE used TMY3 weather data as simulation input, with the cities used to represent each climate zone the same as those used in the ACUAC/ACUHP Test Procedure. The simulation data account for economizer use. The hourly data extracted from the simulations for each system included the total system load (heat removed from the space), the fan fraction (fraction of the hour that the fan is on), and cooling and heating coil rates. The coil cooling/heating rates were used only to determine the system operating mode.

(3) Data from the Commercial Building Energy Consumption Survey (''CBECS'') 2018 were used to estimate,

[34] Because the projected price of standards-compliant equipment is typically higher than the price of baseline equipment, 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.

[35] U.S. Census Bureau, 2017 Annual Wholesale Trade Survey (available at: *www.census.gov/data/tables/2017/econ/awts/annual-reports.html*) (last accessed Feb. 7, 2023).

[36] U.S. Census Bureau, *2017 Economic Census Data* (2017) (available at: *www.census.gov/econ/*) (last accessed Feb. 7, 2023).

[37] Air Conditioning Contractors of America (ACCA), *Financial Analysis for the HVACR Contracting Industry: 2005* (available at: *www.acca.org/store/*) (last accessed Feb. 7, 2023).

[38] Sales Tax Clearinghouse Inc., State Sales Tax Rates Along with Combined Average City and County Rates, 2023 (available at: *thestc.com/STrates.stm*) (last accessed Sept. 11, 2023).

[39] Energy Information Administration (EIA), 2018 Commercial Building Energy Consumption Survey (available at: *www.eia.gov/consumption/commercial/*) (last accessed August 19, 2023).

for those buildings using packaged cooling systems, the relative share of floor space by Census Division and building type. In the 2015 analysis, this description of the relevant features of the building stock with associated weights was referred to as the Generalized Building Sample (''GBS'').

DOE prepared the engineering data for input to the energy use analysis as follows: For each EL and equipment stage, the engineering correlations were used to calculate the net capacity and component power consumption for a set of integer temperatures spanning the range 30 °F to 110 °F (which exceeds the maximum temperature in the TMY3 data). The capacity and power consumption data were then scaled by the system nominal capacity; the power consumption is, therefore, defined on a per-unit-of-capacity basis. The system nominal capacity was defined as the maximum stage capacity at 95 °F.

DOE processed the building simulation data for input to the energy use calculation as follows: First, the data were scaled to the nominal system capacity. For this analysis, consistent with assumption used in the development of the ACUAC/ACUHP Test Procedure, DOE assumed that the system capacity was equal to 1.15 times the peak hourly load. Next, DOE assigned one of four operating modes to each hour: (1) off (zero fan energy use); (2) fan only (fan energy >0 and coil rates = 0); (3) cooling (cooling coil rate >0), and (4) heating (heating coil rate >0). For multizone variable air volume (''VAV'') systems, there were a few hours where both cooling and heating rates are positive; as these hours were dominated by the cooling load, they were assigned to cooling mode.

DOE combined the building simulation data with the engineering data to determine the energy use in each hour, and summed this energy use over all hours to determine the annual summer and winter energy use per unit of capacity. The summer season was defined as May through September, and the winter season as all other months in the year. In each hour, the energy use calculations are adjusted based on the system operating mode:

- *Fan-only mode:* the engineering analysis provided a specific value for fan power during fan-only operation; during these hours the energy use is equal to the fan power multiplied by the fan fraction (to account for the fact that the system may be off during part of the hour) plus the controls power.
- *Heating mode:* as discussed with the ACUAC/HP Working Group, DOE assumed that the fan would operate at maximum stage during heating hours; during these hours the energy use is equal to the fan power multiplied by the fan fraction (to account for the fact that the system may be off during part of the hour) plus the controls power at maximum stage.
- *Cooling mode:* all equipment designs include multi-stage compressors, so the calculation must first determine which stages are operating during the hour. DOE calculated the total heat removed, and compared this to the net capacity at each stage; the highest stage that is less than the total load is the lower stage, and the next stage up is the upper stage. The fraction of load allocated to each stage determines the fraction of the hour that the system operates in each stage (equations describing these calculations are provided in chapter 7 of the direct final rule TSD). DOE used the values of component power for the OAT in the hour to calculate the energy use for the upper and lower stages. The total energy use is equal to the weighted sum of the values for the lower and upper stages. If the lower stage was off, DOE adjusted for cyclic performance using the degradation coefficient and load factor as calculated according to section 6.2, Part-Load Rating, of AHRI 340/360–2007, ''2007 Standard for Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.''
- *Off mode:* the energy use is equal to the controls power for the fan-only mode.

DOE converted the system-level energy use data to building-level energy use data by averaging the energy use over all systems in a building. To calculate this average, DOE weighted each system based on the system nominal capacity. DOE also accounted for the possibility that installation of new equipment would require a conversion curb. DOE estimated that the presence of a conversion curb would add 0.2 to the ESP, with a resulting adjustment to fan power and system net capacity. DOE calculated the energy use two times for each system—once with no assumed conversion curb, and once with the assumed conversion curb. DOE then averaged these results to get a single value for each system. The percent of installations with and without conversion curbs, for each equipment class and efficiency level, was estimated based on data collected for the January 2016 Direct Final Rule. These data were adjusted to account for the current equipment baseline, and the cross-walk between IEER and IVEC, as discussed during the 2023 ECS Negotiations. DOE converted the per-unit energy use to a value appropriate to each representative unit by multiplying the energy use by the representative unit capacity.

2. Generalized Building Sample

The calculations described in the previous section result in summer and winter energy use values for each building prototype, vintage, and climate. To use these data in the LCC, sample weights must be defined that reflect the relative frequency of each of these attributes in the building stock. In addition to building prototype, vintage, and climate, DOE included Census Division (''CD'') and building type as attributes in the building sample. Census Division is included because energy prices depend on these regions. Building type is included as this is the categorization used in CBECS and in the *AEO.*

DOE used CBECS 2018 to determine the total floor space cooled by packaged equipment distributed by Census Division and building type as encoded by Principal Building Activity (''PBA'') in CBECS. DOE mapped the CBECS PBA definitions to the building type definition used in the *AEO* commercial demand module, and the Department used the *AEO* building type definitions as categories in the LCC sample. In general, the mapping of building prototype to building type is straightforward (for example, office, retail, assembly). For the food sales and educational building types, there are two building prototypes (*i.e.,* full-service and quick-service, and primary and secondary schools respectively). Additional data available in CBECS were used to calculate the percentage of building type floor space to allocate to each building prototype.

DOE used four vintage categories: pre-1980, 1980–2003, 2004–2018 and 2019–2029. DOE used CBECS2018 to apportion floor space by vintage and building type for the first three vintage categories. For the fourth category, DOE used *AEO 2023* commercial floor space projections to adjust the floor space to the compliance year 2029. DOE used the *AEO* to estimate, for the period 2019–2029, the floor space added and demolished relative to existing floor space in 2018, for each building type. DOE used these percentages to calculate the existing floor space by vintage and building type in 2029, then converted the absolute numbers to percentages.

DOE combined the climate zones (''CZ'') and Census Divisions into a set of 28 distinct sub-regions, using population data to estimate the weight for each region. These weights were used to distribute the floor space by CD into floor space by CD–CZ combined sub-regions.

DOE used the building simulation data to estimate the total cooling capacity per square foot of cooled floor space for each climate zone, building type and vintage. DOE used the capacity per square foot numbers to convert total cooled floor space to total installed capacity. DOE assigned a weight to each combination of attributes in the building sample based on the percentage of installed capacity.

DOE tailored the sample weights for the small, large, and very large equipment classes using a filter based on system nominal capacity. If the system nominal capacity was less than 0.8 times the representative unit capacity, the system was excluded from the sample (and from the calculation of building-level energy use).

3. Energy Use Adjustment Factors

Building simulations reflect idealized conditions and may over-represent or under-represent heating and cooling loads relative to real-world conditions. In the January 2016 Direct Final Rule, DOE's analysis relied on building simulation data that had been calibrated to CBECS 1995. In the current analysis, DOE's building simulations were not calibrated, so DOE accounted for any deviations from real-world conditions by calculating energy use adjustment factors.

DOE calculated these factors as follows:

- DOE used CBECS 2018 estimates of cooling and ventilation energy use to estimate the average equipment energy use per square foot of cooled floor space as a function of building type.
- DOE used data published with the AEO NEMS model (commercial demand module) to estimate the ratio of the stock average efficiency of packaged cooling equipment in 2018 to the efficiency of the current standard. DOE applied this ratio to convert the CBECS stock-average energy use calculation to a value that represents what the energy use would be if the equipment efficiencies were all equal to the current standard.
- DOE took the calculated energy use per unit of capacity for the EL0 engineering data, combined with the capacity per square foot estimate from the building simulation data, to calculate the equipment energy use per square foot at EL0. As this value varies slightly by equipment class, DOE used shipments weight to calculate an average across all installed stock.
- DOE compared, for each building type, the CBECS 2018 estimate of energy use per square foot at the current standard to the value calculated for the EL0 engineering data. DOE used the ratio of these two values to define an energy use adjustment factor for each building type. In most cases, the factor is larger than 1, reflecting an under-estimate of energy use by the simulation data. However, for education and healthcare buildings, the calculated factor is less than 1, corresponding to an over-estimate of energy use in the simulated data.
- DOE applied the energy use adjustment factors to the energy use values input to the LCC.

DOE considered two other trends that can impact cooling energy use by space-conditioning equipment: (1) changes to building shell characteristics and internal loads, and (2) increases in cooling-degree days (driven by population shifts and estimated weather trends). Both these trends are modeled in the *AEO* commercial demand module. The first is captured in the *AEO* cooling factor, which tends to decrease loads over time. The second is captured in *AEO* estimates of Cooling Degree Days (''CDD'') over the projection period. DOE estimated the combined impact of the two trends, and calculated that the average impact of the combined trends over a 30-year period results in a 2.8-percent increase in equipment energy use. DOE decided to not include the impact of these trends in the energy use analysis and LCC, as these issues were not discussed during the ASRAC negotiations, and so would present a deviation from the agreed-upon methodology. As the small increase would apply to all ELs, DOE determined that there is no impact to the decision criteria.

4. Comments

In response to the May 2020 ECS RFI, the CA IOUs commented that DOE should update the weather data used in the energy use analysis to reflect the temperatures recorded in the U.S. in recent years. The CA IOUs recommend that DOE consider the methodology used by the California Energy Commission to update weather files to analyze the Title 24–2022 Building Energy Code. (CA IOUs, EERE–2019–BT–STD–0042–0020 at p. 5) AHRI and Trane stated that the methodology used in the January 2016 Direct Final Rule is out of date. (AHRI, EERE–2019–BT–STD–0042–0014 at p. 8; Trane, EERE–2019–BT–STD–0042–0016 at p. 9) AHRI and Carrier both recommended using the ASHRAE prototype buildings and the ASHRAE 205, ''Standard Representation of Performance Simulation Data for HVAC&R and Other Facility Equipment,'' standardized equipment modeling approach, along with the Dodge data base, for weighting factors. AHRI and Carrier further suggested that the energy modeling should include real world static pressures for well-designed duct work, economizers, fan speed control, stages of capacity, energy recovery, supply air reset, and static pressure reset. (AHRI, EERE–2019–BT–STD–0042–0014 at pp. 8–9; Carrier, EERE–2019–BT–STD–0042–0013 at pp. 13–14) Carrier added that both heating and cooling should be modeled, as well as occupied and unoccupied operation. (*Id.*)

NEEA recommended that DOE account for part-load operation, staged systems, and varying percentages of outside air. (NEEA, EERE–2019–BT–STD–0042–0024 at p. 9)

In response, DOE reviewed its energy use analysis in light of these comments. To evaluate the adequacy of the TMY3 weather data, DOE downloaded hourly historical dry-bulb temperature data for the period 1998–2020, for the sixteen climate locations used in the TP and ECS analyses, from the National Renewable Energy Laboratory (''NREL'') Physical Solar Model (''PSM'') database, Version 3 (link *https://developer.nrel.gov/docs/solar/nsrdb/*). DOE constructed histograms of the historical data (binned temperature distributions) and compared these to distributions created from the TMY3 weather data. As the focus of the ACUAC/HP Working Group was on cooling, DOE looked primarily at distributions of temperatures greater than or equal to 70 deg F. The data did not show any large discrepancies. Both the maximum temperatures and the percent of annual hours in the high temperature bins were comparable across all sites. DOE also calculated annual 65-degree based heating and cooling degree days (HDD and CDD) for the two datasets; CDD values calculated were 1680 for the TMY3 data and 1672 for the NREL–PSM data; HDD values calculated were 4635 for the TMY3 data and 4634 for the NREL–PSM data. DOE determined that the distribution of hourly temperatures in the TMY3 data are entirely consistent with the actual historical data for the last 20 years. In particular, CDD and HDD metrics, which are most highly correlated with cooling and heating loads, are almost identical between the two data sets. DOE presented these findings to the stakeholders, and did not make any adjustments to the energy use analysis on this basis.

In addition to the review of historical weather data requested by the stakeholders, as noted in section IV.E of this document, DOE also analyzed the projections of CDD trends and commercial sector cooling load trends published in *AEO 2023.* While this review was not requested by stakeholders, for completeness DOE evaluated any potential impacts these trends might have on energy use over the analysis period. DOE found that the combined effect of these two trends would be to increase lifetime energy consumption at the baseline by 2.8%; the same increase would occur at all higher ELs, hence, the impact on energy savings would also be 2.8%. A small increase in energy savings across all ELs cannot change the relative cost-effectiveness of the analyzed TSLs; and these issues were not actively discussed during the 2023 ECS Negotiations. Therefore, DOE decided not to make this adjustment in the DFR.

DOE used four building vintages, including the ASHRAE 90.1–2019 building prototypes, to account for variability in building stock characteristics in the population of buildings using ACUACs/ACUHPs. DOE reviewed and discussed methodologies for weighting the building simulation data with stakeholders during the 2023 ECS Negotiations (*see* EERE–2022–BT–STD–0015–0055 at pp. 26–30). The sales data (Dodge data) presented by stakeholders was from 2006 and may not represent the current market. Instead, DOE presented an alternative approach, based on 2018 CBECS data, 2019 Census data, and supplementary data from *AEO 2023,* which was accepted by stakeholders. More detail on DOE's weighting approach is provided in section IV.E.2 of this document.

During the ACUAC/HP Working Group TP negotiations, static pressures were extensively discussed, and stakeholders adopted new test procedure values more appropriate to real-world conditions. DOE used these values, with a 0.1 increment to account for economizer pressure drop, in this ECS analysis. DOE's engineering data and the methods DOE used to calculate energy use accounted for occupied and unoccupied hours, part-load operation, staged systems, economizer operation, fan speed control, and variable rates of outdoor air flow. As previously discussed, DOE did not conduct an energy use analysis specific to heating.

Furthermore, DOE reviewed its proposed methodology for the energy use analysis in the February 9, 2023 webinar (EERE–2022–BT–STD–0015–0073 at pp. 18–19), the February 22–23, 2023 meeting (EERE–2022–BT–STD–0015–0078 at p. 36), and the March 21–22, 2023 meeting (EERE–2022–BT–STD–0015–0080 at pp. 21–29). In general, this methodology is consistent with that used to develop the weights in the IVEC metric as part of the test procedure negotiations, with scalars developed to match energy use to CBECS 2018. There were no objections to the energy use methodology as presented in ACUAC/HP Working Group meetings.

DOE also reviewed updates to its energy use analysis to account for conversion curbs in the April 24, 2023 slide deck (EERE–2022–BT–STD–0015–0086 at p. 4) and based on discussion regarding installation costs related to conversion curbs at the March 22, 2023 meeting (EERE–2022–BT–STD–0015–0091 at pp. 40–41, 47).

Chapter 7 of the direct final rule TSD provides further details on DOE's energy use analysis for ACUACs and ACUHPs.

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 ACUACs. 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:

- *Life-cycle Cost (''LCC'')* is the total consumer expense of an appliance or equipment over the life of that equipment, 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 equipment.
- *Payback Period (''PBP'')* is the estimated amount of time (in years) it takes consumers to recover the increased purchase cost (including installation) of more-efficient equipment 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 ACUACs 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 equipment.

For each considered efficiency level in each equipment class, DOE calculated the LCC and PBP for a nationally representative set of commercial buildings. As stated previously, DOE developed building samples from the 2018 CBECS. For each sample building, DOE determined the energy consumption for the ACUACs and the appropriate energy price. By developing a representative sample of buildings, the analysis captured the variability in energy consumption and energy prices associated with the use of ACUACs.

Inputs to the LCC calculation include the installed cost to the commercial consumer, operating expenses, the lifetime of the equipment, and a discount rate. Inputs to the calculation of total installed cost include the cost of the equipment—which includes MPCs, manufacturer markups, retailer and distributor markups, and sales taxes (where appropriate)—and installation costs. Inputs to the calculation of operating expenses include annual energy consumption, energy prices and price projections, repair and maintenance costs, equipment lifetimes, and discount rates. Inputs to the payback period calculation include the installed cost to the consumer and first year operating expenses. DOE created distributions of values for equipment lifetime, and discount rates, with probabilities attached to each value, to account for their uncertainty and variability.

The computer model DOE uses to calculate the LCC and PBP relies on a Monte Carlo simulation to incorporate uncertainty and variability into the analysis. The Monte Carlo simulations randomly sample input values from the probability distributions and ACUAC user samples. For this rulemaking, the Monte Carlo approach is implemented in the Python programming language. The model calculated the LCC for equipment at each efficiency level for 10,000 buildings per simulation run. The analytical results include a distribution of 10,000 data points showing the range of LCC savings for a given efficiency level relative to the no-new-standards case efficiency distribution. In performing an iteration of the Monte Carlo simulation for a given commercial consumer, equipment efficiency is chosen based on its probability. If the chosen equipment 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 equipment, DOE avoids overstating the potential benefits from increasing equipment efficiency. DOE calculated the LCC for consumers of ACUACs as if each were to purchase new equipment in the first year of required compliance with new or amended standards. Amended standards apply to ACUACs manufactured after a date that is the later of the date that is three years after publication of any final rule establishing an amended standard or the date that is six years after the effective date of the current standard. (42 U.S.C. 6313(a)(6)(C)(iv)) In this case, the latter date prevails; therefore, DOE used 2029 as the first year of compliance with any amended standards for ACUACs.

Table IV.11 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 computer 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.

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Table IV.11 Summary of Inputs and Methods for the LCC and PBP Analysis*

Inputs	Source/Method
Equipment Cost	Derived by multiplying MPCs by manufacturer, wholesaler, and retailer markups and sales tax, as appropriate. Used constant equipment costs based on historical data.
Installation Costs	Baseline installation cost based on values in the 2016 Direct Final Rule and scaled to the current year. Assumed increased installation cost with weight.
Annual Energy Use	The annual cooling energy use based on EnergyPlus building simulation data combined with equipment efficiency from engineering data. Variability: Based on the distribution of buildings in *CBECS 2018* and regional TMY3 weather data.
Energy Prices	Electricity: Based on EIA's Form 861 data for 2022. Variability: Regional average and marginal energy prices determined for nine Census Divisions, with the Pacific region split into California and other States. Seasonal prices determined for summer and winter.
Energy Price Trends	Based on *AEO 2023* price projections.
Repair and Maintenance Costs	Assumed no change in maintenance cost with efficiency level. For repair cost, assumed increased cost by efficiency level that scales with increased equipment cost.
Equipment Lifetime	Average: 21 years for small, 23 years for large, and 30 years for very large equipment classes.
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	January 1, 2029

* Note: 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.

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DOE reviewed the various LCC inputs at the February 9, 2023 webinar (EERE–2022–BT–STD–0015–0073 at pp. 25–35) and the March 21–22, 2023 meeting (EERE–2022–BT–STD–0015–0080 at pp. 35–47). The only significant stakeholder discussion involved lifetimes and installation, repair, and maintenance costs. These comments are discussed in more detail in their respective following sections.

1. Equipment Cost

To calculate equipment 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 equipment and higher-efficiency equipment, because DOE applies an incremental markup to the increase in MSP associated with higher-efficiency equipment. For ACUACs, DOE reviewed historical producer price index (''PPI'') data for ''unitary air-conditioners, except heat pumps'' spanning 1978 to 2022, but did not find a discernable long-term trend. As a result, DOE applied constant price trends to project the equipment cost to the year of compliance.

2. Installation Cost

The installation cost is the expense to the commercial consumer of installing the ACUAC, in addition to the price of the unit itself. Installation cost includes labor, overhead, and any miscellaneous materials and parts needed to install the equipment. DOE used data from the January 2016 Direct Final Rule to estimate the baseline installation costs for ACUACs, and scaled these values to the current year based on data from the Bureau of Labor Statistics (''BLS'') [40] for materials and labor costs, at yearly rates of 1.95 percent and 2.62 percent, respectively. DOE assumed installation costs are proportional to the equipment weight, as associated with each efficiency level.

DOE reviewed updates to its installation cost analysis to account for conversion curbs that may be required in some cases to accommodate equipment designs with large footprints in the April 24, 2023 slide deck (EERE–2022–BT–STD–0015–0086 at p. 4), based on discussion at the March 22, 2023 meeting (EERE–2022–BT–STD–0015–0091 at pp. 20–21, 40–41, 47). The approach to determining the

[40] Bureau of Labor Statistics data (available at: *www.bls.gov/data/*) (last accessed Sept. 9, 2023).

applicability of conversion curbs in each installation is consistent with that in the January 2016 Direct Final Rule. It generally results in an increased likelihood of consumers encountering conversion curb costs as efficiency levels increase relative to the baseline equipment.

DOE did not account for any electric panel upgrades in this rule, because DOE did not model product switching from ACUAC-furnace to ACUHP installations in this rulemaking, as discussed in section IV.G.4.

3. Annual Energy Consumption

For each sampled building, DOE determined the energy consumption for an ACUAC 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 equipment purchased in the no-new-standards case, and marginal electricity prices for the incremental change in energy use associated with the other efficiency levels considered.

DOE derived electricity prices in 2022 using data from EEI Typical Bills and Average Rates reports. Based upon comprehensive, industry-wide surveys, this semi-annual report presents typical monthly electric bills and average kilowatt-hour costs to the customer as charged by investor-owned utilities. For the commercial sector, DOE calculated electricity prices using the methodology described in Coughlin and Beraki (2019).[41]

DOE's methodology allows electricity prices to vary by sector, region, and season. In the analysis, variability in electricity prices is chosen to be consistent with the way the consumer economic and energy use characteristics are defined in the LCC analysis. For ACUACs, DOE developed annual unit energy consumption values (UECs) by Census Division for each equipment class and efficiency level for the summer (May to September) and winter (October to April) seasons.

The average summer and winter electricity prices were used to measure the baseline energy cost. The summer and winter marginal prices, using a marginal load factor of 0.4, were used to measure the operating cost savings from higher-efficiency ACUACs.

EEI non-residential electricity prices are separated into three rate categories based on annual peak demand: (1) small commercial; (2) large commercial, and (3) industrial. The demand limits for small commercial, large commercial, and industrial are up to 100 kW, 100–1000 kW, and larger than 1000 kW, respectively. CBECS billing data, which includes monthly demand information, were used to calculate the total square footage assigned to each category based on annual peak demand, as a function of building type. For each building in the CBECS billing data, DOE mapped the building to a rate category based on the annual peak demand, and to a building type based on the CBECS Principal Building Activity. DOE calculated the total floor space associated with each building type and rate category, and used this to define, for each building type, a relative weight for each rate category. DOE then calculated a weighted-average (across rate categories) value of the average and marginal electricity price. DOE calculated the weighted-average for all Census Divisions, assuming the rate category weights do not depend on Census Division.

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

To estimate energy prices in future years, DOE multiplied the 2022 energy prices by the projection of annual average price changes for each of the nine Census Divisions from the Reference case in *AEO 2023,* which has an end year of 2050.[42] To estimate price trends after 2050, DOE kept the energy price constant at the 2050 value.

5. Maintenance and Repair Costs

Repair costs are associated with repairing or replacing equipment components that have failed in an appliance; maintenance costs are associated with maintaining the operation of the equipment. Typically, small incremental increases in equipment efficiency entail no, or only minor, changes in maintenance costs compared to baseline efficiency equipment. Therefore, DOE assumed no change in maintenance cost with efficiency level.

For repair costs, DOE used data from the January 2016 Direct Final Rule to estimate the baseline repair costs for ACUACs, and scaled these values to the current year based on data from the BLS for materials and labor costs, at yearly rates of 1.95 percent and 2.62 percent, respectively. DOE assumed repair costs are proportional to the equipment's manufacturer selling price, as associated with each efficiency level. The approach to determining the frequency of equipment repair is consistent with that in the January 2016 Direct Final Rule, and it includes non-compressor repairs conducted in the seventh year, for all consumers.

In response to the May 2020 ECS RFI, AHRI stated that the costs used in previous analyses do not reflect actual repair and maintenance costs and that typical maintenance costs are double the values in RS Means. (AHRI, EERE–2019–BT–STD–0042–0014 at p. 10) In contrast, Trane stated that the methodology used in the January 2016 Direct Final Rule is adequate, although an update to a more recent version of RS Means is appropriate. (Trane, EERE–2019–BT–STD–0042–0016 at p. 10) Trane and Goodman stated that repair and maintenance costs will rise for products using low-GWP refrigerants. (Trane, EERE–2019–BT–STD–0042–0016 at p. 10; Goodman, EERE–2019–BT–STD–0042–0017 at p. 4)

As stated previously, DOE reviewed the various LCC inputs at the February 9, 2023 webinar (EERE–2022–BT–STD–0015–0073 at pp. 25–35) and the March 21–22, 2023 meeting (EERE–2022–BT–STD–0015–0080 at pp. 35–47). At the March 22, 2023 ACUAC/HP Working Group meeting, AHRI and Daikin stated that the maintenance costs were too low. (EERE–2022–BT–STD–0015–0091 at pp. 21, 38–39) In the April 24, 2023 slide deck, DOE confirmed that the maintenance and repair cost numbers were based on negotiated inputs from the previous rulemaking, adjusted for inflation. (EERE–2022–BT–STD–0015–0086 at p. 3)

In response to AHRI, DOE notes that because maintenance costs do not change with efficiency level, they have no impact on the LCC results. In response to Trane, DOE notes that it did not update to a more recent version of RS Means due to additional adjustments made to repair and maintenance costs during the 2016 rulemaking, but it did update the 2016 costs by using the BLS scalars previously discussed. In response to Trane and Goodman, DOE has no data with respect to the impact of low-GWP refrigerants on repair and maintenance costs. This issue was not discussed during the 2023 ECS

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

[42] EIA, *Annual Energy Outlook 2023* (available at: *www.eia.gov/outlooks/aeo/*) (last accessed Oct. 1, 2023).

Negotiations. Furthermore, low-GWP refrigerants would be used at all efficiency levels in the analysis including the no-new-standards case, so any impacts would be independent of the amended standards.

Consequently, DOE continues to use the repair and maintenance costs as discussed during the ACUAC/HP Working Group meetings.

6. Equipment Lifetime

Equipment lifetime is the age at which a unit of covered equipment is retired from service. For the LCC and PBP analysis, DOE develops a distribution of lifetimes to reflect variability in equipment lifetimes in the field.

For small and large ACUAC equipment, DOE used the same lifetime as in the January 2016 Direct Final Rule, which had been developed based on a Weibull distribution. DOE assumed a mean lifetime of 21 years for small equipment classes, and a mean lifetime of 23 years for large equipment classes. For very large equipment classes, DOE created a new distribution with an assumed mean lifetime of 30 years, based on stakeholders' feedback during the 2023 ECS Negotiations. The maximum lifetimes were assumed to be 40 years for the small and large equipment classes and 60 years for the very large equipment classes.

In response to the May 2020 ECS RFI, AHRI disagreed with the Weibull approach to lifetimes and stated that service lifetimes are in the range of 12 to 15 years. (AHRI, EERE–2019–BT–STD–0042–0014 at p. 10) In contrast, Trane stated that the Weibull approach is appropriate and that equipment lifetime should be the same as in the January 2016 Direct Final Rule. (Trane, EERE–2019–BT–STD–0042–0016 at p. 10) Carrier stated that the lifetimes determined by the proposed approach seem reasonable. (Carrier, EERE–2019–BT–STD–0042–0013 at p. 14) AHRI and Carrier both stated that location is an important determinant of lifetime (*e.g.,* reduced lifetimes for units with more runtime hours or for units in coastal areas due to interactions with salt air). (AHRI, EERE–2019–BT–STD–0042–0014 at p.10; Carrier, EERE–2019–BT–STD–0042–0013 at p. 14)

At the March 22, 2023 ACUAC/HP Working Group meeting, there was discussion regarding whether the proposed lifetime as presented was really consistent with the previous rulemaking, as well as a suggestion that the average life of a 30-ton unit would be much shorter than 34 years. (EERE–2022–BT–STD–0015–0091 at pp. 18, 20, 36–38) In the April 24, 2023 slide deck, DOE confirmed that the lifetimes were consistent with those negotiated in the previous rulemaking. (EERE–2022–BT–STD–0015–0086 at p. 3) DOE noted that shipments modeling indicates that a much shorter lifetime, such as a 20-year lifetime, would result in approximately 50% more shipments than demonstrated in the AHRI data. Given that the CUAC market is saturated (*i.e.,* market penetrations are not increasing), about 95% of shipments are for the replacement market. On an average basis, the number of replacements that ship each year is equal to the total installed stock divided by the average lifetime. The total installed stock is an independently observed variable (for example, through CBECS surveys) and therefore cannot change when assumptions about the inputs to the shipments model are varied. This means that, if the equipment lifetime is decreased by a factor of ⅔, then the total shipments must increase by a factor of $3/2$ (*i.e.,* by 50%), to ensure that the installed stock remains constant. Similarly, if AHRI shipments are (for example) underestimated by 10%, then a roughly 10% reduction in mean lifetime would be needed to ensure the model results alight with the observed installed stock. Given the possibility of some uncertainty in AHRI shipments, and in response to ACUAC/HP Working Group discussions, DOE reduced the lifetime for very large equipment by approximately 10%, from 34 to 30 years. To provide further information on the importance of the assumed lifetimes for the LCC analysis, DOE also conducted a sensitivity analysis based on a 20-year lifetime. (*Id.*) The sensitivity analysis showed that consumers were only marginally but not significantly worse off under a 20-year timeline, as relatively heavy discounting in the later years of a unit's lifetime limits any impact. For example, for the very large equipment class at EL 1, under the 20-year scenario, the percent of consumers with net cost increased from 20 to 21% and the LCC savings decreased from $2053 to $1671. (*Id* at p. 14)

In this DFR, DOE continues to use lifetimes with a mean of 21, 23, and 30 years for the small, large, and very large equipment classes, respectively, as discussed in the April 24, 2023 slide deck. DOE is not including additional results for the 20-year-lifetime sensitivity in this direct final rule, but such results can be found in chapter 8 of the direct final rule TSD. In response to AHRI and Carrier, DOE does not assign lifetime based on location, but the distribution includes variability that addresses this issue.

7. Discount Rates

In the calculation of LCC, DOE applies discount rates appropriate to commercial buildings to estimate the present value of future operating cost savings. The discount rate used in the LCC analysis represents the rate from an individual consumer's perspective. DOE estimated a distribution of discount rates for ACUACs based on commercial consumer financing costs and the cost of capital for commercial applications.

For developing discount rates by commercial building type, DOE used the cost of capital to estimate the present value of cash flows to be derived from a typical company project or investment. Most companies use both debt and equity capital to fund investments, so the cost of capital is the weighted-average cost to the firm of equity and debt financing. This corporate finance approach is referred to as the weighted-average cost of capital. DOE used currently available economic data in developing commercial discount rates, with Damodaran Online being the primary data source.[43] The average discount rate across the commercial building types is 6.04 percent.

See chapter 8 of the final rule TSD for further details on the development of 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 equipment efficiencies under the no-new-standards case (*i.e.,* the case without amended or new energy conservation standards).

In response to the May 2020 ECS RFI, AHRI, Carrier, and Trane all commented that they expect the majority of shipments to remain close to the Federal minimum standard level after 2023. (AHRI, EERE–2019–BT–STD–0042–0014 at p. 11; Carrier, EERE–2019–BT–STD–0042–0013 at p. 15; Trane, EERE–2019–BT–STD–0042–0016 at p. 11) PGE stated that ACUACs purchased by customers are often chosen with the minimum required efficiency ratings. (PGE, EERE–2019–BT–STD–0042–0009 at p. 2)

In a presentation at an ACUAC/HP Working Group meeting, industry noted that approximately 65 percent of shipments are at baseline efficiency.

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

(EERE–2022–BT–STD–0015–0081 at p. 5) AHRI subsequently provided confidential data to a DOE contractor regarding shipments of ACUACs and ACUHPs by IEER. The data submitted by AHRI were gathered for 2018–2022; in these data, the market share of equipment with IEER above the 2023 standard is around 10–20 percent. This estimate is approximate, as the IEER bin boundaries in the provided data do not align exactly with either the 2018 or 2023 energy conservation standard levels. Under the 2023 standard, it is expected that a significant fraction of shipments will roll-up to the 2023 minimum, but possibly not the full 80–90% shown in the data; some fraction of shipments may shift to levels above the minimum.

To estimate the energy efficiency distribution of ACUACs for 2029, DOE also reviewed information from the 2015 ASRAC Working Group, combined with information presented during the negotiations on the relationship between the existing metric, IEER, and the new metric, IVEC. The 2015 ASRAC Working Group analysis used data submitted by AHRI to develop separate base-case efficiency distributions for the Small, Large, and Very Large equipment classes. That analysis separated equipment types into constant air volume (''CAV'') and VAV installations, with lower efficiency levels corresponding to CAV (fixed fan speed) designs. In the analysis presented here, DOE's engineering analysis considered only staged or variable-speed designs because its review of models available on the market after the January 1, 2023 compliance date of current standards and confidential discussions with manufacturers indicated that almost all models on the market today offer staged or variable-speed indoor fan designs and very few models, if any, offer single-speed indoor fan designs, even at EL0, implying that going forward, all installations will use some type of VAV equipment. The 2015 ASRAC Working Group base-case efficiency distribution for VAV equipment indicated approximately 15-percent market share for IEER values above the 2023 standard. This estimate is consistent with the confidential data provided by AHRI for the years 2018–2022.

To map the IEER levels to the new IVEC metric, DOE considered information presented during the 2023 ECS Negotiation meetings, specifically scatterplots of IEER vs. IVEC. These scatter plots show a fairly broad range of IVEC for a given band of IEER. For example, for Small ACUACs, for IEER approximately equal to 14.8 (the current standard), the range of plotted IVEC is 10–14. Hence, it seems reasonable to assume that when the market transitions to the new IVEC metric, designs that cluster near a single value of IEER would cover a range of IVEC, and some would, therefore, fall into higher efficiency levels as defined by the IVEC metric. For this reason, DOE assumed 70 percent of equipment at baseline and distributed 30 percent of equipment to higher IVEC-based ELs. For ELs in this direct final rule analysis that did not exist in the 2015 ASRAC analysis, DOE assumed zero market share in the base case.

The estimated market shares for the no-new-standards case for are shown in Table IV.12. See chapter 8 of the direct final rule TSD for further information on the derivation of the efficiency distributions.

Table IV.12 Market Shares for the No-New-Standards Case in the Compliance Year

EL	Small			Large			Very Large		
	IEER	IVEC	Market Share	IEER	IVEC	Market Share	IEER	IVEC	Market Share
0	14.8	10.6	70%	14.2	12	70%	13.2	12	70%
1	15.4	11.6	10%	14.6	12.9	15%	13.5	12.9	30%
2	15.8	12.5	10%	15	13.8	15%	15.5	15.2	-
3	17	13.1	10%	17.5	15.7	-	18.5	18.3	-
4	18	14.3	-	20.1	19.5	-	-	-	-
5	19.9	14.9	-	-	-	-	-	-	-
6	21	16.4	-	-	-	-	-	-	-
7	22.4	18.7	-	-	-	-	-	-	-

DOE notes that the market shares in Table IV.12 are based on shipments data, as described in the preceding paragraphs. DOE also reviewed model counts in the industry-provided dataset and observed models at ELs shown in this table as having zero shipments. It is common for there to be significantly more models (as a percentage of the total) than shipments at higher efficiency levels; there tend to be more shipments per model at lower efficiency levels. However, DOE acknowledges that there are likely to be non-zero shipments at higher ELs where there are models available. Therefore, DOE has performed a sensitivity analysis for small CUACs that distributes the 30% market share above baseline to the first four ELs (7.5% each) rather than 10% each at the first three ELs, as shown in the table. The results of this sensitivity can be found in Chapter 10 of the TSD.

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

While DOE expects economic factors to play a role when consumers, commercial building owners, or builders decide on what type of ACUAC to install, assignment of equipment efficiency for a given installation based solely on economic measures such as life-cycle cost or simple payback period, would not accurately reflect most real-world installations. There are a number of market failures discussed in the economics literature that illustrate how purchasing decisions with respect to energy efficiency are unlikely to be perfectly correlated with energy use, as described subsequently. DOE finds that the method of assignment, which is in part random, simulates behavior in the ACUAC market, where market failures result in purchasing decisions not being perfectly aligned with economic interests. DOE further emphasizes that its approach does not assume that all purchasers of ACUACs make economically irrational decisions (*i.e.,* the lack of a correlation is not the same as a negative correlation). As part of the random assignment, some buildings with large cooling loads will be assigned higher-efficiency ACUACs, and some buildings with particularly low cooling loads will be assigned baseline ACUACs, which aligns with the available data.

The following discussion provides more detail about the various market failures that affect ACUAC purchases. First, a recognized problem in commercial settings is the split incentive problem, where the building owner (or building developer) selects the equipment, and the tenant (or subsequent building owner) pays for energy costs.[44] [45] There are other similarly misaligned incentives embedded in the organizational structure within a given firm or business that can impact the choice of an ACUAC. For example, if one department or individual within an organization is responsible for capital expenditures (and therefore equipment selection) while a separate department or individual is responsible for paying the energy bills, a market failure similar to the split-incentive problem can result.[46] Additionally, managers may have other responsibilities and often have other incentives besides operating cost minimization, such as satisfying shareholder expectations, which can sometimes be focused on short-term returns.[47] Decision-making related to commercial buildings is highly complex and involves gathering information from and for a variety of different market actors. It is common to see conflicting goals across various actors within the same organization, as well as information asymmetries between market actors in the energy efficiency context in commercial building construction.[48]

The arguments for the existence of market failures in the commercial and industrial sectors are corroborated by empirical evidence. One study in particular showed evidence of substantial gains in energy efficiency that could have been achieved without negative repercussions on profitability, but the investments had not been undertaken by firms.[49] The study found that multiple organizational and institutional factors caused firms to require shorter payback periods and higher returns than the cost of capital for alternative investments of similar risk. Another study demonstrated similar results with firms requiring very short payback periods of 1–2 years in order to adopt energy-saving projects, implying hurdle rates of 50 to 100 percent, despite the potential economic benefits.[50]

If DOE developed an efficiency distribution that assigned ACUAC efficiency in the no-new-standards case solely according to energy use or economic considerations such as life-cycle cost or payback period, the resulting distribution of efficiencies within the consumer sample would not reflect any of the market failures above. Thus, DOE concludes such a distribution would not be representative of the ACUAC market.

The use of random assignment is not an assertion of economic irrationality, but instead, it is a methodological approximation of complex consumer behavior. The analysis is neither biased toward high or low energy savings. The methodology does not preferentially assign lower-efficiency ACUACs to buildings in the no-new-standards case where savings from the rule would be greatest, nor does it preferentially assign lower-efficiency ACUACs to buildings in the no-new-standards case where savings from the rule would be smallest. Some consumers were assigned the ACUACs that they would have chosen if they had engaged in perfect economic considerations when purchasing the products. Others were assigned less-efficient ACUACs even where a more-efficient product would eventually result in life-cycle savings, simulating scenarios where, for example, various market failures prevent consumers from realizing those savings. Still others were assigned ACUACs that were *more* efficient than one would expect simply from life-cycle costs analysis, reflecting, say, "green" behavior, whereby consumers ascribe independent value to minimizing harm to the environment.

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 equipment, compared to baseline equipment, through energy cost savings. Payback periods that exceed the life of the equipment mean that the increased total installed cost is not recovered in reduced operating expenses.

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

G. Shipments Analysis

DOE uses projections of annual equipment shipments to calculate the national impacts of potential amended or new energy conservation standards on energy use, NPV, and future manufacturer cash flows.[51] The shipments model takes an accounting approach, tracking market shares of each equipment class and the vintage of units in the stock. Stock accounting uses equipment shipments as inputs to estimate the age distribution of in-service equipment stocks for all years. The age distribution of in-service equipment stocks is a key input to calculations of both the NES and NPV,

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

[45] Blum, H. and Sathaye, J. (2010). "Quantitative Analysis of the Principal-Agent Problem in Commercial Buildings in the U.S.: Focus on Central Space Heating and Cooling," Lawrence Berkeley National Laboratory, LBNL–3557E (available at: *escholarship.org/uc/item/6p1525mg*) (last accessed March 14, 2024).

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

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

[48] International Energy Agency (IEA) (2007). Mind the Gap: Quantifying Principal-Agent Problems in Energy Efficiency. OECD Pub. (available at *www.iea.org/reports/mind-the-gap*) (last accessed March 14, 2024).

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

[50] Andersen, S.T., and Newell, R.G. (2004). "Information programs for technology adoption: the case of energy-efficiency audits," *Resource and Energy Economics,* 26, 27–50.

[51] 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.

because operating costs for any year depend on the age distribution of the stock.

For the current analysis, DOE assumed that any new energy conservation standards for ACUAC and ACUHP would require compliance in 2029. Thus, all units purchased starting in 2029 are affected by the standard level. DOE's analysis considered shipments over a 30-year period, in this case from 2029 through 2058.

To project annual shipments over the analysis period, DOE used key drivers, including floor space forecasts, saturations, and product lifetimes, to project shipments of small, large, and very large air-cooled ACUAC and ACUHP in each market segment, which are then aggregated to estimate total shipments. DOE considered two market segments: (1) shipments to new construction, (2) shipments to existing buildings for replacement.

1. New Shipments

Shipments to new buildings are driven by market saturations (number of units per square foot) and new floor space constructed in each year. DOE assumed that the market saturations for each equipment type of ACUAC and ACUHP stay constant over the analysis period. Table IV.13 shows the saturation for each equipment class:

Table IV.13 Saturation by Each ACUAC and ACUHP Equipment Class

Equipment Class	ACUAC ≥65 and <135 kBtu/h	ACUAC ≥135 and <240 kBtu/h	ACUAC ≥240 and <760 kBtu/h	ACUHP ≥65 and <135 kBtu/h	ACUHP ≥135 and <240 kBtu/h	ACUHP ≥240- and <760 kBtu/h
unit/million sq. ft.	71.46	28.46	9.12	7.94	1.50	0.48

DOE obtained the new floor space projections from the *Annual Energy Outlook 2023* (*AEO 2023*) [52] reference case for the commercial sector.

2. Replacement Shipments

Shipments to existing buildings for replacement are calculated using an accounting framework involving initial shipments and a retirement function. The shipments model is initialized in the present year (2023) with a distribution by vintage for ages up to the maximum lifetime, in this case 60 years. The vintage distribution is obtained from the 2015 rulemaking which is calibrated by the AHRI shipments in 2013. Specifically, the shipments total in 2013 is set equal to the AHRI total in the same year. While AHRI data were available up to 2022, market conditions have led to an irregular shipments pattern. In order to smooth the projection, DOE calibrated to 2013 and used model projections for the period up to 2022. Numerically, the quantity that impacts the NES and NPV calculation is cumulative shipments; DOE confirmed that the difference between cumulative shipments for the model projection vs. AHRI historic data is 1 percent or less. The retirement function is based on a failure probability distribution consistent with LCC calculations described in section IV.F.6 of this document.

3. Stock Calculation

The number units in the existing stock in each year is equal to the sum of total units shipped the same year and the stock in the previous year, with the retired units of the same year removed. The number of 0-year-old units is equal to the number of total units purchased in the same year. As the year is incremented from y − 1 to y, a fraction of the stock is removed; that fraction is determined by survival probability, which uses shipments lifetimes, as discussed in previous section.

4. Comments

In response to the May 2020 ECS RFI, AHRI, Carrier, Goodman, and Trane all commented that historical shipments would not accurately portray the market for ACUACs and ACUHPs, as the impacts of COVID–19 on the HVAC industry are not yet known. (AHRI, EERE–2019–BT–STD–0042–0014 at p. 11; Carrier, EERE–2019–BT–STD–0042–0013 at p. 16; Goodman, EERE–2019–BT–STD–0042–0017 at p. 4; Trane, EERE–2019–BT–STD–0042–0016 at p. 11) AHRI also commented that computer room air conditioner shipments were likely included as ACUAC and ACUHP shipments in the previous rulemaking and that those shipments should be removed in any future shipments analysis for ACUAC and ACUHP. (AHRI, EERE–2019–BT–STD–0042–0014 at p. 11)

Carrier commented that the higher cost of higher-efficiency equipment will lead more customers to repair rather than replace, although the company does not anticipate a change in failure rates or equipment lifetimes. (Carrier, EERE–2019–BT–STD–0042–0013 at p. 15)

PGE stated that the current marketplace split between ACUACs and ACUHPs is estimated at 85 percent to 15 percent. (PGE, EERE–2019–BT–STD–0042–0009 at p. 2) In response to the May 2022 TP/ECS RFI, the CA IOUs stated that while CUHPs are still a small fraction of the market, they expected that CUHPs will play an important role in non-residential space heating electrification efforts in the coming decades. The CA IOUs added that the Consortium for Energy Efficiency's 2019 overview of CUAC/HP programs indicate that States in ASHRAE climate zones two to five are incentivizing electric-only CUHPs. (CA IOUs, EERE–2022–BT–STD–0015–0012 at pp. 4–5) In a presentation at an ACUAC/HP Working Group meeting, industry noted that approximately 10 percent of shipments are heat pumps. (EERE–2022–BT–STD–0015–0081 at p. 6)

DOE reviewed its shipments methodology presented at the February 9, 2023 webinar (EERE–2022–BT–STD–0015–0073 at pp. 37–43), the February 22–23, 2023 ACUAC/HP Working Group meeting ((EERE–2022–BT–STD–0015–0078 at p. 38–40), and the March 21–22, 2023 ACUAC/HP Working Group meeting (EERE–2022–BT–STD–0015–0080 at pp. 49–54). While DOE acknowledges that the impact of COVID–19 on the HVAC industry were unknown at the time that stakeholders submitted comments on the May 2020 ECS RFI, it is DOE practice to use projections of economic and demographic data from the *AEO* as inputs to the DOE shipments and NIA models. These projections account, to the extent possible, for near-term economic impacts and long-term expectations. By the time of publication of this direct final rule, COVID–19-related supply chain issues have largely resolved, so DOE expects that *AEO 2023* continues to provide the best available

[52] EIA, *Annual Energy Outlook 2023* (available at: *www.eia.gov/outlooks/aeo/*) (last accessed Oct. 1, 2023).

source to gauge future shipments of ACUACs and ACUHPs.

In addition, DOE reviewed publicly-available data from the AHRI website and notes that, while the market share of heat pumps aggregated across all size classes is increasing, this increase is dominated by the residential size classes (below 60,000 Btu/hr). DOE recommended that the ACUAC/HP Working Group base its analysis on an assumption that 10-percent of Small unitary product shipments are heat pumps rather than air conditioning only products, and 5-percent of Large and Very Large product shipments are heat pumps, to which the ACUAC/HP Working Group did not disagree. DOE examined *AEO 2023* projections of the market share split between air conditioners and heat pumps and noted that, while there is a significant trend of increasing market share for residential heat pumps, the trend in the commercial sector is much weaker, with less than a 2-percent shift from rooftop AC to HP over 30 years. Furthermore, DOE does not expect that the marginal differences in standard level between ACUACs with all other types of heat and ACUHPs, as discussed in sections III.A and IV.C.2.a, are large enough to cause any significant difference in commercial consumer purchasing decisions. Hence, DOE held the ACUHP market shares constant over the analysis period and did not model any shift from ACUAC-furnace installations to ACUHP installations in either the base case or the standards cases.

Regarding AHRI's comment that computer room air conditioner shipments may have been included historically, DOE notes that this is not clear as computer room air conditioners were added to the scope of ASHRAE Standard 90.1 rather than being carved out of existing ACUAC equipment classes. If any computer room air conditioner shipments were included, DOE expects it would represent a small fraction of total shipments and have limited effects on the analysis. In addition, this concern was not brought up in the context of any ASHRAE Working Group discussions regarding shipments, suggesting that it is not likely a significant issue. For these reasons, DOE has not adjusted total shipments to account for computer room air conditioners.

With regard to the repair *vs.* replace decision, DOE noted during the 2023 ECS Negotiations that, while this issue had been discussed extensively in the 2015 ASRAC negotiations, the impact of this model feature on the policy decision is minimal. Quantitatively, the impact of repairing rather than replacing some fraction of the stock is just to delay the time at which the equipment is replaced; as the lifetime energy use of the equipment is counted in the NES, a delay in the time of replacement has a limited impact on the NES metric. It is also important to note that DOE used the equipment economic lifetime in its analyses (*i.e.,* the time to replacement). It is possible, and even likely, that this observed economic lifetime includes the effect of life-extending equipment repairs in the no-new-standards case. In modeling terms, the question is: which consumers who would have replaced the unit in the no-new-standards case would instead repair it in the standards case? This decision is driven by the difference between the cost of repairing an existing unit, and the incremental cost of a new, more efficient unit. DOE estimated the cost of repair, as discussed in section IV.F.5 of this document, and compared this to the increase in total installed cost (''TIC'') at higher standard levels. Based on this comparison, the increase in units being repaired vs. replaced would be negligible except at max-tech levels, and in this direct final rule, DOE is not adopting max-tech levels.

H. National Impact Analysis

The NIA assesses the NES and the NPV from a national perspective of total consumer costs and savings that would be expected to result from new or amended standards at specific efficiency levels.[53] (''Consumer'' in this context refers to consumers of the equipment being regulated.) DOE calculates the NES and NPV for the potential standard levels considered based on projections of annual equipment shipments, along with the annual energy consumption and total installed cost data from the energy use and LCC analyses.[54] For the present analysis, DOE projected the energy savings, operating cost savings, equipment costs, and NPV of consumer benefits over the lifetime of ACUACs and ACUHPs sold from 2029 through 2058.

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 equipment 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 equipment 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 equipment with efficiencies greater than the standard.

DOE uses a computer 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 computer model uses typical values (as opposed to probability distributions) as inputs.

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

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

[54] For the NIA, DOE adjusts the installed cost data from the LCC analysis to exclude sales tax, which is a transfer.

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

Inputs	Method
Shipments	Annual shipments from shipments model (*see* section IV.G, Shipments Analysis, of this document).
Compliance Date of Standard	January 1, 2029
Efficiency Trends	No-new-standards case: Constant throughout the analysis period. Standard cases: Roll-up to the considered TSL starting from the compliance year.
Annual Energy Consumption per Unit	Annual weighted-average values are a function of shipments-weighted unit energy consumption (UEC).
Total Installed Cost per Unit	Annual weighted-average values are a function of the efficiency distribution (*see* section IV.F, LCC Analysis, of this document).
Annual Energy Cost per Unit	Annual weighted-average values as a function of the annual shipments-weighted unit energy consumption ("UEC") and energy prices at each efficiency level (*see* section IV.E, Energy Use, and section IV.F.4, Energy Prices, of this document).
Repair and Maintenance Cost per Unit	Annual values as a function of efficiency level (*see* section IV.F, LCC analysis, of this document).
Energy Price Trends	Based on Energy Information Administration's ("EIA"'s) *Annual Energy Outlook* (*AEO*) *2023* Reference case projections to 2050 and extrapolation thereafter.
Energy Site-to-Primary and FFC Conversion	Developed to include the energy consumed in extracting, processing, and transporting or distributing primary fuels. It is a time-series conversion factor based on *AEO 2023*.
Discount Rate	Three and seven percent.
Present Year	2024

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DOE discussed its NIA methodology at the February 9, 2023 webinar (EERE–2022–BT–STD–0015–0073 at pp. 44–48) and the March 21–22, 2023 ACUAC/HP Working Group meeting (EERE–2022–BT–STD–0015–0080 at pp. 55–62). There was not any discussion on the NIA methodology during these meetings.

As discussed in section IV.C.3 of this document, DOE did not conduct an LCC analysis for ACUHPs. The energy use analysis calculated the cooling and ventilation energy use for ACUACs and is also representative of the cooling and ventilation energy use for ACUHPs, but the energy use analysis did not calculate the energy use for the heating end-use for ACUHPs. Instead, the data that are output from the LCC for input to the NIA were adjusted to include the heating energy use, operating cost, and related savings for ACUHPs. The NIA also accounted for slightly higher MSPs for ACUHPs, as described in section IV.C, Engineering Analysis, of this document. DOE used the higher MSP for ACUHPs provided by the engineering analysis, but the Department assumed the same installation costs when estimating the total installed cost for ACUHPs.

When considering ACUHPs, DOE made two adjustments to the EL0 LCC sample-averaged output:

- DOE defined a heating energy adder for ACUHPs, based on CBECS 2018. The CBECS includes estimates of cooling, ventilation, and heating energy use for packaged heat pumps. For those buildings using heat pumps for heating, DOE calculated the ratio of energy use for heating, cooling, and ventilation to the energy use for cooling and ventilation only. This ratio is 1.22, which means that for every kwh of cooling and ventilation energy use, on average, ACUHPs would use an additional 0.22 kwh for heating. DOE assumed that this ratio is constant across equipment classes, and added the heating energy use to the sample-average energy use output by the LCC to define total annual energy use.
- DOE calculated a sample-average energy price for each equipment class as the ratio of sample-average annual operating cost to the sample-average annual energy consumption for cooling and ventilation. DOE applied this average price to the heating energy use to estimate the total annual operating cost for ACUHPs.

At higher ELs, DOE estimated the heating energy use as the EL0 value multiplied by the ratio of IVHE at the considered EL (IVHE increases with higher efficiency). DOE added this modified heating energy use to the cooling and ventilation energy use output by the LCC to get the total energy use for ACUHPs at each EL. DOE applied the LCC sample-average energy price to calculate the total operating cost for ACUHPs at each EL.

These summary data, accounting for all energy use and costs for both ACUACs and ACUHPs, were then input to the NIA calculation.

In response to the May 2020 ECS RFI, PGE stated that ACUHPs have significant advantages for customers over ACUACs, as they provide both heating and cooling and, therefore, provide for: (1) lower operating and maintenance costs; (2) decreases in greenhouse gas and localized air pollution; and (3) longer life spans for the equipment. (PGE, EERE–2019–BT–STD–0042–0009 at p. 2) PGE stated that ACUHPs, on average, are sold at higher efficiency ratings compared to ACUACs. Customers choosing heat pump technology use it for both heating and cooling needs, thereby driving greater efficiency gains during both peak seasons. Additionally, in Northern climates, the run time for equipment is substantially higher, so there is a natural tendency to buy more efficient, less expensive units to operate. (*Id.*)

As stated, DOE has incorporated ACUHPs into its NIA analysis. DOE has not identified a different efficiency distribution or different lifetimes for this equipment. However, the NIA does account for heating energy use.

1. Equipment Efficiency Trends

A key component of the NIA is the trend in energy efficiency projected for the no-new-standards case and each of the standards cases. Section IV.F.8 of this document describes how DOE developed an energy efficiency distribution for the no-new-standards case (which yields a shipment-weighted average efficiency) for each of the considered equipment classes for the year of anticipated compliance with an amended or new standard (2029). To project the trend in efficiency absent amended standards for ACUACs and ACUHPs over the entire shipments projection period, DOE held the efficiency distribution constant, as historical data based on IEER may not be indicative of potential trends in IVEC.

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 (2029). In this scenario, the market shares of equipment in the no-new-standards case that do not meet the standard under consideration would ''roll up'' to meet the new standard level, and the market share of equipment above the standard would remain unchanged.

To develop standards-case efficiency trends after 2029, DOE also held the efficiency distribution constant at the rolled-up levels, for similar reasons as in the no-new-standards case.

2. National Energy Savings

The national energy savings analysis involves a comparison of national energy consumption of the considered equipment between each potential standards case (''TSL'') and the case with no new or amended energy conservation standards. DOE calculated the national energy consumption by multiplying the number of units (stock) of each equipment (by vintage or age) by the unit energy consumption (also by vintage). DOE calculated annual NES based on the difference in national energy consumption for the no-new-standards case and for each higher-efficiency standard case. DOE estimated energy consumption and savings based on site energy and converted the electricity consumption and savings to primary energy (*i.e.,* the energy consumed by power plants to generate site electricity) using annual conversion factors derived from *AEO 2023.* Cumulative energy savings are the sum of the NES for each year over the timeframe of the analysis.

Use of higher-efficiency equipment is sometimes associated with a direct rebound effect, which refers to an increase in utilization of the equipment due to the increase in efficiency. DOE did not consider a direct rebound effect for ACUACs and ACUHPs. An important reason for this decision is that in contrast to residential heating and cooling, HVAC operation adjustment in commercial buildings is driven primarily by building managers or owners. The comfort conditions are already established in order to satisfy the occupants, and they are unlikely to change due to installation of higher-efficiency equipment. While it is possible that a small degree of rebound could occur for higher-efficiency ACUACs and ACUHPs, there is no basis to select a specific value. Because the available information suggests that any rebound would be small to negligible, DOE did not include a rebound effect for the direct final rule.

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 (August 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 (August 17, 2012). NEMS is a public domain, multi-sector, partial equilibrium model of the U.S. energy sector [55] that EIA uses to prepare its *Annual Energy Outlook.* The FFC factors incorporate losses in production and delivery in the case of natural gas (including fugitive emissions) and additional energy used to produce and deliver the various fuels used by power plants. The approach used for deriving FFC measures of energy use and emissions is described in appendix 10B of the 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 equipment shipped during the projection period.

As discussed in section IV.F.1 of this document, DOE developed ACUACs and ACUHPs price trends based on historical PPI data. DOE applied the same trends to project prices for each equipment class at each considered efficiency level. For ACUACs and ACUHPs, DOE has used a constant default price trend. DOE's projection of equipment prices is described in appendix 10C of the direct final rule TSD.

To evaluate the effect of uncertainty regarding the price trend estimates, DOE investigated the impact of different equipment price projections on the consumer NPV for the considered TSLs for ACUACs and ACUHPs. In addition to the default price trend, DOE considered two equipment price sensitivity cases: (1) an increasing trend based on the same PPI data but only the years 2000 to 2022 and (2) a decreasing trend based on the same PPI data but only the years 1978 to 2000. 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 are energy cost savings, which are calculated using the estimated energy savings in each year and the projected price of the appropriate form of energy. To estimate energy prices in future years, DOE multiplied the average regional energy prices by the projection of annual national-average residential energy price changes in the Reference case from *AEO 2023,* which has an end year of 2050. Price trends onwards are held constant at 2050 level. As part of the NIA, DOE also analyzed scenarios that used inputs from variants of the *AEO 2023* Reference case that have lower and higher economic growth. Those cases have lower and higher energy price

[55] For more information on NEMS, refer to *The National Energy Modeling System: An Overview,* DOE/EIA–0581(2023), May 2023 (available at: *www.eia.gov/outlooks/aeo/nems/overview/pdf/0581(2023).pdf*) (last accessed Oct. 23, 2023).

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.[56] The discount rates for the determination of NPV are in contrast to the discount rates used in the LCC analysis, which are designed to reflect a consumer's perspective. The 7-percent real value is an estimate of the average before-tax rate of return to private capital in the U.S. economy. The 3-percent real value represents the ''social rate of time preference,'' which is the rate at which society discounts future consumption flows to their present value.

I. Consumer Subgroup Analysis

In analyzing the potential impact of new or amended energy conservation standards on consumers, DOE evaluates the impact on identifiable subgroups of consumers that may be disproportionately affected by a new or amended national standard. The purpose of a subgroup analysis is to determine the extent of any such disproportional impacts. DOE evaluates impacts on particular subgroups of consumers by analyzing the LCC impacts and PBP for those particular consumers from alternative standard levels. For this direct final rule, DOE analyzed the impacts of the considered standard levels on one subgroup: small businesses. The analysis used subsets of the LCC sample composed of buildings that meet the criteria for the considered subgroup. Additionally, electricity prices and discount rates were updated to be representative of small businesses. DOE used the LCC and PBP computer model to estimate the impacts of the considered efficiency levels on this subgroup. 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 amended energy conservation standards on manufacturers of ACUACs and ACUHPs and to estimate the potential impacts of such standards on domestic employment, manufacturing capacity, and cumulative regulatory burden for those manufacturers. The MIA has both quantitative and qualitative aspects. The quantitative part of the MIA includes analyses of projected industry cash flows, the INPV, additional investments in research and development (''R&D'') and manufacturing capital necessary to comply with amended standards, and potential impacts on domestic manufacturing employment. Additionally, the MIA seeks to qualitatively determine how amended energy conservation standards might affect manufacturing capacity and competition, as well as how standards contribute to manufacturers' overall regulatory burden. Finally, the MIA serves to identify any disproportionate impacts on manufacturer subgroups, including small business manufacturers.

The quantitative part of the MIA primarily relies on the GRIM,[57] 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, equipment shipments, manufacturer markups, and investments in R&D and manufacturing capital required to produce compliant equipment. 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 on domestic manufacturing employment. The model uses standard accounting principles to estimate the impacts of more-stringent energy conservation standards on the ACUAC and ACUHP manufacturing industry by comparing changes in INPV and domestic manufacturing employment between the no-new-standards case and the various standards cases (*i.e.,* ''TSLs''). To capture the uncertainty relating to manufacturer pricing strategies following amended 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 regulatory burden 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 ACUAC and ACUHP manufacturing industry based on the market and technology assessment, preliminary manufacturer interviews, and publicly-available information. This included a top-down analysis of ACUAC and ACUHP 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''); R&D expenses; and tax rates). DOE also used public sources of information to further calibrate its initial characterization of the ACUAC and ACUHP manufacturing industry, including company filings of form 10–K from the SEC,[58] corporate annual reports, the U.S. Census Bureau's *Annual Survey of Manufactures,*[59] and reports from Dun & Bradstreet.[60]

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

In addition, during Phase 2, DOE developed interview guides to distribute

[56] U.S. Office of Management and Budget, *Circular A–4: Regulatory Analysis* (available at: *www.whitehouse.gov/omb/information-for-agencies/circulars/*) (last accessed Dec. 11, 2023). DOE used the prior version of Circular A–4 (2003) as a result of the March 1, 2024, effective date of the new version.

[57] A copy of the GRIM spreadsheet tool is available on the DOE website for this rulemaking at *www.regulations.gov/docket/EERE-2022-BT-STD-0015/document.*

[58] U.S. Securities and Exchange Commission, Annual 10–K Reports (Various Years) (available at: *www.sec.gov/edgar/searchedgar/companysearch.html*) (last accessed Oct. 3, 2023).

[59] U.S. Census Bureau, Annual Survey of Manufactures: General Statistics: Statistics for Industry Groups and Industries (2021) (available at: *www.census.gov/programs-surveys/asm/data/tables.html*) (last accessed Dec. 5, 2023).

[60] Dun & Bradstreet Company Profiles, Various Companies (available at: *app.dnbhoovers.com*) (last accessed Oct. 3, 2023).

to manufacturers of ACUACs and ACUHPs in order to develop other key GRIM inputs, including equipment and capital conversion costs, and to gather additional information on the anticipated effects of amended energy conservation standards on revenues, direct employment, capital assets, industry competitiveness, and manufacturer subgroup impacts.

In Phase 3 of the MIA, DOE's contractor conducted structured, detailed interviews with representative ACUAC and ACUHP manufacturers. During these interviews, DOE's contractor discussed efficiency levels, design options, and conversion costs to validate assumptions used in the GRIM. As part of Phase 3, DOE also evaluated subgroups of manufacturers that may be disproportionately impacted by amended standards or that may not be accurately represented by the average cost assumptions used to develop the industry cash-flow analysis. Such manufacturer subgroups may include small business manufacturers, low-volume manufacturers, niche players, and/or manufacturers exhibiting a cost structure that largely differs from the industry average, all of whom could be disproportionately affected by amended energy conservation standards. DOE identified one subgroup for a separate impact analysis: small business manufacturers. The small business subgroup is discussed 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 over time due to new or amended energy conservation standards that result in a higher or lower INPV. The GRIM uses a standard, annual discounted cash-flow analysis that incorporates manufacturer costs, markups, shipments, and industry financial information as inputs. The GRIM models changes in costs, distribution of shipments, investments, and manufacturer margins that could result from an amended energy conservation standard. The GRIM spreadsheet uses the inputs to arrive at a series of annual cash flows, beginning in 2024 (the reference year of the analysis) and continuing to 2058 (the terminal year of the analysis). DOE calculated INPVs by summing the stream of annual discounted cash flows during this period. For manufacturers of ACUACs and ACUHPs, DOE used a real discount rate of 5.9 percent, which was derived from industry financials (*i.e.,* corporate annual reports and public filings to the Securities and Exchange Commission (SEC 10–Ks)).

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 new or amended energy conservation standard on manufacturers. As discussed previously, DOE developed critical GRIM inputs using a number of sources, including publicly-available data, results of the engineering analysis, and information gathered from industry stakeholders during the course of manufacturer interviews and subsequent ACUAC/HP Working Group meetings. 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 equipment is typically more expensive than manufacturing baseline equipment due to the use of more complex components, which are typically more costly than baseline components. The changes in the MPCs of covered equipment can affect the shipments, revenues, gross margins, and cash flow of the industry. In this rulemaking, DOE relies on an efficiency-level approach for small, large, and very large ACUACs/HPs. For a complete description of the MPCs, see section IV.C of this document and 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 and equipment class. 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 2024 (the base year) to 2058 (the end year of the analysis period). In the shipments analysis (*see* section IV.G of this document), DOE estimates the distribution of efficiencies in the no-new-standards case and standards cases for all equipment classes.

For the standards cases in the NIA, DOE used a ''roll-up'' scenario to establish the shipment-weighted efficiency for the year that standards are assumed to become effective (2029). In this scenario, the market shares of equipment in the no-new-standards case that do not meet the standard under consideration would ''roll up'' to meet the new standard level, and the market share of equipment above the standard would remain unchanged. For a complete description of the shipments analysis, *see* section IV.G of this document and chapter 9 of the direct final rule TSD.

c. Capital and Product Conversion Costs

Amended energy conservation standards could cause manufacturers to incur one-time conversion costs to bring their production facilities and equipment designs into compliance. DOE evaluated the level of conversion-related expenditures that would be needed to comply with each considered efficiency level in each equipment 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 one-time investments in property, plant, and equipment necessary to adapt or change existing production facilities such that new, compliant equipment designs can be fabricated and assembled. Product conversion costs are one-time investments in research, development, testing, marketing, and other non-capitalized costs necessary to make equipment designs comply with amended energy conservation standards.

DOE relied on manufacturer feedback to evaluate the level of capital and product conversion costs manufacturers would likely incur at the various TSLs. DOE contractors conducted interviews with six manufacturers of small, large, and very large ACUACs and ACUHPs. The interviewed manufacturers account for approximately 90 percent of unit sales in the industry.

During confidential interviews, DOE's contractor asked manufacturers to estimate the capital conversion costs (*e.g.,* changes in production processes, equipment, and tooling) to meet the various efficiency levels. The capital conversion cost feedback from these interviews was then scaled using market share estimates to estimate total industry capital conversion costs. Manufacturers were also asked to estimate the redesign effort and engineering resources required at various efficiency levels to quantify the product conversion costs. DOE also relied on data submitted throughout the 2023 ECS Negotiations to estimate product conversion costs. Specifically, manufacturers submitted data simulating IVEC ratings for existing models currently rated under IEER as part of the 2023 ECS Negotiations. DOE reviewed the product conversion cost feedback from interviews at each efficiency level and then compared the IVEC simulation data provided during the 2023 ECS Negotiations to IEER data from the CCD in order to extrapolate the number of models industry would need to redesign under amended standards. Based on manufacturer feedback, DOE estimated some industry conversion costs associated with the transition in energy efficiency metrics from IEER to IVEC. To estimate total industry product conversion costs, DOE multiplied the development redesign estimate at each efficiency level for each equipment class by the estimated number of industry basic models in CCD that would require redesign. Manufacturer data were aggregated to better reflect the industry as a whole and to protect confidential information.

Industry conversion costs for the adopted standard (*i.e.,* TSL 3, the Recommended TSL) total $288.0 million. It consists of $70.8 million in capital conversion costs and $217.2 million in product conversion costs.

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. The conversion cost figures used in the GRIM can be found in section V.B.2 of this document. For additional information on the estimated capital and product conversion costs, see chapter 12 of the direct final rule TSD.

d. Manufacturer Markup Scenarios

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

Under the preservation of gross margin percentage scenario, DOE applied a single uniform ''gross margin percentage'' across all efficiency levels, which assumes that following amended standards, manufacturers would be able to maintain the same amount of profit as a percentage of revenues at all efficiency levels within an equipment class. As manufacturer production costs increase with efficiency, this scenario implies that the per-unit dollar profit will increase. Based on publicly-available financial information for ACUAC and ACUHP manufacturers, as well as comments from manufacturer interviews, DOE estimated average gross margin percentages of 23 percent for small ACUACs, 24 percent for small ACUHPs, 25 percent for large ACUACs, 26 percent for large ACUHPs, 29 percent for very large ACUACs, and 30 percent for very large ACUHPs.[61] Manufacturers tend to believe it is optimistic to assume that they would be able to maintain the same gross margin percentage as their production costs increase, particularly for minimally-efficient products. Therefore, this scenario represents a high bound to industry profitability under new or amended energy conservation standard, because manufacturers can fully pass on incremental increases in production costs due to standards to consumers.

Under the preservation of operating profit scenario, DOE modeled a situation in which manufacturers are not able to increase per-unit operating profit in proportion to increases in manufacturer production costs. In the preservation of operating profit scenario, as the cost of production goes up under a standards case, manufacturers are generally required to reduce their manufacturer markups (*i.e.,* margins) to a level that maintains base-case operating profit, which allows them to maintain a cost-competitive offering in the market. DOE implemented this scenario in the GRIM by lowering the manufacturer markups at each TSL to yield approximately the same earnings before interest and taxes in the standards case as in the no-new-standards case in the year after the compliance date of the amended standards. In this scenario, manufacturers maintain their total operating profit in absolute dollars in the standards case, despite higher equipment costs and investment. Therefore, gross margin (as a percentage) shrinks in the standards case for minimally-compliant equipment. The implicit assumption behind this scenario is that the industry can only maintain its operating profit in absolute dollars after the standard. This manufacturer markup scenario represents the lower bound to industry profitability under new or amended energy conservation standards.

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

3. Discussion of MIA Comments

In response to the May 2020 ECS RFI, Lennox asserted that the commercial package air conditioner and commercial warm air furnace manufacturers are facing significant cumulative regulatory burden. (Lennox, EERE–2019–BT–STD–0042–0015 at pp. 7–8)

In response to the May 2020 ECS RFI, Carrier likewise commented that commercial package air conditioner and heat pump manufacturers face a significant regulatory burden, citing regulatory changes to ASHRAE Standard 90.1, the International Energy Conservation Code (''IECC''), California Air Resource Board, and State-level action, stressing the potential overlap between these regulatory actions and the lack of coordination between their governing bodies. Carrier requested DOE to review its approach to multiple regulations and work closely with industry organizations to minimize regulatory burden. (Carrier, EERE–2019–BT–STD–0042–0013 at pp. 18–19)

In response to the May 2020 ECS RFI, Trane commented that multiple regulations affecting the same manufacturer can strain profits and lead companies to abandon product lines or markets. Trane asserted that commercial package air conditioner and commercial warm air furnace manufacturers will experience significant cumulative regulatory burden due to DOE energy conservation standards rulemakings.

[61] The gross margin percentage of 23 percent for small ACUACs is based on a manufacturer markup of 1.30. The gross margin percentage of 24 percent for small ACUHPs is based on a manufacturer markup of 1.32. The gross margin percentage of 25 percent for large ACUACs is based on a manufacturer markup of 1.34. The gross margin percentage of 26 percent for large ACUHPs is based on a manufacturer markup of 1.36. The gross margin percentage of 29 percent for very large ACUACs is based on a manufacturer markup of 1.41. The gross margin percentage of 30 percent for very large ACUHPs is based on a manufacturer markup of 1.43.

(Trane, EERE–2019–BT–STD–0042–0016 at pp. 12–13)

In response to the May 2020 ECS RFI, the Air-Conditioning, Heating, and Refrigeration Institute commented that the industry faces regulatory burden from a variety of sources, including the sunsetting of the UL Standard 1995, State-level GWP limits, and the transition to new efficiency metrics, suggesting that the combined effects of these changes would consume almost all available research and development resources and laboratory time. (AHRI, EERE–2019–BT–STD–0042–0014 at p. 2)

In response to the May 2022 TP/ECS RFI, Lennox asserted that commercial package air conditioner and heat pump manufacturers are facing unprecedented regulatory change regarding the equipment they manufacture, stressing technical and laboratory resources in the industry. (Lennox, EERE–2022–BT–STD–0015–0009 at p. 6) Lennox also recommended that DOE consider the cumulative impact of the refrigerant transition as part of the rulemaking process for amended energy conservation standards. (*Id.* at pp. 5–6)

In response, DOE notes that it analyzes cumulative regulatory burden pursuant to section 13(g) of 10 CFR part 430, subpart C, appendix A (which applies to this equipment per 10 CFR 431.4). As such, the Department will recognize and consider the overlapping effects on manufacturers of new or revised DOE standards and other Federal regulatory actions affecting the same products or equipment that take effect approximately three years before or after the 2029 compliance date (*i.e.,* 2026 to 2032). DOE details the rulemakings and expected conversion expenses of Federal energy conservation standards that could impact ACUAC and ACUHP original equipment manufacturers (''OEMs'') that take effect approximately three years before or after the 2029 compliance date, as discussed in section V.B.2.e of this document. Regarding potential refrigerant regulations, DOE accounts for the potential costs associated with transitioning covered equipment to low-GWP refrigerants in order to comply with Federal and State regulations limiting the use of high-GWP refrigerants in its GRIM. *See* section V.B.2.e of this document for addition information on the estimated refrigerant transition costs.

In response to the May 2020 ECS RFI, AHRI's comment encouraged DOE to reach out to four manufacturers of ACUACs/ACUHPs and CWAFs identified by AHRI as small businesses. (AHRI, EERE–2019–BT–STD–0042–0014 at p. 12) In response to the May 2020 ECS RFI, UCA commented that DOE should be cognizant of the disproportionate impact that regulations may have on small businesses, which, among other issues, may have more limited resources to follow and comply with regulations, and face greater difficulties competing with larger corporations. (UCA, EERE–2019–BT–STD–0042–0006, pp. 1–7 [62])

In response, DOE reviewed the individual company websites of the four small businesses identified by AHRI and confirmed that none of them currently produce equipment covered by this rulemaking. Further, DOE conducted an assessment of the ACUAC/HP market and did not identify any small, domestic OEMs that manufacture ACUAC/HP equipment for the U.S. market. *See* chapter 3 of the direct final rule TSD for a list of OEMs of ACUACs and/or ACUHPs.

K. Emissions Analysis

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

The analysis of electric power sector emissions of CO_2, NO_X, SO_2, and Hg uses emissions intended to represent the marginal impacts of the change in electricity consumption associated with amended or new standards. The methodology is based on results published for the *AEO,* including a set of side cases that implement a variety of efficiency-related policies. The methodology is described in appendix 13A in the direct final rule TSD. The analysis presented in this document uses projections from *AEO 2023.* Power sector emissions of CH_4 and N_2O from fuel combustion are estimated using Emission Factors for Greenhouse Gas Inventories published by the EPA.[63]

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

1. Air Quality Regulations Incorporated in DOE's Analysis

DOE's no-new-standards case for the electric power sector reflects the *AEO,* which incorporates the projected impacts of existing air quality regulations on emissions. *AEO 2023* reflects, to the extent possible, laws and regulations adopted through mid-November 2022, including the emissions control programs discussed in the following paragraphs the emissions control programs discussed in the following paragraphs, and the Inflation Reduction Act.[64]

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 (August 8, 2011). CSAPR requires these States to reduce certain emissions, including annual SO_2 emissions, and went into effect as of January 1, 2015.[65] *AEO 2023*

[62] The UCA comment included two supplemental attachments: Attachment 1, *US DOE LETTER 6.10.2020,* and Attachment 2, *DOE RFI Double Duct Information 6.10.2020.* DOE references as ''Attachment 1'' and ''Attachment 2'' throughout this document. Both attachments are available on the docket.

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

[64] For further information, see the Assumptions to *AEO 2023* 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 Oct. 1, 2023).

[65] 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 (August 8, 2011). EPA subsequently published a supplemental rule in the **Federal Register** that included an additional five States in the CSAPR ozone season program. 76

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

However, beginning in 2016, SO_2 emissions began to fall as a result of the Mercury and Air Toxics Standards (''MATS'') for power plants.[66] 77 FR 9304 (Feb. 16, 2012). The final rule establishes power plant emission standards for mercury, acid gases, and non-mercury metallic toxic pollutants. 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 *AEO 2023*.

CSAPR also established limits on NO_X emissions for numerous States in the eastern half of the United States. Energy conservation standards would have little effect on NO_X emissions in those States covered by CSAPR emissions limits if excess NO_X emissions allowances resulting from the lower electricity demand could be used to permit offsetting increases in NO_X emissions from other EGUs. In such case, NOx emissions would remain near the limit even if electricity generation goes down. Depending on the configuration of the power sector in the different regions and the need for allowances, however, NO_X emissions might not remain at the limit in the case of lower electricity demand. That would mean that standards might reduce NOx emissions in covered States. Despite this possibility, DOE has chosen to be conservative in its analysis and has maintained the assumption that standards will not reduce NO_X emissions in States covered by CSAPR. Energy conservation standards would be expected to reduce NO_X emissions in the States not covered by CSAPR. DOE used *AEO 2023* 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 *AEO 2023,* 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 net 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 equipment shipped in the projection period for each TSL. This section summarizes the basis for the values used for monetizing the emissions benefits and presents the values considered in this direct final rule.

To monetize the benefits of reducing GHG emissions, this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990* published in February 2021 by the IWG (''February 2021 SC–GHG TSD'').[67]

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

DOE exercises its own judgment in presenting monetized climate benefits as recommended by applicable Executive orders, and DOE would reach the same conclusion presented in this 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 IWG on the Social Cost of Greenhouse Gases or by another means, did not affect the rule ultimately adopted by DOE.

DOE estimated the global social benefits of CO_2, CH_4, and N_2O reductions (*i.e.,* SC–GHGs) using SC–GHG values that were based on the interim values presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990,* published in February 2021 by the IWG (''February 2021 SC–GHG TSD''). The SC–GHG is the monetary value of the net harm to society associated with a marginal increase in emissions in a given year, or the benefit of avoiding that increase. In principle, the SC–GHG includes the value of all climate change impacts, including (but not limited to) changes in net agricultural productivity, human health effects, property damage from increased flood risk and natural disasters, disruption of energy systems, risk of conflict, environmental migration, and the value of ecosystem services. The SC–GHG, therefore, reflects the societal value of reducing emissions of the gas in question by one metric ton. The SC–GHG is the theoretically appropriate value to use in conducting benefit-cost analyses of policies that affect CO_2, N_2O, and CH_4 emissions. As a member of the IWG involved in the development of the February 2021 SC–GHG TSD, DOE agreed that the interim SC–GHG estimates represent the most appropriate estimate of the SC–GHG until revised estimates are developed reflecting the latest, peer-reviewed science. *See* 87 FR 78382, 78406–78408 for discussion of the development and details of the IWG SC–GHG estimates.

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

FR 80760 (Dec. 27, 2011) (Supplemental Rule). EPA also published in the **Federal Register** the CSAPR Update for the 2008 ozone NAAQS. 81 FR 74504 (Oct. 26, 2016).

[66] In order to continue operating, coal power plants must have either flue gas desulfurization or dry sorbent injection systems installed. Both technologies, which are used to reduce acid gas emissions, also reduce SO_2 emissions.

[67] See *www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf* (last accessed August 1, 2023).

lower.[68] Second, the IAMs used to produce these interim estimates do not include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature and the science underlying their ''damage functions'' (*i.e.,* the core parts of the IAMs that map global mean temperature changes and other physical impacts of climate change into economic—both market and nonmarket—damages) lags behind the most recent research. For example, limitations include the incomplete treatment of catastrophic and non-catastrophic impacts in the 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 is aware that in December 2023, EPA issued a new set of SC–GHG estimates in connection with a final rulemaking under the Clean Air Act.[69] As DOE had used the IWG interim values in proposing this rule and is currently reviewing the updated 2023 SC–GHG values, for this direct final rule, DOE used these updated 2023 SC–GHG values to conduct a sensitivity analysis of the value of GHG emissions reductions associated with alternative standards for ACUACs and ACUHPs (see section IV.L.1.c of this notice). DOE notes that because EPA's estimates are considerably higher than the IWG's interim SC–GHG values applied for this direct final rule, an analysis that uses the EPA's estimates results in significantly greater climate-related benefits. However, such results would not affect DOE's decision in this direct final rule. As stated elsewhere in this document, DOE would reach the same conclusion regarding the economic justification of the standards presented in this direct final rule without considering the IWG's interim SC–GHG values, which DOE agrees are conservative estimates. For the same reason, if DOE were to use EPA's higher SC–GHG estimates, they would not change DOE's conclusion that the standards are economically justified.

DOE's derivations of the SC–GHG (*i.e.,* SC–CO_2, SC–N_2O, and SC–CH_4) values used for this direct final rule 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 of this document.

a. Social Cost of Carbon Dioxide

The SC–CO_2 values used for this direct final rule were based on the values developed for the IWG's February 2021 TSD, which are shown in Table IV.15 in five-year increments from 2020 to 2050. DOE notes that it has exercised its discretion in adopting the IWG's estimates, and as previously stated, DOE finds 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 set of annual values that DOE used, which was adapted from estimates published by EPA,[70] is presented in Appendix 14A of the direct final rule TSD. These estimates are based on methods, assumptions, and parameters identical to the estimates published by the IWG (which were based on EPA modeling), and include values for 2051 to 2070. DOE expects additional climate benefits to accrue for equipment still operating after 2070, but a lack of available SC–CO_2 estimates for emissions years beyond 2070 prevents DOE from monetizing these potential benefits in this analysis.

Table IV.15 Annual SC-CO_2 Values from 2021 Interagency Update, 2020–2050 (2020$ per Metric Ton CO_2)

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

DOE multiplied the CO_2 emissions reduction estimated for each year by the SC–CO_2 value for that year in each of the four cases. DOE adjusted the values to 2022$ using the implicit price deflator for gross domestic product (''GDP'') from the Bureau of Economic Analysis. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the four cases using the specific discount rate that had been used to obtain the SC–CO_2 values in each case. *See* chapter 13 of the direct final rule TSD for the annual emissions reductions and *see*

[68] Interagency Working Group on Social Cost of Greenhouse Gases (IWG) (2021) Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990. February. United States Government (available at: *www.whitehouse.gov/briefing-room/blog/2021/02/26/a-return-to-science-evidence-based-estimates-of-the-benefits-of-reducing-climate-pollution/*) (last accessed Nov. 1, 2023).

[69] See *www.epa.gov/environmental-economics/scghg.*

[70] *See* EPA, Revised 2023 and Later Model Year Light-Duty Vehicle GHG Emissions Standards: Regulatory Impact Analysis, Washington, DC (December 2021) (available at: *nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1013ORN.pdf*) (last accessed Feb. 21, 2023).

also appendix 14A of the direct final rule TSD for the annual SC–CO_2 values.

Regarding the May 2020 ECS RFI, DOE received comments from Policy Integrity regarding the social cost of carbon used in the emissions monetization analysis. Policy Integrity commented that DOE should account for the benefits of greenhouse gas emissions reductions from the use of higher-efficiency equipment using the global estimate of the social cost of greenhouse gases, and that the values developed by the IWG are the best available. (Policy Integrity, EERE–2019–BT–STD–0042–007 at pp. 2–3, 5)

In response, DOE agrees that the global estimate of the SC–GHG is appropriate to use in its analysis. The SC–GHG values used in this analysis are based on the best available science and economics. The IWG is in the process of assessing how best to incorporate the latest peer-reviewed science and the recommendations of the National Academies to develop an updated set of SC–GHG estimates, and DOE remains engaged in that process.

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. DOE notes that it has exercised its discretion in adopting the IWG's estimates, and as previously stated, DOE finds 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. Table IV.16 shows the updated sets of SC–CH_4 and SC–N_2O estimates from the latest interagency update in five-year increments from 2020 to 2050. The full set of annual values used is presented in Appendix 14–A of the direct final rule TSD. To capture the uncertainties involved in regulatory impact analysis, DOE has determined it is appropriate to include all four sets of SC–CH_4 and SC–N_2O values, as recommended by the IWG. DOE derived values after 2050 using the approach described previously for the SC–CO_2.

Table IV.16 Annual SC-CH_4 and SC-N_2O Values from 2021 Interagency Update, 2020–2050 (2020$ per Metric Ton)

Year	SC-CH_4				SC-N_2O			
	Discount Rate and Statistic				Discount Rate and Statistic			
	5%	3%	2.5%	3%	5%	3%	2.5 %	3%
	Average	Average	Average	95th percentile	Average	Average	Average	95th percentile
2020	670	1500	2000	3900	5800	18000	27000	48000
2025	800	1700	2200	4500	6800	21000	30000	54000
2030	940	2000	2500	5200	7800	23000	33000	60000
2035	1100	2200	2800	6000	9000	25000	36000	67000
2040	1300	2500	3100	6700	10000	28000	39000	74000
2045	1500	2800	3500	7500	12000	30000	42000	81000
2050	1700	3100	3800	8200	13000	33000	45000	88000

DOE multiplied the CH_4 and N_2O emissions reduction estimated for each year by the SC–CH_4 and SC–N_2O estimates for that year in each of the cases. DOE adjusted the values to 2022$ using the implicit price deflator for 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. *See* chapter 13 of the direct final rule TSD for the annual emissions reduction, and *see also* appendix 14A of the direct final rule TSD for the annual SC–CH_4 and SC–N_2O values.

c. Sensitivity Analysis Using EPA's New SC–GHG Estimates

In December 2023, EPA issued an updated set of SC–GHG estimates (2023 SC–GHG) in connection with a final rulemaking under the Clean Air Act. These estimates incorporate recent research and address recommendations of the National Academies (2017) and comments from a 2023 external peer review of the accompanying technical report.

For this rulemaking, DOE used these updated 2023 SC–GHG values to conduct a sensitivity analysis of the value of GHG emissions reductions associated with alternative standards for ACUACs and ACUHPs. This sensitivity analysis provides an expanded range of potential climate benefits associated with amended standards. The final year of EPA's new 2023 SC–GHG estimates is 2080; therefore, DOE did not monetize the climate benefits of GHG emissions reductions occurring after 2080.

The overall climate benefits are greater when using the higher, updated 2023 SC–GHG estimates, compared to the climate benefits using the older IWG SC–GHG estimates. The results of the sensitivity analysis are presented in appendix 14C of the direct final rule TSD.

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 benefit-per-ton estimates for that sector from the EPA's Benefits Mapping and Analysis Program.[71] DOE used EPA's values for $PM_{2.5}$-related benefits associated with NO_X and SO_2 and for ozone-related benefits associated with NO_X for 2025, 2030, and 2040, calculated with discount rates of 3 percent and 7 percent. DOE used linear interpolation to define values for the years not given in the 2025 to 2040 range; for years beyond 2040, the values are held constant. DOE combined the EPA regional benefit-per-ton estimates with regional information on electricity consumption and emissions from *AEO 2023* to define weighted-average national values for NO_X and SO_2 (*see* appendix 14B of the direct final rule TSD).

[71] U.S. Environmental Protection Agency, Estimating the Benefit per Ton of Reducing Directly-Emitted $PM_{2.5}$, $PM_{2.5}$ Precursors and Ozone Precursors from 21 Sectors (available at: *www.epa.gov/benmap/estimating-benefit-ton-reducing-directly-emitted-pm25-pm25-precursors-and-ozone-precursors*) (last accessed Nov. 1, 2023).

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 *AEO 2023*. 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 *AEO 2023* 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 equipment subject to standards, their suppliers, and related service firms. The MIA addresses those impacts. Indirect employment impacts are changes in national employment that occur due to the shift in expenditures and capital investment caused by the purchase and operation of more-efficient appliances. Indirect employment impacts from standards consist of the net jobs created or eliminated in the national economy, other than in the manufacturing sector being regulated, caused by: (1) reduced spending by consumers on energy; (2) reduced spending on new energy supply by the utility industry; (3) increased consumer spending on the equipment 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 BLS. BLS regularly publishes its estimates of the number of jobs per million dollars of economic activity in different sectors of the economy, as well as the jobs created elsewhere in the economy by this same economic activity. Data from BLS indicate that expenditures in the utility sector generally create fewer jobs (both directly and indirectly) than expenditures in other sectors of the economy.[72] 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'').[73] 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 there are 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 (2034), 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 ACUACs and ACUHPs. It addresses the TSLs examined by DOE, the projected impacts of each of these levels if adopted as energy conservation standards for ACUACs and ACUHPs, and the standard 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 new or amended standards for products and equipment at the equipment class level and by grouping individual efficiency levels for each class into TSLs. Use of TSLs allows DOE to identify and consider industry-level manufacturer cost interactions between the equipment classes, to the extent that there are such interactions, and national-level price elasticity of 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 four TSLs for ACUACs and ACUHPs. DOE developed TSLs that combine efficiency levels for each analyzed equipment 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 amended energy conservation standards for ACUACs and ACUHPs. TSL 4 represents the maximum technologically feasible (''max-tech'') energy efficiency for all equipment classes. TSL 3 represents the efficiency levels recommended by the ACUAC/HP Working Group. TSL 2 and TSL 1 represent intermediate efficiency levels between baseline and TSL 3 for the small and large equipment classes, but

[72] *See* U.S. Department of Commerce–Bureau of Economic Analysis. *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (''RIMS II'')* (1997) U.S. Government Printing Office: Washington, DC (available at: *www.bea.gov/resources/methodologies/RIMSII-user-guide*) (last accessed August 1, 2023).

[73] 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.

correspond to the same efficiency level for very large equipment classes as TSL 3.

Table V.1 Trial Standard Levels for ACUACs and ACUHPs

TSL	Efficiency Level*		
	Small	Large	Very Large
1	2	1	1
2	3	1	1
3 (Recommended)	4	2	1
4	7	4	3

*For the IVEC and IVHE values at each efficiency level, see Table IV.6 and Table IV.7.

While representative ELs were included in the TSLs, DOE considered all efficiency levels as part of its analysis.[74]

B. Economic Justification and Energy Savings

1. Economic Impacts on Individual Consumers

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

a. Life-Cycle Cost and Payback Period

In general, higher-efficiency equipment affect consumers in two ways: (1) purchase price increases and (2) annual operating costs decrease. Inputs used for calculating the LCC and PBP include total installed costs (*i.e.,* equipment 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 equipment 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 ACUAC equipment class. As discussed previously, in section IV.C.3 of this document, separate LCC and PBP results were not run for ACUHPs, but values related to ACUHP shipments are considered in the NIA. In the first of each pair of tables, the simple payback is measured relative to the baseline equipment. 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 equipment with higher efficiency in the no-new-standards case, the average savings are less than the difference between the average LCC of the baseline equipment 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 equipment 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 Small ACUACs

TSL	Efficiency Level	Average Costs (*2022$*)				Simple Payback (*years*)	Average Lifetime (*years*)
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	17,936	1,392	21,888	39,824	--	21
--	1	18,366	1,310	20,961	39,327	5.46	21
1	2	18,670	1,231	20,045	38,716	4.72	21
2	3	19,115	1,139	19,018	38,132	4.82	21
3	4	19,653	1,089	18,468	38,121	5.91	21
--	5	20,756	1,037	17,975	38,732	8.46	21
--	6	21,566	959	17,134	38,700	8.98	21
4	7	22,467	923	16,791	39,258	10.44	21

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

[74] Efficiency levels that were analyzed for this direct final rule are discussed in sections IV.C.1 and IV.C.2 of this document. Results by efficiency level are presented in chapters 8, 10, and 12 of the direct final rule TSD.

Table V.3 Average LCC Savings Relative to the No-New-Standards Case for Small ACUACs

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* (*2022$*)	Percent of Consumers that Experience Net Cost
--	1	495	13%
1	2	1,047	22%
2	3	1,523	9%
3	4	1,380	26%
--	5	768	47%
--	6	800	49%
4	7	242	60%

* The savings represent the average LCC for affected consumers.

Table V.4 Average LCC and PBP Results for Large ACUACs

TSL	Efficiency Level	Average Costs (*2022$*)				Simple Payback (*years*)	Average Lifetime (*years*)
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	30,602	2,924	42,733	73,336	--	23
1, 2	1	31,125	2,770	40,837	71,962	3.45	23
3	2	31,647	2,616	38,941	70,588	3.45	23
--	3	33,749	2,439	36,929	70,678	6.74	23
4	4	36,467	2,061	32,351	68,818	7.05	23

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

Table V.5 Average LCC Savings Relative to the No-New-Standards Case for Large ACUACs

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* (*2022$*)	Percent of Consumers that Experience Net Cost
1, 2	1	1,363	3%
3	2	2,488	4%
--	3	2,021	33%
4	4	3,880	31%

* The savings represent the average LCC for affected consumers.

Table V.6 Average LCC and PBP Results for Very Large ACUACs

TSL	Efficiency Level	Average Costs (*2022$*)				Simple Payback (*years*)	Average Lifetime (*years*)
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	0	58,902	6,426	100,241	159,143	--	30
1,2,3	1	59,461	5,931	93,252	152,713	1.13	30
--	2	64,344	5,114	81,793	146,137	4.21	30
4	3	75,201	4,183	69,244	144,444	7.46	30

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

Table V.7 Average LCC Savings Relative to the No-New-Standards Case for Very Large ACUACs

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* (*2022$*)	Percent of Consumers that Experience Net Cost
1,2,3	1	6,431	1%
--	2	11,073	5%
4	3	12,766	24%

* The savings represent the average LCC for affected consumers.

b. Consumer Subgroup Analysis

In the consumer subgroup analysis, DOE estimated the impact of the considered TSLs on small businesses. Table V.8 through Table V.10 compare the average LCC savings and PBP at each efficiency level for the consumer subgroup, along with similar metrics for the entire consumer sample for ACUACs (once again, ACUHPs, are considered only in the NIA). In most cases, the average LCC savings and PBP for small businesses at the considered efficiency levels are not substantially different from the average for all commercial consumers. Chapter 11 of the direct final rule TSD presents the complete LCC and PBP results for the subgroup.

Table V.8 Comparison of LCC Savings and PBP for Small Business Consumers and All Consumers: Small ACUACs

TSL	Efficiency Level	Average LCC Savings (*2022$*)		Payback Period (*years*)	
		Small Businesses	All Purchasers	Small Businesses	All Purchasers
--	1	449	495	4.53	5.46
1	2	959	1,047	3.91	4.72
2	3	1,447	1,523	3.95	4.82
3	4	1,271	1,380	4.86	5.91
--	5	707	768	6.86	8.46
--	6	693	800	7.31	8.98
4	7	162	242	8.46	10.44

Table V.9 Comparison of LCC Savings and PBP for Small Business Consumers and All Consumers: Large ACUACs

TSL	Efficiency Level	Average LCC Savings (*2022$*)		Payback Period (*years*)	
		Small Businesses	All Purchasers	Small Businesses	All Purchasers
1, 2	1	1,331	1,363	2.71	3.45
3	2	2,426	2,488	2.71	3.45
--	3	2,065	2,021	5.2	6.74
4	4	3,905	3,880	5.45	7.05

Table V.10 Comparison of LCC Savings and PBP for Small Business Consumers and All Consumers: Very Large ACUACs

TSL	Efficiency Level	Average LCC Savings (*2022$*)		Payback Period (*years*)	
		Small Businesses	All Purchasers	Small Businesses	All Purchasers
1,2,3	1	5,701	6,431	0.91	1.13
--	2	9,191	11,073	3.4	4.21
4	3	10,036	12,766	5.93	7.46

2. Economic Impacts on Manufacturers

DOE performed an MIA to estimate the impact of amended energy conservation standards on manufacturers of ACUACs and ACUHPs. 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. Table V.12 and Table V.13 summarize the estimated financial impacts (represented by changes in INPV) of potential amended energy conservation standards on manufacturers of ACUACs and ACUHPs, as well as the conversion costs that DOE estimates manufacturers of ACUACs and ACUHPs would incur at each TSL.

As discussed in section IV.J.2.d of this document, to evaluate the range of cash-flow impacts on the ACUAC/ACUHP industry, DOE modeled two manufacturer markup scenarios that correspond to the range of anticipated market responses to amended standards. DOE modeled: (1) the preservation of gross margin percentage scenario and (2) the preservation of operating profit scenario. Under the preservation of gross margin percentage scenario, DOE applied a single uniform ''gross margin percentage'' across all efficiency levels. As MPCs increase with efficiency, this scenario implies that the absolute dollar markup will increase. DOE assumed a manufacturer ''gross margin percentage'' of 23 percent for small ACUACs, 24 percent for small ACUHPs, 25 percent for large ACUACs, 26 percent for large ACUHPs, 29 percent for very large ACUACs, and 30 percent for very large ACUHPs. This manufacturer markup is the same as the one DOE assumed in the engineering analysis and the no-new-standards case of the GRIM. Because this scenario assumes that a manufacturer's absolute dollar markup would increase as MPCs increase in the standards cases, it represents the upper (less severe) bound to industry profitability under potential amended energy conservation standards. Specifically, the industry will be able to maintain its average no-new-standards case gross margin (as a percentage of revenue) despite the higher production costs in the standards cases. In general, the larger the MPC increases, the less likely manufacturers are to achieve the cash flow from operations calculated in this scenario because it is less likely that manufacturers will be able to fully markup these larger production cost increases.

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. It represents the lower (more severe) bound to industry profitability under potential amended energy conservation standards because no additional operating profit is earned on the higher MPCs, thereby eroding profit margins as a percentage of total revenue.

Each of the modeled manufacturer markup scenarios results in a unique set of cash-flows and corresponding INPVs at each TSL. In the following discussion, the INPV results refer to the difference in industry value between the no-new-standards case and each standards case resulting from the sum of discounted cash-flows from the reference year (2024) through the end of the analysis period (2058). To provide perspective on the short-run cash-flow impact, DOE includes in the discussion of results a comparison of free cash flow between the no-new-standards case and the standards case at each TSL in the year before compliance with new standards is required. This figure represents the size of the required conversion costs relative to the cash flow generated by the ACUAC/ACUHP industry in the absence of amended energy conservation standards.

Table V.12 Manufacturer Impact Analysis for ACUACs/HPs Under the Preservation of Gross Margin Scenario

	Units	No-New-Standards Case	Trial Standard Level*			
			1	2	3	4
INPV	*2022$ millions*	2,653.0	2,608.8	2,577.0	2,573.5	1,822.9
Change in INPV	*2022$ millions*	-	(44.2)	(76.0)	(79.5)	(830.1)
	%	-	(1.7)	(2.9)	(3.0)	(31.3)
Free Cash Flow (2028)	*2022$ millions*	111.9	67.5	43.4	21.5	(677.1)
Change in Free Cash Flow (2028)	*2022$ millions*	-	(44.4)	(68.5)	(90.4)	(789.0)
	%	-	(39.7)	(61.2)	(80.8)	(705.2)
Product Conversion Costs	*2022$ millions*	32.4	124.9	171.1	217.2	1,443.2
Capital Conversion Costs	*2022$ millions*	9.8	38.4	56.9	70.8	447.8
Total Investment Required**	*2022$ millions*	42.2	163.2	228.0	288.0	1,891.0

* Numbers in parentheses indicate a negative value.

**Numbers may not sum exactly due to rounding.

Table V.13 Manufacturer Impact Analysis for ACUACs/HPs Under the Preservation of Operating Profit Scenario

	Units	No-New-Standards Case	Trial Standard Level*			
			1	2	3	4
INPV	*2022$ millions*	2,653.0	2,560.1	2,511.2	2,459.1	1,102.4
Change in INPV	*2022$ millions*	-	(92.9)	(141.7)	(193.9)	(1,550.6)
	%	-	(3.5)	(5.3)	(7.3)	(58.4)
Free Cash Flow (2028)	*2022$ millions*	111.9	67.5	43.4	21.5	(677.1)
Change in Free Cash Flow (2028)	*2022$ millions*	-	(44.4)	(68.5)	(90.4)	(789.0)
	%	-	(39.7)	(61.2)	(80.8)	(705.2)
Product Conversion Costs	*2022$ millions*	32.4	124.9	171.1	217.2	1,443.2
Capital Conversion Costs	*2022$ millions*	9.8	38.4	56.9	70.8	447.8
Total Investment Required**	*2022$ millions*	42.2	163.2	228.0	288.0	1,891.0

* Numbers in parentheses indicate a negative value.

**Numbers may not sum exactly due to rounding.

At TSL 1, DOE estimates that impacts on INPV range from −$92.9 million to −$44.2 million, or a change in INPV of −3.5 percent to −1.7 percent. At TSL 1, industry free cash-flow (operating cash flow minus capital expenditures and capital conversion costs) is $67.5 million, which is a decrease of $44.4 million, or a drop of 39.7 percent, compared to the no-new-standards case value of $111.9 million in 2028, the year before the compliance date of amended energy conservation standards. Industry conversion costs total $163.2 million.

TSL 1 would set the energy conservation standard for small ACUACs/HPs at EL 2, large ACUACs/HPs at EL 1, and very large ACUACs/HPs at EL 1. At TSL 1, DOE estimates that manufacturers would incur approximately $124.9 million in product conversion costs, as some small ACUACs/HPs, large ACUACs/HPs, and very large ACUACs/HPs would need to be redesigned to comply with the standard. DOE also estimates that manufacturers would incur approximately $38.4 million in capital conversion costs.

At TSL 1, DOE estimates that approximately 52 percent of small ACUAC/HP models currently available for purchase, 64 percent of large ACUAC/HP models, and 64 percent of very large ACUAC/HP models would have the capability of meeting the efficiency levels required at TSL 1, necessitating a significant amount of product redesign. DOE estimates that seven of the nine manufacturers of small ACUACs/HPs offer small ACUACs/HPs that would meet the efficiency level required at TSL 1. DOE estimates that seven of the eight manufacturers of large ACUACs/HPs offer large ACUACs/HPs that meet the efficiency level required at TSL 1. DOE estimates that six of the eight manufacturers of very large ACUACs/HPs offer very large ACUACs/HPs that meet the efficiency level required at TSL 1.

At TSL 1, the shipment-weighted average MPC for all ACUACs/HPs increases by 2.6 percent relative to the no-new-standards case shipment-weighted-average MPC for all ACUACs/HPs in 2029. The incremental increases in MPC lead to different profitability and cash-flows under the two manufacturer markup scenarios. However, the conversion costs are the key driver on impacts to the industry, with the $163.2 million in conversion costs, being the major contributor to changes of −3.5 percent and −1.7 percent of INPV at TSL 1 under the preservation of operating profit scenario and the preservation of gross margin scenario, respectively.

At TSL 2, DOE estimates that impacts on INPV range from −$141.7 million to −$76.0 million, or a change in INPV of −5.3 percent to −2.9 percent. At TSL 2, industry free cash-flow is $43.4 million, which is a decrease of $68.5 million, or a drop of 61.2 percent, compared to the no-new-standards case value of $111.9 million in 2028, the year before the compliance date of amended energy conservation standards. Industry conversion costs total $228.0 million.

TSL 2 would set the energy conservation standard for small ACUACs/HPs at EL 3, large ACUACs/HPs at EL 1, and very large ACUACs/HPs at EL 1. At TSL 2, DOE estimates that manufacturers would incur approximately $171.1 million in product conversion costs, as some small ACUACs/HPs, large ACUACs/HPs, and very large ACUACs/HPs would need to be redesigned to comply with the standard. DOE also estimates that manufacturers would incur approximately $56.9 million in capital conversion costs.

At TSL 2, DOE estimates that approximately 43 percent of small ACUAC/HP models currently available for purchase, 64 percent of large ACUAC/HP models, and 64 percent of very large ACUAC/HP models would have the capability of meeting the efficiency levels required at TSL 2, necessitating a significant amount of product redesign. DOE estimates that six of the nine manufacturers of small ACUACs/HPs offer small ACUACs/HPs that would meet the efficiency level required at TSL 2. DOE estimates that seven of the eight manufacturers of large ACUACs/HPs offer large ACUACs/HPs that meet the efficiency level required at TSL 2. DOE estimates that six of the eight manufacturers of very large ACUACs/HPs offer very large ACUACs/HPs that meet the efficiency level required at TSL 2.

At TSL 2, the shipment-weighted average MPC for all ACUACs/HPs increases by 3.6 percent relative to the no-new-standards case shipment-weighted-average MPC for all ACUACs/HPs in 2029. The incremental increases in MPC lead to different profitability and cash-flows under the two manufacturer markup scenarios. However, the conversion costs are the key driver on impacts to the industry, with the $228.0 million in conversion costs, being the major contributor to changes of −5.3 percent and −2.9 percent of INPV at TSL 2 under the preservation of operating profit scenario and the preservation of gross margin scenario, respectively.

At TSL 3 (*i.e.,* the ACUAC/HP Working Group recommended levels), DOE estimates that impacts on INPV would range from −$193.9 million to −$79.5 million, or a change in INPV of −7.3 percent to −3.0 percent. At TSL 3, industry free cash-flow is $21.5 million, which is a decrease of $90.4 million, or a drop of 80.8 percent, compared to the no-new-standards case value of $111.9 million in 2028, the year before the compliance date of amended energy conservation standards. Industry conversion costs total $288.0 million.

TSL 3 would set the energy conservation standard for small ACUACs/HPs at EL 4, large ACUACs/HPs at EL 2, and very large ACUACs/HPs at EL 1. At TSL 3, DOE estimates that manufacturers would incur approximately $217.2 million in product conversion costs, as some small ACUACs/HPs, large ACUACs/HPs, and very large ACUACs/HPs would need to be redesigned to comply with the standard. DOE also estimates that manufacturers would incur approximately $70.8 million in capital conversion costs.

At TSL 3, DOE estimates that approximately 37 percent of small ACUAC/HP models available for purchase, 50 percent of large ACUAC/HP models, and 64 percent of very large ACUAC/HP models have the capability of meeting the efficiency levels required at TSL 3, necessitating a significant amount of product redesign. DOE estimates that five of the nine manufacturers of small ACUACs/HPs offer small ACUACs/HPs that would meet the efficiency level required at TSL 3. DOE estimates that six of the eight manufacturers of large ACUACs/HPs offer large ACUACs/HPs that meet the efficiency level required at TSL 3. DOE estimates that six of the eight manufacturers of very large ACUACs/HPs offer very large ACUACs/HPs that meet the efficiency level required at TSL 3.

At TSL 3, the shipment-weighted average MPC for all ACUACs/HPs increases by 6.3 percent relative to the no-new-standards case shipment-weighted-average MPC for all ACUACs/HPs in 2029. The incremental increases in MPC lead to different profitability and cash-flows under the two manufacturer markup scenarios. However, the conversion costs are the key driver on impacts to the industry, with the $288.0 million in conversion costs, being the major contributor to changes of −7.3 percent and −3.0 percent of INPV at TSL 3 under the preservation of operating profit scenario and the preservation of gross margin scenario, respectively.

At TSL 4 (max-tech), DOE estimates that impacts on INPV range from −$1,550.6 million to −$830.1 million, or a change in INPV of −58.4 percent to −31.3 percent. At TSL 4, industry free cash-flow is −$677.1 million, which is a decrease of $789.0 million, or a drop of 705.2 percent, compared to the no-new-standards case value of $111.9 million in 2028, the year before the compliance date of amended energy conservation standards. The negative free-cash-flow calculation indicates manufacturers may need to access cash reserves or outside capital to finance conversion efforts. Industry conversion costs total $1,891.0 million.

TSL 4 would set the energy conservation standard for small ACUACs/HPs at EL 7, large ACUACs/HPs at EL 4, and very large ACUACs/HPs at EL 3. At TSL 4, DOE estimates that manufacturers would incur approximately $1,443.2 million in product conversion costs, as the majority of small ACUACs/HPs, large ACUACs/HPs, and very large ACUACs/HPs would need to be redesigned to comply with the standard. DOE also estimates that manufacturers would incur approximately $447.8 million in capital conversion costs.

At TSL 4, DOE estimates that approximately 2 percent of small ACUAC/HP models available for purchase, 10 percent of large ACUAC/HP models, and 1 percent of very large ACUAC/HP models would have the capability of meeting the efficiency levels required at TSL 4, necessitating a significant amount of product redesign. DOE estimates that only three of the nine manufacturers of small ACUACs/HPs offer small ACUACs/HPs that would meet the efficiency level required at TSL 4. DOE estimates that only two of the eight manufacturers of large ACUACs/HPs offer large ACUACs/HPs that meet the efficiency level required at TSL 4. DOE estimates that only one of the eight manufacturers of very large ACUACs/HPs offer very large ACUACs/HPs that meet the efficiency level required at TSL 4.

At max-tech, DOE expects that manufacturers would have to contend with significant engineering uncertainty (considering that very few manufacturers produce models that would meet the efficiency level required at TSL 4) and would need to invest heavily in product redesign at all capacities. At TSL 4, the shipment-weighted average MPC for all ACUACs/HPs increases by 30.3 percent relative to the no-new-standards case shipment-weighted-average MPC for all ACUACs/HPs in 2029. The incremental increases in MPC lead to different profitability and cash-flows under the two manufacturer markup scenarios. However, the conversion costs continue to be the key driver on impacts to the industry, with the $1,891.0 million in conversion costs, being the major contributor to changes of −58.4 percent and −31.3 percent of INPV at TSL 4 under the preservation of operating profit scenario and the preservation of gross margin scenario, respectively.

b. Direct Impacts on Employment

To quantitatively assess the potential impacts of amended energy conservation standards on direct employment in the ACUACs and ACUHPs 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 the most up-to-date statistical data from the 2021 *ASM,*[75] BLS employee compensation data,[76] and the results of the engineering analysis.

Labor expenditures related to equipment manufacturing depend on the labor intensity of the equipment, 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

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

[76] U.S. Bureau of Labor Statistics, *Employer Costs for Employee Compensation* (June 2023) (Sept. 12, 2023) (available at: *www.bls.gov/news.release/pdf/ecec.pdf*) (last accessed Dec. 5, 2023).

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 equipment. This value is derived from manufacturer interviews, product database analysis, and publicly-available information. Based on information obtained during manufacturer interviews, DOE estimates that 50 percent of ACUACs/HPs are produced domestically.

The domestic production employees estimate covers production line workers, including line supervisors, who are directly involved in fabricating, processing, or assembling equipment 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.[77] DOE's estimates only account for production workers who manufacture the specific equipment covered by this rulemaking.

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

Direct employment is the sum of domestic production employees and non-production employees. Using the GRIM, DOE estimates in the absence of amended energy conservation standards, there would be 3,429 domestic production and non-production employees for ACUACs/HPs in 2029. Table V.14 shows the range of the impacts of amended energy conservation standards on U.S. manufacturing employment in the ACUAC/HP industry. The following discussion provides a qualitative evaluation of the range of potential impacts presented in Table V.14.

Table V.14 Domestic Direct Employment Impacts for ACUAC/HPs in 2029*

	No-New-Standards Case	TSL 1	TSL 2	TSL 3	TSL 4
Direct Employment in 2029	3,429	912 to 3,450	912 to 3,521	912 to 3,707	912 to 4,807
Potential Changes in Direct Employment Workers in 2029*	-	(2,517) to 21	(2,517) to 92	(2,517) to 278	(2,517) to 1,378

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

The direct employment impacts shown in Table V.14 represent the potential domestic employment changes that could result following the compliance date of the amended standards for ACUACs and ACUHPs. Employment could increase or decrease due to the labor content of the various equipment being manufactured domestically. The upper bound estimate corresponds to an increase in the number of domestic workers that would result from amended energy conservation standards if manufacturers continue to produce the same scope of covered equipment within the United States after compliance takes effect and would require additional labor to produce more-efficient equipment. To establish a conservative lower bound, DOE assumes all manufacturers would shift production to foreign countries with lower labor costs. At lower TSLs, DOE believes the likelihood of changes in production location due to amended standards are low due to feedback from industry that they would not expect major changes to their production lines and processes, with the majority of conversion costs driven by equipment redesign (*i.e.,* investments in research, development, testing, marketing, and other non-capitalized costs). However, as amended standards increase in stringency and both the complexity and cost of production facility updates increases, manufacturers are more likely to revisit their production location decisions.

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

c. Impacts on Manufacturing Capacity

Based on manufacturer feedback, DOE expects there would be relatively low capital conversion costs at TSLs below the max-tech level (including TSL 3, the Recommended TSL), which indicates that major updates to manufacturing lines will likely not be required to meet amended standards. At max-tech (*i.e.,* TSL 4), it is unclear if most manufacturers would have the engineering capacity to complete the necessary redesigns within the compliance period. However, because the Recommended TSL would not require max-tech efficiencies, DOE does not expect manufacturers would face long-term capacity constraints due to the standard levels detailed in this direct final rule. Furthermore, accepting that manufacturers fully considered the investment and capacity implications prior to voluntarily entering into the ACUAC/HP Working Group ECS Term Sheet, DOE infers that manufacturers would not have agreed to standard levels that they could not reasonably meet within the compliance period.

[77] The comprehensive description of production and non-production workers is available online at: *www2.census.gov/programs-surveys/asm/technical-documentation/questionnaire/2021/instructions/MA_10000_Instructions.pdf,* ''Definitions and Instructions for the Annual Survey of Manufacturers, MA–10000'' (pp. 13–14) (last accessed June 1, 2023).

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 used the results of the industry characterization to group manufacturers exhibiting similar characteristics. Specifically, DOE investigated small businesses as a manufacturer subgroup that could be disproportionally impacted by energy conservation standards and could merit additional analysis in the MIA. DOE did not identify any other adversely impacted manufacturer subgroups for this rulemaking based on the results of the industry characterization.

DOE analyzes the impacts on small businesses in a separate analysis for the amended energy conservation standards proposed in the NOPR published elsewhere in this issue of the **Federal Register** and in chapter 12 of the direct final rule TSD. In summary, the SBA defines a ''small business'' as having 1,250 employees or less for North American Industry Classification System (''NAICS'') code 333415, ''Air Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing.'' Based on this classification, DOE did not identify any domestic OEMs that qualify as a small business. For a discussion of 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 examining at the cumulative impact of multiple DOE standards and the regulatory actions of other Federal agencies, States, and localities 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, multiple regulations affecting the same manufacturer can strain profits and lead companies to abandon equipment lines or markets with lower expected future returns than competing equipment. For these reasons, DOE conducts an analysis of cumulative regulatory burden as part of its rulemakings pertaining to appliance efficiency.

For this cumulative regulatory burden analysis, DOE examined Federal, equipment-specific regulations that could affect ACUAC and ACUHP manufacturers that take effect approximately three years before or after the 2029 compliance date. Table V.15 presents the DOE energy conservation standards that would impact manufacturers of ACUAC and ACUHP equipment in the 2026 to 2032 timeframe.

Table V.15 Compliance Dates and Expected Conversion Expenses of Federal Energy Conservation Standards Affecting ACUAC and ACUHP Original Equipment Manufacturers

Federal Energy Conservation Standard	Number of OEMs*	Number of OEMs Affected by Today's Rule**	Approx. Standards Compliance Year	Industry Conversion Costs *(Millions)*	Industry Conversion Costs / Equipment Revenue***
Room Air Conditioners 88 FR 34298 (May 26, 2023)	8	1	2026	$24.8 (2021$)	0.4%
Consumer Pool Heaters 88 FR 34624 (May 30, 2023)	20	1	2028	$48.4 (2021$)	1.5%
Consumer Water Heaters† 88 FR 49058 (July 28, 2023)	22	1	2030	$228.1 (2022$)	1.3%
Consumer Boilers† 88 FR 55128 (August 14, 2023)	24	2	2030	$98.0 (2022$)	3.6%
Walk-in Coolers and Freezers† 88 FR 60746 (September 5, 2023)	79	3	2027	$89.0 (2022$)	0.8%
Commercial Water Heating Equipment 88 FR 69686 (October 6, 2023)	15	1	2026	$42.7 (2022$)	5.3%
Consumer Furnaces 88 FR 87502 (December 18, 2023)	15	6	2029	$162.0 (2022$)	1.8%
Fans and Blowers† 89 FR 3714 (January 19, 2024)	87	2	2030	$888.1 (2022$)	2.4%

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

** This column presents the number of OEMs producing ACUACs and ACUHPs that are also listed as OEMs in the identified energy conservation standard that is contributing to cumulative regulatory burden.

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

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

Refrigerant Regulations

DOE evaluated the potential impacts of State and Federal refrigerant regulations, such as the California Air Resources Board (''CARB'') rulemaking prohibiting the use of refrigerants with a GWP of 750 or greater starting January 1, 2025 for ''Other Air-conditioning Equipment,'' which includes covered equipment under this rulemaking,[78] and

[78] State of California Air Resource Board, ''Prohibitions on Use of Certain Hydrofluorocarbons in Stationary Refrigeration, Stationary Air-

Continued

the October 2023 EPA Final Rule which establishes a GWP limit of 700 for refrigerants used in light commercial air conditioning and heat pump systems (which includes ACUACs and ACUHPs) manufactured January 1, 2025, or later. 88 FR 73098, 73206, 73208. Based on market research and information from manufacturer interviews, DOE expects that ACUAC/HP manufacturers will transition to flammable refrigerants (*e.g.,* R–32) in response to these refrigerant GWP restrictions. *See* section IV.C.4 of this document for additional information. DOE understands that switching from non-flammable to flammable refrigerants requires time and investment to redesign ACUAC/HP units and to upgrade production facilities to accommodate the additional structural and safety precautions required. DOE expects manufacturers will need to transition to an A2L[79] refrigerant to comply with upcoming refrigerant regulations, prior to the expected 2029 compliance date of the amended energy conservation standards.

Investments required to transition to flammable refrigerants in response to Federal or State regulations, including EPA's final rule, necessitate a level of resource allocation beyond typical annual R&D and capital expenditures. DOE considers the cost associated with the refrigerant transition in its GRIM to be independent of DOE actions related to any amended energy conservation standards. DOE accounted for the costs associated with redesigning ACUAC/HPs to make use of flammable refrigerants in the GRIM in the no-new-standards case and standards cases to reflect the cumulative regulatory burden from Federal and State refrigerant regulation. DOE relied on manufacturer feedback in confidential interviews and a report prepared by CARB,[80] to estimate the industry refrigerant transition costs. To avoid underestimating the potential costs, DOE used the more conservative costs reported in the report prepared by CARB. Based on feedback, DOE assumed that the transition to low-GWP refrigerants would require industry to invest approximately $210 million in equipment redesign.

3. National Impact Analysis

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

a. Significance of Energy Savings

To estimate the energy savings attributable to potential amended standards for ACUACs and ACUHPs, 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 equipment purchased in the 30-year period that begins in the year of anticipated compliance with amended standards (2029–2058). Table V.16 presents DOE's projections of the national energy savings for each TSL considered for ACUACs and ACUHPs. The savings were calculated using the approach described in section IV.H.2 of this document.

conditioning, and Other End-Uses Regulation,'' Amendments effective January 1, 2022 (available at: *ww2.arb.ca.gov/sites/default/files/barcu/regact/2020/hfc2020/frorevised.pdf*) (last accessed Oct. 18, 2023).

[79] A2L is a refrigerant classification from the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (''ASHRAE'') Standard 34: ''Designation and Safety Classification of Refrigerants.'' The A2L class defines refrigerants that are nontoxic, but mildly flammable. *See* section IV.C.4 of this document for additional discussion on low-GWP refrigerants.

[80] Report prepared by the state of California's Air Resources Board, ''Proposed Amendments to the Prohibitions on Use of Certain Hydrofluorocarbons in Stationary Refrigeration, Chillers, Aerosols, Propellants, and Foam End-Uses Regulation'' (2020) (available at: *ww2.arb.ca.gov/sites/default/files/barcu/regact/2020/hfc2020/appb.pdf?_ga=2.199664686.188689668.1697147618-702155270.1695067053*) (last accessed Oct. 18, 2023).

Table V.16 Cumulative National Energy Savings for ACUACs and ACUHPs; 30 Years of Shipments (2029–2058)

Energy Savings	Equipment Class	Trial Standard Level			
		1	2	3	4
		(quads)			
Source Energy	Small AC	1.5	2.4	3.1	5.0
	Large AC	0.6	0.6	1.2	4.1
	Very Large AC	0.7	0.7	0.7	4.2
	Small HP	0.2	0.3	0.3	0.6
	Large HP	0.0	0.0	0.1	0.2
	Very Large HP	0.0	0.0	0.0	0.2
	Total	3.0	4.1	5.4	14.4
FFC Energy	Small AC	1.5	2.5	3.2	5.2
	Large AC	0.6	0.6	1.2	4.2
	Very Large AC	0.7	0.7	0.7	4.4
	Small HP	0.2	0.3	0.3	0.6
	Large HP	0.0	0.0	0.1	0.2
	Very Large HP	0.0	0.0	0.0	0.2
	Total	3.1	4.2	5.5	14.8

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 nine years, rather than 30 years, of equipment shipments. The choice of a nine-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 equipment lifetime, equipment manufacturing cycles, or other factors specific to ACUACs and ACUHPs. 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 nine-year analytical period are presented in Table V.17. The impacts are counted over the lifetime of ACUACs and ACUHPs purchased in 2029–2037.

[81] U.S. Office of Management and Budget, *Circular A–4: Regulatory Analysis* (Sept. 17, 2003) (available at: *www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/circulars/A4/a-4.pdf* (last accessed Oct. 23, 2023).

[82] For ASHRAE equipment, EPCA requires DOE to review its standards every six years, and requires, for certain products, a three-year period after any new standard is promulgated before compliance is required, except that in no case may any new standards be required within six years of the compliance date of the previous standards. (42 U.S.C. 6313(a)(6)(C)) If DOE makes a determination that amended standards are not needed, it must conduct a subsequent review within three years following such a determination. (*Id.*) As DOE is evaluating the need to amend the standards, the sensitivity analysis is based on the review timeframe associated with amended standards. While adding a six-year review to the three-year compliance period adds up to nine years, DOE notes that it may undertake reviews at any time within the six-year period and that the three-year compliance date may yield to the six-year backstop. A nine-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 six years rather than three years.

Table V.17 Cumulative National Energy Savings for ACUACs and ACUHPs; 9 Years of Shipments (2029–2037)

Energy Savings	Equipment Class	Trial Standard Level			
		1	2	3	4
		(quads)			
Source Energy	Small AC	0.4	0.7	0.8	1.4
	Large AC	0.2	0.2	0.3	1.1
	Very Large AC	0.2	0.2	0.2	1.2
	Small HP	0.0	0.1	0.1	0.2
	Large HP	0.0	0.0	0.0	0.1
	Very Large HP	0.0	0.0	0.0	0.1
	Total	0.8	1.1	1.5	4.0
FFC Energy	Small AC	0.4	0.7	0.9	1.4
	Large AC	0.2	0.2	0.3	1.2
	Very Large AC	0.2	0.2	0.2	1.2
	Small HP	0.0	0.1	0.1	0.2
	Large HP	0.0	0.0	0.0	0.1
	Very Large HP	0.0	0.0	0.0	0.1
	Total	0.9	1.2	1.5	4.1

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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 ACUACs and ACUHPs. 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.18 shows the consumer NPV results with impacts counted over the lifetime of equipment purchased in 2029–2058.

[83] U.S. Office of Management and Budget, *Circular A–4: Regulatory Analysis* (Sept. 17, 2003) (available at: *www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/circulars/A4/a-4.pdf*) (last accessed Oct. 23, 2023).

Table V.18 Cumulative Net Present Value of Consumer Benefits for ACUACs and ACUHPs; 30 Years of Shipments (2029–2058)

Discount rate	Equipment Class	Trial Standard Level			
		1	2	3	4
		(billion $2022)			
3 percent	Small AC	4.5	7.0	7.4	3.0
	Large AC	2.0	2.0	4.0	8.4
	Very Large AC	2.7	2.7	2.7	8.8
	Small HP	0.6	0.8	0.8	0.4
	Large HP	0.1	0.1	0.2	0.5
	Very Large HP	0.2	0.2	0.2	0.5
	Total	10.1	13.0	15.3	21.7
7 percent	Small AC	1.4	2.1	1.9	-1.6
	Large AC	0.7	0.7	1.3	1.6
	Very Large AC	0.9	0.9	0.9	1.5
	Small HP	0.2	0.3	0.2	-0.2
	Large HP	0.0	0.0	0.1	0.1
	Very Large HP	0.1	0.1	0.1	0.1
	Total	3.2	4.0	4.4	1.5

The NPV results based on the aforementioned nine-year analytical period are presented in Table V.19. The impacts are counted over the lifetime of equipment purchased in 2029–2037. 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.19 Cumulative Net Present Value of Consumer Benefits for ACUACs and ACUHPs; 9 Years of Shipments (2029–2037)

Discount rate	Equipment Class	Trial Standard Level			
		1	2	3	4
		(billion $2022)			
3 percent	Small AC	1.7	2.6	2.8	1.2
	Large AC	0.8	0.8	1.5	3.2
	Very Large AC	1.0	1.0	1.0	3.3
	Small HP	0.2	0.3	0.3	0.2
	Large HP	0.0	0.0	0.1	0.2
	Very Large HP	0.1	0.1	0.1	0.2
	Total	3.8	4.8	5.7	8.2
7 percent	Small AC	0.7	1.0	0.9	-0.8
	Large AC	0.3	0.3	0.6	0.8
	Very Large AC	0.5	0.5	0.5	0.8
	Small HP	0.1	0.1	0.1	-0.1
	Large HP	0.0	0.0	0.0	0.1
	Very Large HP	0.0	0.0	0.0	0.1
	Total	1.6	2.0	2.2	0.8

The previous results reflect the use of a default (constant) trend to estimate the change in price for ACUACs and ACUHPs over the analysis period (see section IV.H of this document). DOE also conducted a sensitivity analysis that considered one scenario with a declining price trend in combination with *AEO* High-Economic-Growth (high benefit) and one scenario with an increasing price trend in combination with *AEO* Low-Economic-Growth (low benefit). For 30-year shipments at the amended TSL, in the high benefit scenario, NPV of consumer benefits results at 3 percent and 7 percent discount rates, respectively, are $17.3 billion and $5.2 billion USD. In the low benefit scenario, NPV of consumer benefits results at 3 percent and 7 percent discount rates, respectively, are $14.0 billion and $3.9 billion USD. In the reference scenario, the NPV of consumer benefits results at 3 percent and 7 percent discount rates, respectively, are $15.3 billion and $4.4 billion USD. The full results of these alternative cases are presented in appendix 10C of the direct final rule TSD.

c. Indirect Impacts on Employment

DOE estimates that amended energy conservation standards for ACUACs and ACUHPs will reduce energy expenditures for consumers of that equipment, with the resulting net savings being redirected to other forms of economic activity. These expected shifts in spending and economic activity could affect the demand for labor. As described in section IV.N of this document, DOE used an input/output model of the U.S. economy to estimate indirect employment impacts of the TSLs that DOE considered. There are uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Therefore, DOE generated results for near-term timeframes (2029–2034), 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 Equipment

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 ACUACs and ACUHPs under consideration in this rulemaking. Manufacturers of this equipment 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 of this document, EPCA directs the Attorney General of the United States (''Attorney General'') to determine the impact, if any, of any lessening of competition likely to result from a proposed standard and to transmit such determination in writing to the Secretary within 60 days of the publication of a proposed rule, together with an analysis of the nature and extent of the impact. To assist the Attorney General in making this determination, DOE has provided DOJ with copies of the direct final rule, the related NOPR, and the accompanying TSD for review. DOE will consider DOJ's comments on the DFR in determining how to proceed with this rulemaking. 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 any 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 ACUACs and ACUHPs is expected to yield environmental benefits in the form of reduced emissions of certain air pollutants and greenhouse gases. Table V.20 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.

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Table V.20 Cumulative Emissions Reduction for ACUACs and ACUHPs Shipped in 2029–2058

Pollutant (unit)	Trial Standard Level			
	1	2	3	4
Power Sector Emissions				
CO_2 (million metric tons)	56.33	75.77	99.52	266.67
CH_4 (thousand tons)	3.29	4.43	5.82	15.57
N_2O (thousand tons)	0.45	0.60	0.79	2.11
NO_X (thousand tons)	23.23	31.30	41.13	109.77
SO_2 (thousand tons)	14.01	18.85	24.76	66.29
Hg (tons)	0.09	0.13	0.17	0.45
Upstream Emissions				
CO_2 (million metric tons)	5.22	7.02	9.22	24.72
CH_4 (thousand tons)	475.64	639.48	839.72	2,252.67
N_2O (thousand tons)	0.02	0.03	0.04	0.11
NO_X (thousand tons)	81.55	109.64	143.97	386.21
SO_2 (thousand tons)	0.30	0.40	0.53	1.42
Hg (tons)	0.00	0.00	0.00	0.00
Total FFC Emissions				
CO_2 (million metric tons)	61.55	82.79	108.73	291.39
CH_4 (thousand tons)	478.93	643.91	845.55	2,268.24
N_2O (thousand tons)	0.47	0.63	0.83	2.21
NO_X (thousand tons)	104.78	140.93	185.10	495.97
SO2 (thousand tons)	14.31	19.25	25.29	67.71
Hg (tons)	0.09	0.13	0.17	0.45

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As part of the analysis for this rulemaking, DOE estimated monetary benefits likely to result from the reduced emissions of CO_2 that DOE estimated for each of the considered TSLs for ACUACs and ACUHPs. Section IV.L of this document discusses the SC–CO_2 values that DOE used. Table V.21 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.21 Present Value of CO_2 Emissions Reduction for ACUACs and ACUHPs Shipped in 2029–2058

TSL	SC-CO_2 Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average			95th-percentile
	(million 2022$)			
1	486.1	2,144.7	3,384.9	6,489.2
2	662.7	2,922.2	4,611.1	8,842.4
3	876.0	3,861.9	6,093.4	11,685.9
4	2,265.9	10,006.0	15,796.3	30,273.8

As discussed in section IV.L.2 of this document, DOE estimated the monetized climate benefits likely to result from the reduced emissions of CH_4 and N_2O that DOE estimated for each of the considered TSLs for ACUACs and ACUHPs. Table V.22 presents the value of the CH_4 emissions reduction at each TSL, and Table V.23 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.22 Present Value of Methane Emissions Reduction for ACUACs and ACUHPs Shipped in 2029–2058

TSL	SC-CH_4 Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average			95th-percentile
	(*million 2022$*)			
1	176.6	550.1	774.6	1,455.6
2	240.7	749.0	1,054.4	1,981.6
3	318.1	989.6	1,393.1	2,618.1
4	823.9	2,569.2	3,618.5	6,798.4

Table V.23 Present Value of Nitrous Oxide Emissions Reduction for ACUACs and ACUHPs Shipped in 2029–2058

TSL	SC-N_2O Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average			95th-percentile
	(*million 2022$*)			
1	1.5	6.0	9.3	16.0
2	2.0	8.1	12.7	21.8
3	2.6	10.8	16.8	28.7
4	6.8	27.9	43.5	74.5

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 are 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 ACUACs and ACUHPs. The dollar-per-ton values that DOE used are discussed in section IV.L of this document. Table V.24 presents the present value for NO_X emissions reduction for each TSL calculated using 7-percent and 3-percent discount rates, and Table V.25 presents similar results for SO_2 emissions reductions. The results in these tables reflect application of EPA's low dollar-per-ton values, which reflects DOE's primary estimate. 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 NO_X Emissions Reduction for ACUACs and ACUHPs Shipped in 2029–2058

TSL	7% Discount Rate	3% Discount Rate
	(*million 2022$*)	
1	4,144.9	1,392.2
2	5,622.5	1,899.5
3	7,414.1	2,510.5
4	19,435.2	6,484.2

Table V.25 Present Value of SO_2 Emissions Reduction for ACUACs and ACUHPs Shipped in 2029–2058

TSL	3% Discount Rate	7% Discount Rate
	(*million 2022$*)	
1	799.5	272.5
2	1,084.6	371.8
3	1,430.3	491.4
4	3,748.2	1,268.7

The benefits of reduced CO_2, CH_4, and N_2O emissions are collectively referred to as ''climate benefits.'' The effects of SO_2 and NO_X emissions reductions are collectively referred to as ''health benefits.'' Not all the public health and environmental benefits from the reduction of greenhouse gases, NO_X, and SO_2 are captured in the values above, and additional unquantified benefits from the reductions of those pollutants, as well as from the reduction of direct PM and other co-pollutants, may be significant. DOE has not included monetary benefits of the reduction of Hg emissions for this direct final rule because the amount of reduction is expected the be very small.

7. Other Factors

The Secretary of Energy, in determining whether a standard is economically justified, may consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6313(a)(6)(B)(ii)(VII)) No other factors were considered in this analysis.

8. Summary of Economic Impacts

Table V.26 presents the NPV values that result from adding the monetized estimates of the potential economic, climate, and health benefits resulting from reduced GHG, 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 ACUACs and ACUHPs, and are measured for the lifetime of equipment shipped in 2029–2058. 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 ACUACs and ACUHPs shipped in 2029–2058. The climate benefits associated with four SC–GHG estimates are shown in Table V.26. DOE does not have a single, central SC–GHG point estimate, and it emphasizes the value of considering the benefits calculated using all four SC–GHG estimates.

Table V.26 NPV of Consumer Benefits Combined with Present Value of Monetized Climate Benefits and Health Benefits from Emissions Reductions

Category	TSL 1	TSL 2	TSL 3	TSL 4
3% discount rate for Consumer NPV and Health Benefits (billion 2022$)				
5.0% Average SC-GHG Case	15.7	20.6	25.3	48.0
3.0% Average SC-GHG Case	17.8	23.3	29.0	57.5
2.5% Average SC-GHG Case	19.2	25.3	31.6	64.3
3.0% 95^{th}-percentile SC-GHG Case	23.0	30.5	38.5	82.0
7% discount rate for Consumer NPV and Health Benefits (billion 2022$)				
5.0% Average SC-GHG Case	5.5	7.2	8.6	12.4
3.0% Average SC-GHG Case	7.6	10.0	12.3	21.9
2.5% Average SC-GHG Case	9.0	12.0	14.9	28.8
3.0% 95^{th}-percentile SC-GHG Case	12.8	17.1	21.7	46.4

C. Conclusion

As noted previously, EPCA specifies that, for any commercial and industrial equipment addressed under 42 U.S.C. 6313(a)(6)(A)(i), DOE may prescribe an energy conservation standard more stringent than the level for such equipment in ASHRAE Standard 90.1, as amended,[84] only if "clear and convincing evidence" shows that a more-stringent standard would result in significant additional conservation of energy and is technologically feasible and economically justified. (42 U.S.C. 6313(a)(6)(A)(ii)(II)) For this direct final rule, DOE considered the impacts of amended standards for ACUACs and ACUHPs 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 additional amount of energy.

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

1. Benefits and Burdens of TSLs Considered for ACUACs and ACUHPs Standards

Table V.27 and Table V.28 summarize the quantitative impacts estimated for each TSL for ACUACs and ACUHPs. The national impacts are measured over the lifetime of ACUACs and ACUHPs purchased in the 30-year period that begins in the anticipated year of compliance with amended standards (2029–2058). The energy savings, emissions reductions, and value of emissions reductions refer to full-fuel-cycle results. DOE is presenting monetized benefits of GHG emissions reductions in accordance with the applicable Executive Orders, and DOE would reach the same conclusion presented in this document in the absence of the social cost of greenhouse gases, including the Interim Estimates presented by the IWG. The efficiency levels contained in each TSL are described in section V.A of this document.

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[84] As discussed in section II.B.2, ASHRAE 90.1–2019 updated the minimum efficiency levels for ACUACs and ACUHPs to align with those adopted by DOE in the January 2016 Direct Final Rule—*i.e.,* ASHRAE 90.1–2019 includes minimum efficiency levels that are aligned with the current Federal energy conservation standards. ASHRAE 90.1–2022 includes the same minimum efficiency levels for ACUACs and ACUHPs as ASHRAE 90.1–2019.

Table V.27 Summary of Analytical Results for ACUACs and ACUHPs TSLs: National Impacts

Category	TSL 1	TSL 2	TSL 3 (Recommended)	TSL 4
Cumulative FFC National Energy Savings (*quads*)				
Quads	3.13	4.20	5.52	14.81
Cumulative FFC Emissions Reduction (*total FFC emissions*)				
CO_2 (*million metric tons*)	61.55	82.79	108.73	291.39
CH_4 (*thousand tons*)	478.93	643.91	845.55	2,268.24
N_2O (*thousand tons*)	0.47	0.63	0.83	2.21
SO_2 (*thousand tons*)	14.31	19.25	25.29	67.71
NO_X (*thousand tons*)	104.78	140.93	185.10	495.97
Hg (*tons*)	0.09	0.13	0.17	0.45
Present Value of Benefits and Costs (*3% discount rate, billion 2022$*)				
Consumer Operating Cost Savings	13.52	18.23	23.89	61.32
Climate Benefits*	2.70	3.68	4.86	12.60
Health Benefits**	4.94	6.71	8.84	23.18
Total Monetized Benefits†	21.17	28.62	37.59	97.11
Consumer Incremental Equipment Costs‡	3.40	5.27	8.59	39.65
Consumer Net Benefits	10.12	12.96	15.30	21.67
Total Net Benefits	17.77	23.35	29.00	57.46
Present Value of Benefits and Costs (*7% discount rate, billion 2022$*)				
Consumer Operating Cost Savings	5.02	6.81	8.94	22.61
Climate Benefits*	2.70	3.68	4.86	12.60
Health Benefits**	1.66	2.27	3.00	7.75
Total Monetized Benefits†	9.39	12.76	16.81	42.96
Consumer Incremental Equipment Costs‡	1.81	2.80	4.56	21.06
Consumer Net Benefits	3.22	4.01	4.39	1.54
Total Net Benefits	7.58	9.96	12.25	21.90

Note: This table presents the costs and benefits associated with ACUACs and ACUHPs shipped in 2029−2058. These results include benefits to consumers which accrue after 2058 from the equipment shipped in 2029−2058.

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

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

† Total and net benefits include consumer, climate, and health benefits that can be 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.

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

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Table V.28 Summary of Analytical Results for ACUACs and ACUHPs TSLs: Manufacturer and Consumer Impacts

Category	TSL 1	TSL 2	TSL 3 (Recommended)	TSL 4
Manufacturer Impacts				
Industry NPV (*million 2022$*) (No-new-standards case INPV = 2,653.0)	2,560.1 - 2,608.8	2,511.2 - 2,577.0	2,459.1 - 2,573.5	1,102.4 - 1,822.9
Industry NPV (*% change*)	(3.5) - (1.7)	(5.3) - (2.9)	(7.3) - (3.0)	(58.4) - (31.3)
Consumer Average LCC Savings (*2022$*)				
Small ACUACs	1,047	1,523	1,380	242
Large ACUACs	1,363	1,363	2,488	3,880
Very Large ACUACs	6,431	6,431	6,431	12,766
Shipment-Weighted Average*	1,662	1,974	2,154	2,379
Consumer Simple PBP (*years*)				
Small ACUACs	4.72	4.82	5.91	10.44
Large ACUACs	3.45	3.45	3.45	7.05
Very Large ACUACs	1.13	1.13	1.13	7.46
Shipment-Weighted Average*	4.05	4.12	4.83	9.32
Percentage of Consumers that Experience a Net Cost				
Small ACUACs	22	9	26	60
Large ACUACs	3	3	4	31
Very Large ACUACs	1	1	1	24
Shipment-Weighted Average*	15	7	18	49

Note: Parentheses indicate negative (-) values.
* Weighted by shares of each equipment class in total projected shipments in 2022.

DOE first considered TSL 4, which represents the max-tech efficiency levels. The max-tech efficiency levels for all equipment classes would require complete redesigns of almost all models currently available on the market to be optimized around the new test procedure and energy efficiency metrics to provide better field performance. TSL 4 could necessitate using a combination of numerous design options, including the most efficient compressors, fans and motor designs, more-efficient heat exchangers, and/or advanced controls. TSL 4 would save an estimated 14.8 quads of energy, an amount DOE considers significant. Under TSL 4, the NPV of consumer net benefit would be $1.5 billion using a discount rate of 7 percent, and $21.7 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 4 are 291.4 Mt of CO_2, 67.7 thousand tons of SO_2, 496.0 thousand tons of NO_X, 0.45 tons of Hg, 2,268.2 thousand tons of CH_4, and 2.2 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 $12.6 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 4 is $7.8 billion using a 7-percent discount rate and $23.2 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 $21.9 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 4 is $57.5 billion. The estimated total NPV is provided for additional information; however, DOE primarily relies upon the NPV of consumer benefits when determining whether a potential standard level is economically justified.

At TSL 4, the average LCC impact is a savings of $242 for small ACUACs, $3,880 for large ACUACs, and $12,766 for very large ACUACs. The simple payback period is 10 years for small ACUACs and seven years for large and very large ACUACs. The fraction of consumers experiencing a net LCC cost is 60 percent for small ACUACs, 31 percent for large ACUACs, and 24 percent for very large ACUACs. On a shipment-weighted average basis, the average LCC impact is a savings of $2,379, the simple payback period is 9 years, and the fraction of consumers experiencing a net LCC cost is 49 percent.

At TSL 4, the projected change in INPV ranges from a decrease of $1,550.6 million to a decrease of $830.1 million, which corresponds to decreases of 58.4 percent to 31.3 percent, respectively. DOE estimates that industry would need to invest $1,891 million to comply with standards set at TSL 4. DOE estimates that approximately 2 percent of small ACUAC/HP models, 10 percent of large ACUAC/HP models, and 1 percent of very large ACUAC/HP models currently available for purchase meet the efficiency levels that would be required at TSL 4 after testing using the amended test procedure and when represented in the new metric. Very few manufacturers produce equipment at TSL 4 efficiency levels at this time. DOE estimates that only three of the nine manufacturers of small ACUACs/HPs currently offer models that meet the efficiency levels that would be required for small ACUACs/HPs at TSL 4. DOE estimates that only two of the eight manufacturers of large ACUACs/HPs currently offer models that meet the efficiency levels that would be required for large ACUACs/HPs at TSL 4. DOE estimates that only one of the eight manufacturers of very large ACUACs/HPs currently offers models that meet the efficiency level that would be required for very large ACUACs/HPs at TSL 4.

At TSL 4, DOE understands that all of the manufacturers would need to utilize significant engineering resources to redesign their current offerings to bring them into compliance with TSL 4 efficiencies. All manufacturers would have to invest heavily in their production facilities and source more-efficient components for incorporation into their designs. One of the challenges that certain members of the ACUAC/HP Working Group expressed was ensuring the footprint of the large and very large ACUACs and ACUHPs did not grow to a level that was not sustainable for existing retrofits. While there was some uncertainty surrounding what those footprints might look like, most manufacturers were generally concerned that TSL 4 could require such increases especially for very large models. DOE understands that to meet max-tech IVEC levels, a high fraction of models would need larger cabinet footprints to accommodate the increased size of efficiency-improving design options, which would require substantial investment in retooling as well as redesign engineering efforts.

DOE estimates that at TSL 4, most manufacturers would be required to redesign every ACUAC/HP model offering covered by this rulemaking. Some manufacturers may not have the engineering capacity to complete the necessary redesigns within the compliance period. If manufacturers were unable to redesign all their covered ACUAC/HP models within the compliance period, they would likely prioritize redesigns based on model sales volume. In such case, model offerings of large and very large ACUACs/HPs might decrease given that there are many capacities offered for large and very large ACUACs/HPs and comparatively fewer shipments across which to distribute conversion costs. Furthermore, DOE recognizes that a standard set at max-tech could greatly limit equipment differentiation in the ACUAC/ACUHP market.

Based upon the previous considerations, the Secretary concludes that at TSL 4 for ACUACs and ACUHPs, the benefits of energy savings, positive NPV of consumer benefits, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the impacts on manufacturers, including the large conversion costs, profit margin impacts that could result in a large reduction in INPV, and the scale and magnitude of the redesign efforts needed for manufacturers to bring their current equipment offerings into compliance at this TSL. DOE is concerned that manufacturers may narrow their equipment offerings and focus on high-volume models to meet the standard within the compliance window. DOE is also concerned with the potential footprint implications especially for very large ACUAC/HP models as manufacturer optimize around the new test procedure and metric for the largest of ACUAC/HP models. Consequently, DOE has concluded that it is unable to make a determination, supported by clear and convincing evidence, that TSL 4 is economically justified.

DOE then considered TSL 3 (the Recommended TSL), which represents efficiency levels 4, 2, and 1 for small, large, and very large ACUACs and ACUHPs, respectively. At TSL 3 efficiency levels, DOE understands that manufacturers would likely need to implement fewer design options than needed for TSL 4. These design options could include increasing outdoor and/or indoor coil size, modifying compressor staging, and improving fan and/or fan motor efficiency in order to meet these levels. These technologies and design paths are familiar to manufacturers as they produce equipment today that can meet TSL 3 efficiency levels, but they are not optimized around the new test procedure and metrics, which are more representative of field performance. The Recommended TSL would save an estimated 5.5 quads of energy, an amount DOE considers significant. Under TSL 3, the NPV of consumer net benefit would be $4.4 billion using a discount rate of 7 percent, and $15.3 billion using a discount rate of 3 percent.

The cumulative emissions reductions at the Recommended TSL are 108.7 Mt of CO_2, 25.3 thousand tons of SO_2, 185.1 thousand tons of NO_X, 0.2 tons of Hg, 845.6 thousand tons of CH_4, and 0.8 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 $4.86 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at the Recommended TSL is $3.0 billion using a 7-percent discount rate and $8.8 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, health benefits from reduced SO_2 and NO_X emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 3 is $12.3 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 3 is $29.0 billion. The estimated total NPV is provided for additional information; however, DOE primarily relies upon the NPV of consumer benefits when determining whether a potential standard level is economically justified.

At the Recommended TSL, the average LCC impact is a savings of $1,380 for small ACUACs, $2,488 for large ACUACs, and $6,431 for very large ACUACs. The simple payback period is six years for small ACUACs, 3.5 years for large ACUACs, and 1 year for very large ACUACs. The fraction of consumers experiencing a net LCC cost is 26 percent for small ACUACs, 4 percent for large ACUACs, and 1 percent for very large ACUACs. On a shipment-weighted average basis, the average LCC impact is a savings of $2,154, the simple payback period is 4.8 years, and the fraction of consumers experiencing a net LCC cost is 18 percent.

At the Recommended TSL, TSL 3, the projected change in INPV ranges from a decrease of $193.9 million to a decrease $79.5 million, which correspond to decreases of 7.3 percent and 3.0 percent, respectively. DOE estimates that industry must invest $288 million to comply with standards set at the Recommended TSL. The ACUAC/HP Working Group manufacturers were more comfortable with TSL 3 efficiency levels because the technologies anticipated to be used are the same as technologies employed in the commercially available products today. In some cases, manufacturers believed existing cabinets could be maintained, while in other cases, investments would be needed to modify production equipment for new cabinet designs to optimize fan design and accommodate other changes. DOE estimates that at TSL 3 efficiency levels manufacturers might likely utilize staging of the compressor instead of moving the entire market to variable-speed compressors. However, DOE understands that both of these are options that manufacturers may choose to improve efficiency for those models needing redesign. While DOE estimates that there are currently few shipments at the Recommended TSL, particularly for small ACUACs/HPs (as discussed in section IV.F.8 of this document), DOE estimates that approximately 37 percent of small ACUAC/HP models, 50 percent of large ACUAC/HP models, and 64 percent of very large ACUAC/HP models currently available would have the capability of meeting the efficiency levels required at

TSL 3 without being redesigned. This indicates that there is already a significant number of models available on the market that would meet the Recommended TSL when represented in the new metric, and that the technology to meet these standards is readily available. Manufacturers understand the design pathways and have significant experience with the existing technologies needed to bring the remaining models into compliance within the timeframe given. DOE estimates that five of the nine manufacturers of small ACUACs/HPs offer small ACUACs/HPs that would meet the efficiency level required at TSL 3. DOE estimates that six of the eight manufacturers of large ACUACs/HPs offer large ACUACs/HPs that meet the efficiency level required at TSL 3. DOE estimates that six of the eight manufacturers of very large ACUACs/HPs offer very large ACUACs/HPs that meet the efficiency level required at TSL 3. Given the support expressed by the ACUAC/HP Working Group for TSL 3 (the Recommended TSL), DOE believes that all manufacturers of ACUACs/HPs will be able to redesign their model offerings in the compliance timeframe.

After considering the analysis and weighing the benefits and burdens, the Secretary has concluded that the Recommended TSL (TSL 3) for ACUACs and ACUHPs is in accordance with 42 U.S.C. 6313(a)(6)(B), which contains provisions for adopting a uniform national standard more stringent than the amended ASHRAE Standard 90.1 [85] for the equipment considered in this document. Specifically, the Secretary has determined, supported by clear and convincing evidence as described in this direct final rule and accompanying TSD, that such adoption would result in significant additional 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. At this TSL, the average LCC savings for consumers of ACUACs is positive. An estimated 18 percent of ACUAC consumers experience a net cost. The FFC national energy savings are significant, and the NPV of consumer benefits is positive using both a 3-percent and 7-percent discount rate. Notably, the benefits to consumers vastly outweigh the cost to manufacturers. At the Recommended TSL, the NPV of consumer benefits, even measured at the more conservative discount rate of 7 percent, is over 47 times higher than the maximum estimated manufacturers' loss in INPV. The economic justification for standard levels at the Recommended TSL is clear and convincing even without weighing the estimated monetary value of emissions reductions. When those emissions reductions are included—representing $4.9 billion in climate benefits (associated with the average SC–GHG at a 3-percent discount rate), and $9.0 billion (using a 3-percent discount rate) or $3.0 billion (using a 7-percent discount rate) in health benefits—the rationale becomes stronger still.

Accordingly, the Secretary has concluded that the Recommended TSL (TSL 3) would offer the maximum improvement in efficiency that is technologically feasible and economically justified and would result in the significant additional conservation of energy. The Secretary has also concluded, by clear and convincing evidence, that the adoption of the recommended standards would result in the significant conservation of energy and is technologically feasible and economically justified. As stated, DOE conducts the walk-down analysis to determine the TSL that represents the maximum improvement in energy efficiency that is technologically feasible and economically justified as required under EPCA. The walk-down is not a comparative analysis, as a comparative analysis would result in the maximization of net benefits instead of energy savings that are technologically feasible and economically justified, which would be contrary to the statute. *See* 86 FR 70892, 70908 (Dec. 13, 2021). Although DOE has not conducted a comparative analysis to select the amended energy conservation standards, DOE notes that compared to TSL 4, the Recommended TSL results in shorter payback periods and fewer consumers with net cost and results in a lower maximum decrease in INPV and lower manufacturer conversion costs.

Although DOE considered amended standard levels for ACUACs and ACUHPs by grouping the efficiency levels for each equipment class into TSLs, DOE evaluates all analyzed efficiency levels in its analysis. Although there are ELs for each equipment class above those of TSL 3, the previously discussed uncertainty around the economic justification to support amended standards at TSL 4 applies for all efficiency levels higher than those of the Recommended TSL. As discussed, there is substantial uncertainty as to which combinations of design options manufacturers may employ to achieve high IVEC levels (*i.e.,* those above the Recommended TSL), which may result in very high product conversion costs. In addition, manufacturers' capacity to redesign all models that do not meet the amended standard levels is constrained by resources devoted to the low-GWP refrigerant transition and becomes increasingly difficult as minimum efficiency levels increases above the Recommended TSL. Also, similar to TSL 4, many more cabinets would need to be redesigned at efficiency levels above those at TSL 3, which would require substantial investment in design and retooling. For small ACUACs and ACUHPs, adopting an efficiency level above that at TSL 3 would result in nearly 50 percent of purchasers experiencing a net cost. For large and very large ACUACs and ACUHPs, higher ELs could potentially result in reduced configuration and model availability due to large jumps in failing model counts, high cost of redesign, high conversion costs, and lower shipment volumes (as compared to small ACUACs and ACUHPs) across which to distribute conversion costs. Therefore, DOE has concluded that it is unable to make a determination, supported by clear and convincing evidence, that efficiency levels above TSL 3 are economically justified.

However, at the Recommended TSL, there are substantially more model offerings currently available on the market, and significantly less redesign would be required than for higher efficiency levels. Additionally, the efficiency levels at TSL 3 result in positive LCC savings for all equipment classes and with far fewer consumers experiencing a net LCC cost, and mitigate the impacts on INPV and conversion costs to the point where DOE has concluded they are economically justified, as discussed for the Recommended TSL in the preceding paragraphs.

Under the authority provided by 42 U.S.C. 6295(p)(4) and 6316(b)(1), DOE is issuing this direct final rule that adopts amended energy conservation standards for ACUACs and ACUHPs at the Recommended TSL (TSL 3). The amended energy conservation standards for ACUACs and ACUHPs, which are expressed as minimum efficiency values

[85] As discussed in section II.B.2 of this document, ASHRAE Standard 90.1–2019 updated the minimum efficiency levels for ACUACs and ACUHPs to align with those adopted by DOE in the January 2016 Direct Final Rule (*i.e.,* ASHRAE Standard 90.1–2019 includes minimum efficiency levels that are aligned with the current Federal energy conservation standards). ASHRAE Standard 90.1–2022 includes the same minimum efficiency levels for ACUACs and ACUHPs as ASHRAE Standard 90.1–2019.

in terms of IVEC and IVHE, are shown in Table V.29.

Table V.29 Amended Energy Conservation Standards for ACUACs and ACUHPs (Compliance Starting 2029)

Cooling Capacity	Subcategory	Supplementary Heating Type	Minimum Efficiency
≥65,000 Btu/h and <135,000 Btu/h	AC	Electric Resistance Heating or No Heating	IVEC = 14.3
		All Other Types of Heating	IVEC = 13.8
	HP	All Types of Heating or No Heating	IVEC = 13.4 IVHE = 6.2
≥135,000 Btu/h and <240,000 Btu/h	AC	Electric Resistance Heating or No Heating	IVEC = 13.8
		All Other Types of Heating	IVEC = 13.3
	HP	All Types of Heating or No Heating	IVEC = 13.1 IVHE = 6.0
≥240,000 Btu/h and <760,000 Btu/h	AC	Electric Resistance Heating or No Heating	IVEC = 12.9
		All Other Types of Heating	IVEC = 12.2
	HP	All Types of Heating or No Heating	IVEC = 12.1 IVHE = 5.8

2. Annualized Benefits and Costs of the Standards

The benefits and costs of the adopted standards can also be expressed in terms of annualized values. The annualized net benefit is: (1) the annualized national economic value (expressed in 2022$) of the benefits from operating equipment that meet the adopted standards (consisting primarily of operating cost savings from using less energy), minus increases in equipment purchase costs, and (2) the annualized monetary value of the climate and health benefits from emissions reductions.

Table V.30 shows the annualized values for ACUACs and ACUHPs under the Recommended TSL (TSL 3), expressed in 2022$. The results under the primary estimate are as follows.

Using a 7-percent discount rate for consumer benefits and costs and health benefits from reduced NOx and SO_2 emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the standards for ACUACs and ACUHPs adopted in this rule is $481.3 million per year in increased equipment costs, while the estimated annual benefits are $944.7 million in reduced equipment operating costs, $279.2 million in climate benefits, and $317.1 million in health benefits. In this case, the net benefit would amount to $1.1 billion per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the standards for ACUACs and ACUHPs is $493.2 million per year in increased equipment costs, while the estimated annual benefits are $1371.6 billion in reduced operating costs, $279.2 million in climate benefits, and $507.9 million in health benefits. In this case, the net benefit amounts to $1.7 billion per year.

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Table V.30 Annualized Benefits and Costs of Amended Energy Conservation Standards for ACUACs and ACUHPs (Recommended TSL 3)

Category	Million 2022$/year		
	Primary Estimate	Low-Net-Benefits Estimate	High-Net-Benefits Estimate
3% discount rate			
Consumer Operating Cost Savings	1,371.6	1,326.3	1,432.6
Climate Benefits*	279.2	278.0	285.1
Health Benefits**	507.9	505.7	518.6
Total Monetized Benefits†	2,158.7	2,110.0	2,236.3
Consumer Incremental Equipment Costs‡	493.2	526.8	423.9
Total Net Benefits	1,665.5	1,583.2	1,812.4
Change in Producer Cash Flow (INPV)‡‡	(13) – (5)		
7% discount rate			
Consumer Operating Cost Savings	944.7	915.9	984.9
Climate Benefits (3% discount rate)*	279.2	278.0	285.1
Health Benefits**	317.1	316.1	323.0
Total Monetized Benefits†	1,541.0	1,509.9	1,593.0
Consumer Incremental Equipment Costs‡	481.3	509.9	422.0
Total Net Benefits	1,059.7	1,000.1	1,171.0
Change in Producer Cash Flow (INPV)‡‡	(13) – (5)		

Note: This table presents the costs and benefits associated with ACUACs and ACUHPs shipped in 2029-2058. These results include consumer, climate, and health benefits that accrue after 2058 from the products shipped in 2029-2058. The Primary, Low-Net-Benefits, and High-Net-Benefits Estimates utilize projections of energy prices and floor space from the *AEO 2023* Reference case, Low-Economic-Growth case, and High-Economic-Growth case, respectively. In addition, incremental equipment costs reflect a constant rate in the Primary Estimate, an increasing rate in the Low Net Benefits Estimate, and a decreasing rate in the High Net Benefits Estimate. The methods used to derive projected price trends are explained in sections IV.F.1 and IV.H.3 of this document. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

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

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

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

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

‡‡ Operating Cost Savings are calculated based on the life-cycle costs analysis and national impact analysis as discussed in detail below. *See* sections IV.F and IV.H of this document. DOE's national impacts analysis includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the equipment and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (*i.e.*, the manufacturer impact analysis, or "MIA"). See section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. The annualized change in INPV is calculated using the industry weighted-average cost of capital value of 5.9 percent that is estimated in the manufacturer impact analysis (see chapter 12 of the direct final rule TSD for a complete description of the industry weighted-average cost of capital). For ACUACs and ACUHPs, the annualized change in INPV ranges from -$13 million to -$5 million. DOE accounts for that range of likely impacts in analyzing whether a trial standard level is economically justified. See section V.C of this document. DOE is presenting the range of impacts to the INPV under two manufacturer markup scenarios: the Preservation of Gross Margin scenario, which is the manufacturer markup scenario used in the calculation of Consumer Operating Cost Savings in this table; and the Preservation of Operating Profit Markup scenario, where DOE assumed manufacturers would not be able to increase per-unit operating profit in proportion to increases in manufacturer production costs. DOE includes the range of estimated annualized change in INPV in the above table, drawing on the MIA explained further in section IV.J of this document to provide additional context for assessing the estimated impacts of this direct final rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A-4 and E.O. 12866. If DOE were to include the INPV into the annualized net benefit calculation for this direct final rule, the annualized net benefits would range from $1,652 million to $1,660 million at 3-percent discount rate and would range from $1,046 million to $1,054 million at 7-percent discount rate. Parentheses () indicate negative values.

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VI. Procedural Issues and Regulatory Review

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

Executive Order ("E.O.") 12866, "Regulatory Planning and Review," 58 FR 51735 (Oct. 4, 1993), as supplemented and reaffirmed by E.O. 13563, "Improving Regulation and Regulatory Review," 76 FR 3821 (Jan. 21, 2011), and amended by E.O. 14094, "Modernizing Regulatory Review," 88 FR 21879 (April 11, 2023), requires agencies, to the extent permitted by law, to: (1) propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify); (2) tailor regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations; (3) select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity); (4) to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt; and (5) identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public. DOE emphasizes as well that E.O. 13563 requires agencies to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible. In its guidance, the Office of Information and Regulatory Affairs (''OIRA'') in the Office of Management and Budget (''OMB'') has emphasized that such techniques may include identifying changing future compliance costs that might result from technological innovation or anticipated behavioral changes. For the reasons stated in 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, as amended by E.O. 14094. 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 (August 16, 2002), DOE published procedures and policies in the **Federal Register** 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 ACUAC/HP Working Group ECS Term Sheet meets the necessary requirements under EPCA to issue this direct final rule for energy conservation standards for ACUACs and ACUHPs under the procedures in 42 U.S.C. 6295(p)(4). DOE notes that the NOPR for energy conservation standards for ACUACs and ACUHPs published elsewhere in this issue of the **Federal Register** contains a regulatory flexibility analysis.

C. Review Under the Paperwork Reduction Act of 1995

Under the procedures established by the Paperwork Reduction Act of 1995 (''PRA''), a person is not required to respond to a collection of information by a Federal agency unless that collection of information displays a currently valid OMB Control Number. OMB Control Number 1910–1400, Compliance Statement Energy/Water Conservation Standards for Appliances, is currently valid and assigned to the certification reporting requirements applicable to covered products and equipment, including ACUACs and ACUHPs.

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

DOE is not amending the existing certification or reporting requirements or establishing new DOE reporting requirements for ACUACs and ACUHPs in this direct final rule. Instead, if determined to be necessary, DOE may consider proposals to establish associated certification requirements and reporting for ACUACs and ACUHPs under a separate, future rulemaking regarding appliance and equipment certification. DOE will address changes to OMB Control Number 1910–1400 at that time, as necessary. Therefore, DOE has concluded that the amended energy conservation standards for ACUACs and ACUHPs will not impose additional costs for manufacturers related to reporting and certification.

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 direct final 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 otherwise 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 (August 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 States, on the relationship between the National Government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the equipment that is the subject of this direct final rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6316(a) and (b); 42 U.S.C. 6297) Therefore, no further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

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

G. Review Under the Unfunded Mandates Reform Act of 1995

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

DOE has concluded that this direct final rule may require expenditures of $100 million or more in any one year by the private sector. Such expenditures may include: (1) investment in research and development and in capital expenditures by ACUAC and ACUHP manufacturers in the years between the direct final rule and the compliance date for the amended standards and (2) incremental additional expenditures by consumers to purchase higher-efficiency ACUACs and ACUHPs, starting at the compliance date for the applicable standard.

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

Under section 205 of UMRA, DOE is obligated to identify and consider a reasonable number of regulatory alternatives before promulgating a rule for which a written statement under section 202 is required. (2 U.S.C. 1535(a)) DOE is required to select from those alternatives the most cost-effective and least burdensome alternative that achieves the objectives of the rule, unless DOE publishes an explanation for doing otherwise, or the selection of such an alternative is inconsistent with law. As required by 42 U.S.C. 6313(a)(6)(C)(i), this direct final rule establishes amended energy conservation standards for ACUACs and ACUHPs that DOE has determined to be both technologically feasible and economically justified, and save a significant additional amount of energy, as required by 42 U.S.C. 6313(a)(6)(A)(ii)(II) and (a)(6)(B)(ii). A full discussion of the alternatives considered by DOE is presented in chapter 17 of the TSD for this direct final rule.

H. Review Under 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 amended energy conservation standards for ACUACs and ACUHPs, 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. Review Under the Information Quality Bulletin for Peer Review

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 (Jan. 14, 2005).

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 DOE's analyses. DOE is in the process of evaluating the resulting December 2021 NAS report.[87]

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 the Office of Information and Regulatory Affairs has determined that this action meets the criteria set forth in 5 U.S.C. 804(2).

[86] The 2007 ''Energy Conservation Standards Rulemaking Peer Review Report'' is available at the following website: *www.energy.gov/eere/buildings/downloads/energy-conservation-standards-rulemaking-peer-review-report-0* (last accessed Sept. 26, 2023).

[87] The December 2021 NAS report is available at *www.nationalacademies.org/our-work/review-of-methods-for-setting-building-and-equipment-performance-standards* (last accessed Dec. 5, 2023).

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 431

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

Signing Authority

This document of the Department of Energy was signed on April 12, 2024, by Jeffrey Marootian, Principal Deputy Assistant Secretary for Energy Efficiency and Renewable Energy, pursuant to delegated authority from the Secretary of Energy. That document with the original signature and date is maintained by DOE. For administrative purposes only, and in compliance with requirements of the Office of the Federal Register, the undersigned DOE Federal Register Liaison Officer has been authorized to sign and submit the document in electronic format for publication, as an official document of the Department of Energy. This administrative process in no way alters the legal effect of this document upon publication in the **Federal Register**.

Signed in Washington, DC, on April 17, 2024.

Treena V. Garrett,

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

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

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

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

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

■ 2. Revise § 431.97 to read as follows:

§ 431.97 Energy efficiency standards and their compliance dates.

(a) All basic models of commercial package air conditioning and heating equipment must be tested for performance using the applicable DOE test procedure in § 431.96, be compliant with the applicable standards set forth in paragraphs (b) through (i) of this section, and be certified to the Department under 10 CFR part 429.

(b) Each air-cooled commercial package air conditioning and heating equipment (excluding air-cooled equipment with cooling capacity less than 65,000 Btu/h and double-duct air conditioners or heat pumps) manufactured on or after January 1, 2023, and before January 1, 2029, must meet the applicable minimum energy efficiency standard level(s) set forth in table 1 to this paragraph (b). Each air-cooled commercial package air conditioning and heating equipment (excluding air-cooled equipment with cooling capacity less than 65,000 Btu/h and double-duct air conditioners or heat pumps) manufactured on or after January 1, 2029, must meet the applicable minimum energy efficiency standard level(s) set forth in table 2 to this paragraph (b). Each water-cooled commercial package air conditioning and heating equipment manufactured on or after the compliance date listed in table 3 to this paragraph (b) must meet the applicable minimum energy efficiency standard level(s) set forth in table 3. Each evaporatively-cooled commercial air conditioning and heating equipment manufactured on or after the compliance date listed in table 4 to this paragraph (b) must meet the applicable minimum energy efficiency standard level(s) set forth in table 4. Each double-duct air conditioner or heat pump manufactured on or after January 1, 2010, must meet the applicable minimum energy efficiency standard level(s) set forth in table 5 to this paragraph (b).

TABLE 1 TO PARAGRAPH (b)—MINIMUM EFFICIENCY STANDARDS FOR AIR-COOLED COMMERCIAL PACKAGE AIR CONDITIONING AND HEATING EQUIPMENT WITH A COOLING CAPACITY GREATER THAN OR EQUAL TO 65,000 BTU/h (EXCLUDING DOUBLE-DUCT AIR-CONDITIONERS AND HEAT PUMPS)

Cooling capacity	Subcategory	Supplementary heating type	Minimum efficiency [1]	Compliance date: equipment manufactured starting on . . .
Air-Cooled Commercial Package Air Conditioning and Heating Equipment With a Cooling Capacity Greater Than or Equal to 65,000 Btu/h (Excluding Double-Duct Air Conditioners and Heat Pumps)				
≥65,000 Btu/h and <135,000 Btu/h	AC	Electric Resistance Heating or No Heating	IEER = 14.8	January 1, 2023.
≥65,000 Btu/h and <135,000 Btu/h	AC	All Other Types of Heating	IEER = 14.6	January 1, 2023.
≥65,000 Btu/h and <135,000 Btu/h	HP	Electric Resistance Heating or No Heating	IEER = 14.1 COP = 3.4	January 1, 2023.
≥65,000 Btu/h and <135,000 Btu/h	HP	All Other Types of Heating	IEER = 13.9 COP = 3.4	January 1, 2023.
≥135,000 Btu/h and <240,000 Btu/h	AC	Electric Resistance Heating or No Heating	IEER = 14.2	January 1, 2023.
≥135,000 Btu/h and <240,000 Btu/h	AC	All Other Types of Heating	IEER = 14.0	January 1, 2023.
≥135,000 Btu/h and <240,000 Btu/h	HP	Electric Resistance Heating or No Heating	IEER = 13.5 COP = 3.3	January 1, 2023.
≥135,000 Btu/h and <240,000 Btu/h	HP	All Other Types of Heating	IEER = 13.3 COP = 3.3	January 1, 2023.
≥240,000 Btu/h and <760,000 Btu/h	AC	Electric Resistance Heating or No Heating	IEER = 13.2	January 1, 2023.
≥240,000 Btu/h and <760,000 Btu/h	AC	All Other Types of Heating	IEER = 13.0	January 1, 2023.
≥240,000 Btu/h and <760,000 Btu/h	HP	Electric Resistance Heating or No Heating	IEER = 12.5 COP = 3.2	January 1, 2023.
≥240,000 Btu/h and <760,000 Btu/h	HP	All Other Types of Heating	IEER = 12.3 COP = 3.2	January 1, 2023.

[1] See section 3 of appendix A to this subpart for the test conditions upon which the COP standards are based.

TABLE 2 TO PARAGRAPH (b)—UPDATED MINIMUM EFFICIENCY STANDARDS FOR AIR-COOLED COMMERCIAL PACKAGE AIR CONDITIONING AND HEATING EQUIPMENT WITH A COOLING CAPACITY GREATER THAN OR EQUAL TO 65,000 BTU/h (EXCLUDING DOUBLE-DUCT AIR CONDITIONERS AND HEAT PUMPS)

Cooling capacity	Subcategory	Supplementary heating type	Minimum efficiency	Compliance date: equipment manufactured starting on . . .
Air-Cooled Commercial Package Air Conditioning and Heating Equipment With a Cooling Capacity Greater Than or Equal to 65,000 Btu/h (Excluding Double-Duct Air Conditioners and Heat Pumps)				
≥65,000 Btu/h and <135,000 Btu/h	AC	Electric Resistance Heating or No Heating	IVEC = 14.3	January 1, 2029.
≥65,000 Btu/h and <135,000 Btu/h	AC	All Other Types of Heating	IVEC = 13.8	January 1, 2029.
≥65,000 Btu/h and <135,000 Btu/h	HP	All Types of Heating	IVEC = 13.4 IVHE = 6.2	January 1, 2029.
≥135,000 Btu/h and <240,000 Btu/h	AC	Electric Resistance Heating or No Heating	IVEC = 13.8	January 1, 2029.
≥135,000 Btu/h and <240,000 Btu/h	AC	All Other Types of Heating	IVEC = 13.3	January 1, 2029.
≥135,000 Btu/h and <240,000 Btu/h	HP	All Types of Heating	IVEC = 13.1 IVHE = 6.0	January 1, 2029.
≥240,000 Btu/h and <760,000 Btu/h	AC	Electric Resistance Heating or No Heating	IVEC = 12.9	January 1, 2029.
≥240,000 Btu/h and <760,000 Btu/h	AC	All Other Types of Heating	IVEC = 12.2	January 1, 2029.
≥240,000 Btu/h and <760,000 Btu/h	HP	All Types of Heating	IVEC = 12.1 IVHE = 5.8	January 1, 2029.

TABLE 3 TO PARAGRAPH (b)—MINIMUM COOLING EFFICIENCY STANDARDS FOR WATER-COOLED COMMERCIAL PACKAGE AIR CONDITIONING EQUIPMENT

Cooling capacity	Supplementary heating type	Minimum efficiency	Compliance date: equipment manufactured starting on . . .
Water-Cooled Commercial Package Air Conditioning Equipment			
<65,000 Btu/h	All	EER = 12.1	October 29, 2003.
≥65,000 Btu/h and <135,000 Btu/h	No Heating or Electric Resistance Heating	EER = 12.1	June 1, 2013.
≥65,000 Btu/h and <135,000 Btu/h	All Other Types of Heating	EER = 11.9	June 1, 2013.
≥135,000 Btu/h and <240,000 Btu/h	No Heating or Electric Resistance Heating	EER = 12.5	June 1, 2014.
≥135,000 Btu/h and <240,000 Btu/h	All Other Types of Heating	EER = 12.3	June 1, 2014.
≥240,000 Btu/h and <760,000 Btu/h	No Heating or Electric Resistance Heating	EER = 12.4	June 1, 2014.
≥240,000 Btu/h and <760,000 Btu/h	All Other Types of Heating	EER = 12.2	June 1, 2014.

TABLE 4 TO PARAGRAPH (b)—MINIMUM COOLING EFFICIENCY STANDARDS FOR EVAPORATIVELY-COOLED COMMERCIAL PACKAGE AIR CONDITIONING EQUIPMENT

Cooling capacity	Supplementary heating type	Minimum efficiency	Compliance date: equipment manufactured starting on . . .
Evaporatively-Cooled Commercial Package Air Conditioning Equipment			
<65,000 Btu/h	All	EER = 12.1	October 29, 2003.
≥65,000 Btu/h and <135,000 Btu/h	No Heating or Electric Resistance Heating	EER = 12.1	June 1, 2013.
≥65,000 Btu/h and <135,000 Btu/h	All Other Types of Heating	EER = 11.9	June 1, 2013.
≥135,000 Btu/h and <240,000 Btu/h	No Heating or Electric Resistance Heating	EER = 12.0	June 1, 2014.
≥135,000 Btu/h and <240,000 Btu/h	All Other Types of Heating	EER = 11.8	June 1, 2014.
≥240,000 Btu/h and <760,000 Btu/h	No Heating or Electric Resistance Heating	EER = 11.9	June 1, 2014.
≥240,000 Btu/h and <760,000 Btu/h	All Other Types of Heating	EER = 11.7	June 1, 2014.

TABLE 5 TO PARAGRAPH (b)—MINIMUM EFFICIENCY STANDARDS FOR DOUBLE-DUCT AIR CONDITIONERS OR HEAT PUMPS

Cooling capacity	Subcategory	Supplementary heating type	Minimum efficiency [1]	Compliance date: equipment manufactured starting on . . .
Double-Duct Air Conditioners or Heat Pumps				
≥65,000 Btu/h and <135,000 Btu/h	AC	Electric Resistance Heating or No Heating	EER = 11.2	January 1, 2010.
≥65,000 Btu/h and <135,000 Btu/h	AC	All Other Types of Heating	EER = 11.0	January 1, 2010.
≥65,000 Btu/h and <135,000 Btu/h	HP	Electric Resistance Heating or No Heating	EER = 11.0 COP = 3.3	January 1, 2010.
≥65,000 Btu/h and <135,000 Btu/h	HP	All Other Types of Heating	EER = 10.8 COP = 3.3	January 1, 2010.
≥135,000 Btu/h and <240,000 Btu/h	AC	Electric Resistance Heating or No Heating	EER = 11.0	January 1, 2010.
≥135,000 Btu/h and <240,000 Btu/h	AC	All Other Types of Heating	EER = 10.8	January 1, 2010.
≥135,000 Btu/h and <240,000 Btu/h	HP	Electric Resistance Heating or No Heating	EER = 10.6 COP = 3.2	January 1, 2010.
≥135,000 Btu/h and <240,000 Btu/h	HP	All Other Types of Heating	EER = 10.4 COP = 3.2	January 1, 2010.
≥240,000 Btu/h and <300,000 Btu/h	AC	Electric Resistance Heating or No Heating	EER = 10.0	January 1, 2010.
≥240,000 Btu/h and <300,000 Btu/h	AC	All Other Types of Heating	EER = 9.8	January 1, 2010.
≥240,000 Btu/h and <300,000 Btu/h	HP	Electric Resistance Heating or No Heating	EER = 9.5 COP = 3.2	January 1, 2010.
≥240,000 Btu/h and <300,000 Btu/h	HP	All Other Types of Heating	EER = 9.3 COP = 3.2	January 1, 2010.

[1] See section 3 of appendix A to this subpart for the test conditions upon which the COP standards are based.

(c) Each water-source heat pump manufactured starting on the compliance date listed in table 6 to this paragraph (c) must meet the applicable minimum energy efficiency standard level(s) set forth in this paragraph (c).

TABLE 6 TO PARAGRAPH (c)—MINIMUM EFFICIENCY STANDARDS FOR WATER-SOURCE HEAT PUMPS (WATER-TO-AIR, WATER-LOOP)

Cooling capacity	Minimum efficiency	Compliance date: equipment manufactured starting on . . .
Water-Source Heat Pumps (Water-to-Air, Water-Loop)		
<17,000 Btu/h	EER = 12.2 COP = 4.3	October 9, 2015.
≥17,000 Btu/h and <65,000 Btu/h	EER = 13.0 COP = 4.3	October 9, 2015.
≥65,000 Btu/h and <135,000 Btu/h	EER = 13.0 COP = 4.3	October 9, 2015.

(d) Each non-standard size packaged terminal air conditioner (PTAC) and packaged terminal heat pump (PTHP) manufactured on or after October 7, 2010, must meet the applicable minimum energy efficiency standard level(s) set forth in table 7 to this paragraph (d). Each standard size PTAC manufactured on or after October 8, 2012, and before January 1, 2017, must meet the applicable minimum energy efficiency standard level(s) set forth in table 7. Each standard size PTHP manufactured on or after October 8, 2012, must meet the applicable minimum energy efficiency standard level(s) set forth in table 7. Each standard size PTAC manufactured on or after January 1, 2017, must meet the applicable minimum energy efficiency standard level(s) set forth in table 8 to this paragraph (d).

TABLE 7 TO PARAGRAPH (d)—MINIMUM EFFICIENCY STANDARDS FOR PTAC AND PTHP

Equipment type	Category	Cooling capacity	Minimum efficiency	Compliance date: products manufactured on and after . . .
PTAC	Standard Size	<7,000 Btu/h	EER = 11.7	October 8, 2012.[2]
		≥7,000 Btu/h and ≤15,000 Btu/h.	EER = 13.8 − (0.3 × Cap [1])	October 8, 2012.[2]
		>15,000 Btu/h	EER = 9.3	October 8, 2012.[2]
	Non-Standard Size	<7,000 Btu/h	EER = 9.4	October 7, 2010.
		≥7,000 Btu/h and ≤15,000 Btu/h.	EER = 10.9 − (0.213 × Cap [1])	October 7, 2010.
		>15,000 Btu/h	EER = 7.7	October 7, 2010.
PTHP	Standard Size	<7,000 Btu/h	EER = 11.9 COP = 3.3	October 8, 2012.
		≥7,000 Btu/h and ≤15,000 Btu/h.	EER = 14.0 − (0.3 × Cap [1]) COP = 3.7 − (0.052 × Cap [1])	October 8, 2012.
		>15,000 Btu/h	EER = 9.5 COP = 2.9	October 8, 2012.
	Non-Standard Size	<7,000 Btu/h	EER = 9.3 COP = 2.7	October 7, 2010.
		≥7,000 Btu/h and ≤15,000 Btu/h.	EER = 10.8 − (0.213 × Cap [1]) COP = 2.9 − (0.026 × Cap [1])	October 7, 2010.
		>15,000 Btu/h	EER = 7.6 COP = 2.5	October 7, 2010.

[1] "Cap" means cooling capacity in thousand Btu/h at 95 °F outdoor dry-bulb temperature.
[2] And manufactured before January 1, 2017. See table 8 to this paragraph (d) for updated efficiency standards that apply to this category of equipment manufactured on and after January 1, 2017.

TABLE 8 TO PARAGRAPH (d)—UPDATED MINIMUM EFFICIENCY STANDARDS FOR PTAC

Equipment type	Category	Cooling capacity	Minimum efficiency	Compliance date: products manufactured on and after . . .
PTAC	Standard Size	<7,000 Btu/h	EER = 11.9	January 1, 2017.
		≥7,000 Btu/h and ≤15,000 Btu/h.	EER = 14.0 − (0.3 × Cap [1])	January 1, 2017.
		>15,000 Btu/h	EER = 9.5	January 1, 2017.

[1] "Cap" means cooling capacity in thousand Btu/h at 95 °F outdoor dry-bulb temperature.

(e)(1) Each single package vertical air conditioner and single package vertical heat pump manufactured on or after January 1, 2010, but before October 9, 2015 (for models ≥65,000 Btu/h and <135,000 Btu/h), or October 9, 2016 (for models ≥135,000 Btu/h and <240,000 Btu/h), must meet the applicable minimum energy conservation standard level(s) set forth in this paragraph (e)(1).

TABLE 9 TO PARAGRAPH (e)(1)—MINIMUM EFFICIENCY STANDARDS FOR SINGLE PACKAGE VERTICAL AIR CONDITIONERS AND SINGLE PACKAGE VERTICAL HEAT PUMPS

Equipment type	Cooling capacity	Sub-category	Efficiency level	Compliance date: products manufactured on and after . . .
Single package vertical air conditioners and single package vertical heat pumps, single-phase and three-phase.	<65,000 Btu/h	AC	EER = 9.0	January 1, 2010.
		HP	EER = 9.0 COP = 3.0	January 1, 2010.
Single package vertical air conditioners and single package vertical heat pumps.	≥65,000 Btu/h and <135,000 Btu/h	AC	EER = 8.9	January 1, 2010.
		HP	EER = 8.9 COP = 3.0	January 1, 2010.
Single package vertical air conditioners and single package vertical heat pumps.	≥135,000 Btu/h and <240,000 Btu/h	AC	EER = 8.6	January 1, 2010.
		HP	EER = 8.6 COP = 2.9	January 1, 2010.

(2) Each single package vertical air conditioner and single package vertical heat pump manufactured on and after October 9, 2015 (for models ≥65,000 Btu/h and <135,000 Btu/h), or October 9, 2016 (for models ≥135,000 Btu/h and <240,000 Btu/h), but before September 23, 2019, must meet the applicable minimum energy conservation standard level(s) set forth in this paragraph (e)(2).

TABLE 10 TO PARAGRAPH (e)(2)—MINIMUM EFFICIENCY STANDARDS FOR SINGLE PACKAGE VERTICAL AIR CONDITIONERS AND SINGLE PACKAGE VERTICAL HEAT PUMPS

Equipment type	Cooling capacity	Sub-category	Efficiency level	Compliance date: products manufactured on and after . . .
Single package vertical air conditioners and single package vertical heat pumps, single-phase and three-phase.	<65,000 Btu/h	AC	EER = 9.0	January 1, 2010.
		HP	EER = 9.0 COP = 3.0	January 1, 2010.
Single package vertical air conditioners and single package vertical heat pumps.	≥65,000 Btu/h and <135,000 Btu/h	AC	EER = 10.0	October 9, 2015.
		HP	EER = 10.0 COP = 3.0	October 9, 2015.
Single package vertical air conditioners and single package vertical heat pumps.	≥135,000 Btu/h and <240,000 Btu/h	AC	EER = 10.0	October 9, 2016.
		HP	EER = 10.0 COP = 3.0	October 9, 2016.

(3) Each single package vertical air conditioner and single package vertical heat pump manufactured on and after September 23, 2019, must meet the applicable minimum energy conservation standard level(s) set forth in this paragraph (e)(3).

TABLE 11 TO PARAGRAPH (e)(3)—UPDATED MINIMUM EFFICIENCY STANDARDS FOR SINGLE PACKAGE VERTICAL AIR CONDITIONERS AND SINGLE PACKAGE VERTICAL HEAT PUMPS

Equipment type	Cooling capacity	Sub-category	Efficiency level	Compliance date: products manufactured on and after . . .
Single package vertical air conditioners and single package vertical heat pumps, single-phase and three-phase.	<65,000 Btu/h	AC	EER = 11.0	September 23, 2019.
		HP	EER = 11.0 COP = 3.3	September 23, 2019.
Single package vertical air conditioners and single package vertical heat pumps.	≥65,000 Btu/h and <135,000 Btu/h	AC	EER = 10.0	October 9, 2015.
		HP	EER = 10.0 COP = 3.0	October 9, 2015.
Single package vertical air conditioners and single package vertical heat pumps.	≥135,000 Btu/h and <240,000 Btu/h	AC	EER = 10.0	October 9, 2016.
		HP	EER = 10.0 COP = 3.0	October 9, 2016.

(f)(1) Each computer room air conditioner with a net sensible cooling capacity less than 65,000 Btu/h manufactured on or after October 29, 2012, and before May 28, 2024 and each computer room air conditioner with a net sensible cooling capacity greater than or equal to 65,000 Btu/h and less than 760,000 Btu/h manufactured on or after October 29, 2013, and before May 28, 2024 must meet the applicable minimum energy efficiency standard level(s) set forth in this paragraph (f)(1).

TABLE 12 TO PARAGRAPH (f)(1)—MINIMUM EFFICIENCY STANDARDS FOR COMPUTER ROOM AIR CONDITIONERS

Equipment type	Net sensible cooling capacity	Minimum SCOP efficiency	
		Downflow	Upflow
Air-Cooled	<65,000 Btu/h	2.20	2.09
	≥65,000 Btu/h and <240,000 Btu/h	2.10	1.99

TABLE 12 TO PARAGRAPH (f)(1)—MINIMUM EFFICIENCY STANDARDS FOR COMPUTER ROOM AIR CONDITIONERS—Continued

Equipment type	Net sensible cooling capacity	Minimum SCOP efficiency	
		Downflow	Upflow
	≥240,000 Btu/h and <760,000 Btu/h	1.90	1.79
Water-Cooled	<65,000 Btu/h	2.60	2.49
	≥65,000 Btu/h and <240,000 Btu/h	2.50	2.39
	≥240,000 Btu/h and <760,000 Btu/h	2.40	2.29
Water-Cooled with Fluid Economizer	<65,000 Btu/h	2.55	2.44
	≥65,000 Btu/h and <240,000 Btu/h	2.45	2.34
	≥240,000 Btu/h and <760,000 Btu/h	2.35	2.24
Glycol-Cooled	<65,000 Btu/h	2.50	2.39
	≥65,000 Btu/h and <240,000 Btu/h	2.15	2.04
	≥240,000 Btu/h and <760,000 Btu/h	2.10	1.99
Glycol-Cooled with Fluid Economizer	<65,000 Btu/h	2.45	2.34
	≥65,000 Btu/h and <240,000 Btu/h	2.10	1.99
	≥240,000 Btu/h and <760,000 Btu/h	2.05	1.94

(2) Each computer room air conditioner manufactured on or after May 28, 2024, must meet the applicable minimum energy efficiency standard level(s) set forth in this paragraph (f)(2).

TABLE 13 TO PARAGRAPH (f)(2)—UPDATED MINIMUM EFFICIENCY STANDARDS FOR FLOOR-MOUNTED COMPUTER ROOM AIR CONDITIONERS

Equipment type	Downflow and upflow ducted			Upflow non-ducted and horizontal flow		
	Net sensible cooling capacity	Minimum NSenCOP efficiency		Net sensible cooling capacity	Minimum NSenCOP efficiency	
		Downflow	Upflow ducted		Upflow non-ducted	Horizontal flow
Air-Cooled	<80,000 Btu/h	2.70	2.67	<65,000 Btu/h	2.16	2.65
	≥80,000 Btu/h and <295,000 Btu/h	2.58	2.55	≥65,000 Btu/h and <240,000 Btu/h	2.04	2.55
	≥295,000 Btu/h and <930,000 Btu/h	2.36	2.33	≥240,000 Btu/h and <760,000 Btu/h	1.89	2.47
Air-Cooled with Fluid Economizer.	<80,000 Btu/h	2.70	2.67	<65,000 Btu/h	2.09	2.65
	≥80,000 Btu/h and <295,000 Btu/h	2.58	2.55	≥65,000 Btu/h and <240,000 Btu/h	1.99	2.55
	≥295,000 Btu/h and <930,000 Btu/h	2.36	2.33	≥240,000 Btu/h and <760,000 Btu/h	1.81	2.47
Water-Cooled	<80,000 Btu/h	2.82	2.79	<65,000 Btu/h	2.43	2.79
	≥80,000 Btu/h and <295,000 Btu/h	2.73	2.70	≥65,000 Btu/h and <240,000 Btu/h	2.32	2.68
	≥295,000 Btu/h and <930,000 Btu/h	2.67	2.64	≥240,000 Btu/h and <760,000 Btu/h	2.20	2.60
Water-Cooled with Fluid Economizer.	<80,000 Btu/h	2.77	2.74	<65,000 Btu/h	2.35	2.71
	≥80,000 Btu/h and <295,000 Btu/h	2.68	2.65	≥65,000 Btu/h and <240,000 Btu/h	2.24	2.60
	≥295,000 Btu/h and <930,000 Btu/h	2.61	2.58	≥240,000 Btu/h and <760,000 Btu/h	2.12	2.54
Glycol-Cooled	<80,000 Btu/h	2.56	2.53	<65,000 Btu/h	2.08	2.48
	≥80,000 Btu/h and <295,000 Btu/h	2.24	2.21	≥65,000 Btu/h and <240,000 Btu/h	1.90	2.18
	≥295,000 Btu/h and <930,000 Btu/h	2.21	2.18	≥240,000 Btu/h and <760,000 Btu/h	1.81	2.18
Glycol-Cooled with Fluid Economizer.	<80,000 Btu/h	2.51	2.48	<65,000 Btu/h	2.00	2.44
	≥80,000 Btu/h and <295,000 Btu/h	2.19	2.16	≥65,000 Btu/h and <240,000 Btu/h	1.82	2.10
	≥295,000 Btu/h and <930,000 Btu/h	2.15	2.12	≥240,000 Btu/h and <760,000 Btu/h	1.73	2.10

TABLE 14 TO PARAGRAPH (f)(2)—MINIMUM EFFICIENCY STANDARDS FOR CEILING-MOUNTED COMPUTER ROOM AIR CONDITIONERS

Equipment type	Net sensible cooling capacity	Minimum NSenCOP efficiency	
		Ducted	Non-ducted
Air-Cooled with Free Air Discharge Condenser	<29,000 Btu/h	2.05	2.08
	≥29,000 Btu/h and <65,000 Btu/h	2.02	2.05
	≥65,000 Btu/h and <760,000 Btu/h	1.92	1.94
Air-Cooled with Free Air Discharge Condenser and Fluid Economizer	<29,000 Btu/h	2.01	2.04
	≥29,000 Btu/h and <65,000 Btu/h	1.97	2
	≥65,000 Btu/h and <760,000 Btu/h	1.87	1.89
Air-Cooled with Ducted Condenser	<29,000 Btu/h	1.86	1.89
	≥29,000 Btu/h and <65,000 Btu/h	1.83	1.86
	≥65,000 Btu/h and <760,000 Btu/h	1.73	1.75
Air-Cooled with Fluid Economizer and Ducted Condenser	<29,000 Btu/h	1.82	1.85
	≥29,000 Btu/h and <65,000 Btu/h	1.78	1.81
	≥65,000 Btu/h and <760,000 Btu/h	1.68	1.7
Water-Cooled	<29,000 Btu/h	2.38	2.41
	≥29,000 Btu/h and <65,000 Btu/h	2.28	2.31

TABLE 14 TO PARAGRAPH (f)(2)—MINIMUM EFFICIENCY STANDARDS FOR CEILING-MOUNTED COMPUTER ROOM AIR CONDITIONERS—Continued

Equipment type	Net sensible cooling capacity	Minimum NSenCOP efficiency	
		Ducted	Non-ducted
	≥65,000 Btu/h and <760,000 Btu/h	2.18	2.2
Water-Cooled with Fluid Economizer	<29,000 Btu/h	2.33	2.36
	≥29,000 Btu/h and <65,000 Btu/h	2.23	2.26
	≥65,000 Btu/h and <760,000 Btu/h	2.13	2.16
Glycol-Cooled	<29,000 Btu/h	1.97	2
	≥29,000 Btu/h and <65,000 Btu/h	1.93	1.98
	≥65,000 Btu/h and <760,000 Btu/h	1.78	1.81
Glycol-Cooled with Fluid Economizer	<29,000 Btu/h	1.92	1.95
	≥29,000 Btu/h and <65,000 Btu/h	1.88	1.93
	≥65,000 Btu/h and <760,000 Btu/h	1.73	1.76

(g)(1) Each variable refrigerant flow air conditioner or heat pump manufactured on or after the compliance date listed in table 15 to this paragraph (g)(1) and prior to January 1, 2024, must meet the applicable minimum energy efficiency standard level(s) set forth in this paragraph (g)(1).

TABLE 15 TO PARAGRAPH (g)(1)—MINIMUM EFFICIENCY STANDARDS FOR VARIABLE REFRIGERANT FLOW MULTI-SPLIT AIR CONDITIONERS AND HEAT PUMPS

Equipment type	Cooling capacity	Heating type [1]	Efficiency level	Compliance date: equipment manufactured on and after . . .
VRF Multi-Split Air Conditioners (Air-Cooled)	≥65,000 Btu/h and <135,000 Btu/h.	No Heating or Electric Resistance Heating	11.2 EER	January 1, 2010.
		All Other Types of Heating	11.0 EER	January 1, 2010.
	≥135,000 Btu/h and <240,000 Btu/h.	No Heating or Electric Resistance Heating	11.0 EER	January 1, 2010.
		All Other Types of Heating	10.8 EER	January 1, 2010.
	≥240,000 Btu/h and <760,000 Btu/h.	No Heating or Electric Resistance Heating	10.0 EER	January 1, 2010.
		All Other Types of Heating	9.8 EER	January 1, 2010.
VRF Multi-Split Heat Pumps (Air-Cooled)	≥65,000 Btu/h and <135,000 Btu/h.	No Heating or Electric Resistance Heating	11.0 EER, 3.3 COP	January 1, 2010.
		All Other Types of Heating	10.8 EER, 3.3 COP	January 1, 2010.
	≥135,000 Btu/h and <240,000 Btu/h.	No Heating or Electric Resistance Heating	10.6 EER, 3.2 COP	January 1, 2010.
		All Other Types of Heating	10.4 EER, 3.2 COP	January 1, 2010.
	≥240,000 Btu/h and <760,000 Btu/h.	No Heating or Electric Resistance Heating	9.5 EER, 3.2 COP	January 1, 2010.
		All Other Types of Heating	9.3 EER, 3.2 COP	January 1, 2010.
VRF Multi-Split Heat Pumps (Water-Source)	<17,000 Btu/h	Without Heat Recovery	12.0 EER, 4.2 COP	October 29, 2012. October 29, 2003.
		With Heat Recovery	11.8 EER 4.2 COP	October 29, 2012. October 29, 2003.
	≥17,000 Btu/h and <65,000 Btu/h.	All	12.0 EER, 4.2 COP	October 29, 2003.
	≥65,000 Btu/h and <135,000 Btu/h.	All	12.0 EER, 4.2 COP	October 29, 2003.
	≥135,000 Btu/h and <760,000 Btu/h.	Without Heat Recovery	10.0 EER, 3.9 COP	October 29, 2013.
		With Heat Recovery	9.8 EER, 3.9 COP	October 29, 2013.

[1] VRF multi-split heat pumps (air-cooled) with heat recovery fall under the category of "All Other Types of Heating" unless they also have electric resistance heating, in which case it falls under the category for "No Heating or Electric Resistance Heating."

(2) Each variable refrigerant flow air conditioner or heat pump (except air-cooled systems with cooling capacity less than 65,000 Btu/h) manufactured on or after January 1, 2024, must meet the applicable minimum energy efficiency standard level(s) set forth in this paragraph (g)(2).

TABLE 16 TO PARAGRAPH (g)(2)—UPDATED MINIMUM EFFICIENCY STANDARDS FOR VARIABLE REFRIGERANT FLOW MULTI-SPLIT AIR CONDITIONERS AND HEAT PUMPS

Equipment type	Size category	Heating type	Minimum efficiency
VRF Multi-Split Air Conditioners (Air-Cooled)	≥65,000 and <135,000 Btu/h	All	15.5 IEER.
	≥135,000 and <240,000 Btu/h	All	14.9 IEER.
	≥240,000 Btu/h and <760,000 Btu/h	All	13.9 IEER.
VRF Multi-Split Heat Pumps (Air-Cooled)	≥65,000 and <135,000 Btu/h	Heat Pump without Heat Recovery	14.6 IEER, 3.3 COP.
		Heat Pump with Heat Recovery	14.4 IEER, 3.3 COP.
	≥135,000 and <240,000 Btu/h	Heat Pump without Heat Recovery	13.9 IEER, 3.2 COP.
		Heat Pump with Heat Recovery	13.7 IEER, 3.2 COP.
	≥240,000 Btu/h and <760,000 Btu/h	Heat Pump without Heat Recovery	12.7 IEER, 3.2 COP.
		Heat Pump with Heat Recovery	12.5 IEER, 3.2 COP.
VRF Multi-Split Heat Pumps (Water-Source)	<65,000 Btu/h	Heat Pump without Heat Recovery	16.0 IEER, 4.3 COP.
		Heat Pump with Heat Recovery	15.8 IEER, 4.3 COP.
	≥65,000 and <135,000 Btu/h	Heat Pump without Heat Recovery	16.0 IEER, 4.3 COP.
		Heat Pump with Heat Recovery	15.8 IEER, 4.3 COP.
	≥135,000 and <240,000 Btu/h	Heat Pump without Heat Recovery	14.0 IEER, 4.0 COP.
		Heat Pump with Heat Recovery	13.8 IEER, 4.0 COP.
	≥240,000 Btu/h and <760,000 Btu/h	Heat Pump without Heat Recovery	12.0 IEER, 3.9 COP.
		Heat Pump with Heat Recovery	11.8 IEER, 3.9 COP.

(h) Each direct expansion-dedicated outdoor air system manufactured on or after the compliance date listed in table 17 to this paragraph (h) must meet the applicable minimum energy efficiency standard level(s) set forth in this paragraph (h).

TABLE 17 TO PARAGRAPH (h)—MINIMUM EFFICIENCY STANDARDS FOR DIRECT EXPANSION-DEDICATED OUTDOOR AIR SYSTEMS

Equipment category	Subcategory	Efficiency level	Compliance date: equipment manufactured starting on . . .
Direct expansion-dedicated outdoor air systems.	(AC)—Air-cooled without ventilation energy recovery systems.	ISMRE2 = 3.8	May 1, 2024.
	(AC w/VERS)—Air-cooled with ventilation energy recovery systems.	ISMRE2 = 5.0	May 1, 2024.
	(ASHP)—Air-source heat pumps without ventilation energy recovery systems.	ISMRE2 = 3.8 ISCOP2 = 2.05	May 1, 2024.
	(ASHP w/VERS)—Air-source heat pumps with ventilation energy recovery systems.	ISMRE2 = 5.0 ISCOP2 = 3.20	May 1, 2024.
	(WC)—Water-cooled without ventilation energy recovery systems.	ISMRE2 = 4.7	May 1, 2024.
	(WC w/VERS)—Water-cooled with ventilation energy recovery systems.	ISMRE2 = 5.1	May 1, 2024.
	(WSHP)—Water-source heat pumps without ventilation energy recovery systems.	ISMRE2 = 3.8 ISCOP2 = 2.13	May 1, 2024.
	(WSHP w/VERS)—Water-source heat pumps with ventilation energy recovery systems.	ISMRE2 = 4.6 ISCOP2 = 4.04	May 1, 2024.

(i) Air-cooled, three-phase, commercial package air conditioning and heating equipment with a cooling capacity of less than 65,000 Btu/h and air-cooled, three-phase variable refrigerant flow multi-split air conditioning and heating equipment with a cooling capacity of less than 65,000 Btu/h manufactured on or after the compliance date listed in tables 18 and 19 to this paragraph (i) must meet the applicable minimum energy efficiency standard level(s) set forth in this paragraph (i).

TABLE 18 TO PARAGRAPH (i)—MINIMUM EFFICIENCY STANDARDS FOR AIR-COOLED, THREE-PHASE, COMMERCIAL PACKAGE AIR CONDITIONING AND HEATING EQUIPMENT WITH A COOLING CAPACITY OF LESS THAN 65,000 Btu/h AND AIR-COOLED, THREE-PHASE, SMALL VARIABLE REFRIGERANT FLOW MULTI-SPLIT AIR CONDITIONING AND HEATING EQUIPMENT WITH A COOLING CAPACITY OF LESS THAN 65,000 Btu/h

Equipment type	Cooling capacity	Subcategory	Minimum efficiency	Compliance date: equipment manufactured starting on . . .
Commercial Package Air Conditioning Equipment	<65,000 Btu/h	Split-System	13.0 SEER	June 16, 2008.[1]
Commercial Package Air Conditioning Equipment	<65,000 Btu/h	Single-Package	14.0 SEER	January 1, 2017.[1]
Commercial Package Air Conditioning and Heating Equipment.	<65,000 Btu/h	Split-System	14.0 SEER 8.2 HSPF	January 1, 2017.[1]
Commercial Package Air Conditioning and Heating Equipment.	<65,000 Btu/h	Single-Package	14.0 SEER 8.0 HSPF	January 1, 2017.[1]
VRF Air Conditioners	<65,000 Btu/h		13.0 SEER	June 16, 2008.[1]

TABLE 18 TO PARAGRAPH (i)—MINIMUM EFFICIENCY STANDARDS FOR AIR-COOLED, THREE-PHASE, COMMERCIAL PACKAGE AIR CONDITIONING AND HEATING EQUIPMENT WITH A COOLING CAPACITY OF LESS THAN 65,000 BTU/h AND AIR-COOLED, THREE-PHASE, SMALL VARIABLE REFRIGERANT FLOW MULTI-SPLIT AIR CONDITIONING AND HEATING EQUIPMENT WITH A COOLING CAPACITY OF LESS THAN 65,000 BTU/h—Continued

Equipment type	Cooling capacity	Subcategory	Minimum efficiency	Compliance date: equipment manufactured starting on . . .
VRF Heat Pumps	<65,000 Btu/h		13.0 SEER 7.7 HSPF	June 16, 2008.[1]

[1] And manufactured before January 1, 2025. For equipment manufactured on or after January 1, 2025, see table 19 to this paragraph (i) for updated efficiency standards.

TABLE 19 TO PARAGRAPH (i)—UPDATED MINIMUM EFFICIENCY STANDARDS FOR AIR-COOLED, THREE-PHASE, COMMERCIAL PACKAGE AIR CONDITIONING AND HEATING EQUIPMENT WITH A COOLING CAPACITY OF LESS THAN 65,000 BTU/h AND AIR-COOLED, THREE-PHASE, SMALL VARIABLE REFRIGERANT FLOW MULTI-SPLIT AIR CONDITIONING AND HEATING EQUIPMENT WITH A COOLING CAPACITY OF LESS THAN 65,000 BTU/h

Equipment type	Cooling capacity	Subcategory	Minimum efficiency	Compliance date: equipment manufactured starting on . . .
Commercial Package Air Conditioning Equipment	<65,000 Btu/h	Split-System	13.4 SEER2	January 1, 2025.
Commercial Package Air Conditioning Equipment	<65,000 Btu/h	Single-Package	13.4 SEER2	January 1, 2025.
Commercial Package Air Conditioning and Heating Equipment.	<65,000 Btu/h	Split-System	14.3 SEER2 7.5 HSPF2	January 1, 2025.
Commercial Package Air Conditioning and Heating Equipment.	<65,000 Btu/h	Single-Package	13.4 SEER2 6.7 HSPF2	January 1, 2025.
Space-Constrained Commercial Package Air Conditioning Equipment.	≤30,000 Btu/h	Split-System	12.7 SEER2	January 1, 2025.
Space-Constrained Commercial Package Air Conditioning Equipment.	≤30,000 Btu/h	Single-Package	13.9 SEER2	January 1, 2025.
Space-Constrained Commercial Package Air Conditioning and Heating Equipment.	≤30,000 Btu/h	Split-System	13.9 SEER2 7.0 HSPF2	January 1, 2025.
Space-Constrained Commercial Package Air Conditioning and Heating Equipment.	≤30,000 Btu/h	Single-Package	13.9 SEER2 6.7 HSPF2	January 1, 2025.
Small-Duct, High-Velocity Commercial Package Air Conditioning.	<65,000 Btu/h	Split-System	13.0 SEER2	January 1, 2025.
Small-Duct, High-Velocity Commercial Package Air Conditioning and Heating Equipment.	<65,000 Btu/h	Split-System	14.0 SEER2 6.9 HSPF2	January 1, 2025.
VRF Air Conditioners	<65,000 Btu/h		13.4 SEER2	January 1, 2025.
VRF Heat Pumps	<65,000 Btu/h		13.4 SEER2 7.5 HSPF2	January 1, 2025.

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