DEPARTMENT OF ENERGY

10 CFR Part 430

[Docket Number EERE–2014–BT–STD–0048]

RIN 1904–AD37

Energy Conservation Program: Energy Conservation Standards for Residential Central 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 of 1975 (EPCA), as amended, prescribes energy conservation standards for various consumer products and certain commercial and industrial equipment, including residential central air conditioners and heat pumps. EPCA also requires the U.S. Department of Energy (DOE) to periodically determine whether more-stringent, amended standards would be technologically feasible and economically justified, and would save a significant amount of energy. In this direct final rule, DOE adopts amended energy conservation standards for residential central air conditioners and heat pumps.

DATES: The effective date of this rule is May 8, 2017 unless adverse comment is received by April 26, 2017. 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 in this final rule will be required for central air conditioners and heat pumps as specified in this final rule starting on January 1, 2023.

ADDRESSES: The docket, 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, some documents listed in the index, such as those containing information that is exempt from public disclosure, may not be publicly available.

A link to the docket Web page for residential central air conditioners and heat pumps can be found at: *www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx/ruleid/72.* The *www.regulations.gov* Web page contains instructions on how to access all documents, including public comments, in the docket.

For further information on how to submit a comment or review other public comments and the docket, contact the Appliance and Equipment Standards staff at (202) 586–6636 or by email: *Appliance_Standards_Public_Meetings@ee.doe.gov.*

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SUPPLEMENTARY INFORMATION:

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I. Synopsis of the Direct Final Rule

Title III, Part B [1] of the Energy Policy and Conservation Act of 1975 (EPCA or the Act), Public Law 94–163 (42 U.S.C. 6291–6309, as codified), established the Energy Conservation Program for Consumer Products Other Than Automobiles.[2] These products include central air conditioners (CACs) and heat pumps (HPs), the subject of this rulemaking. (42 U.S.C. 6292(a)(3))

Pursuant to EPCA, any new or amended energy conservation standard must be designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) Furthermore, the new or amended standard must result in the significant conservation of energy. (42 U.S.C. 6295(o)(3)(B)) The statute also provides that not later than six years after issuance of any final rule establishing or amending a standard, DOE must publish either a notice of determination that standards for the product do not need to be amended or a notice of proposed rulemaking including new proposed energy conservation standards (proceeding to a final rule, as appropriate). (42 U.S.C. 6295(m)(1)) Once complete, this rulemaking will satisfy these statutory requirements.

In light of the above and under the authority provided by 42 U.S.C. 6295(p)(4), DOE is issuing this direct final rule amending the energy conservation standards for residential central air conditioners and heat pumps. The amendments outlined in this document reflect the culmination of a DOE rulemaking that included the following notices and stakeholder comments thereon: November 2014 request for information (RFI) (79 FR 65603 (Nov. 5, 2014)); August 2015 notice of data availability (NODA) (80 FR 52206 (August 28, 2015)); and the 2015–2016 Appliance Standards and Rulemaking Federal Advisory Committee (ASRAC) central air conditioners and heat pumps working group negotiations, hereinafter referred to as ''the Negotiations'' (80 FR 40938 (July 14, 2015)). See section II.B.2 for a detailed history of the current rulemaking.

The consensus reached by the CAC/HP ASRAC Working Group, hereinafter referred to as ''the CAC/HP Working Group,'' on amended energy conservation standards is outlined in the ASRAC Working Group Term Sheet, hereinafter referred to as ''the Term Sheet.'' (ASRAC Working Group Term Sheet, Docket No. EERE–2014–BT–STD–0048, No. 0076) After carefully considering the Term Sheet, DOE determined that the recommendations contained therein are compliant with 42 U.S.C. 6295(o), as required by 42 U.S.C. 6295(p)(4)(A)(i) for the issuance of a direct final rule. As required by 42 U.S.C. 6295(p)(4)(A)(i), DOE is simultaneously publishing a NOPR proposing that the identical standard levels contained in this direct final rule be adopted. Consistent with the statute, DOE is providing a 110-day public comment period on the direct final rule. (42 U.S.C. 6295(p)(4)(B)) If DOE determines that any comments received provide a reasonable basis for withdrawal of the direct final rule under 42 U.S.C. 6295(o), DOE will continue the rulemaking under the NOPR. (42 U.S.C. 6295(p)(4)(C)) See section II.A for more details on DOE's statutory authority.

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

DOE conducted separate test procedure rulemakings simultaneously with the energy conservation standard rulemaking to amend the DOE central air conditioners and heat pumps test procedure. The amended DOE CAC/HP test procedure and associated rulemakings are discussed in detail in section III.F. As per the request of the CAC/HP Working Group, the analyses documented in this direct final rule are based on the DOE test procedure at the time of the 2015–2016 Negotiations. Efficiency levels selected on the basis of these analyses were then translated to efficiency levels based on the amended test procedure. This methodology was first advocated by Carrier/United Technologies Corporation (UTC) and adopted by stakeholders during the Negotiations. (ASRAC Public Meeting, No. 87 at p. 48) This methodology is also reflected in the Term Sheet. Recommendation #8 of the Term Sheet includes standard levels based on the test procedure at the time of the 2015–2016 Negotiations. (ASRAC Term Sheet, No. 76 at pp. 4–5) The standard levels established by this direct final rule are translated levels based on the test procedure established by the test procedure final rule issued by DOE on November 30, 2016, hereinafter referred to as the ''November 2016 test procedure final rule,'' (which is codified in 10 CFR part 430, subpart B, appendix M1).[3] (Docket No. EERE–2016–BT–TP–0029)

Ultimately, DOE found that the standard levels recommended in the Term Sheet would result in significant energy savings and are technologically feasible and economically justified. Table I–1 documents the amended standards for central air conditioners and heat pumps based on the DOE test procedure at the time of the 2015–2016 Negotiations. The amended standards correspond to the recommended trial standard level (TSL) (as described in section V.A) and are expressed in terms of Seasonal Energy Efficiency Ratio (SEER), Energy Efficiency Ratio (EER), and Heating Seasonal Performance Factor (HSPF). The amended standards are the same as those recommended by the Working Group. These amended standards apply to all central air conditioners and heat pumps listed in Table I–1 and manufactured in, or imported into, the United States starting on January 1, 2023. The amended

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

[2] All references to EPCA in this document refer to the statute as amended through the Energy Efficiency Improvement Act of 2015 (EEIA 2015), Public Law 114–11 (April 30, 2015).

[3] The test procedure final rule issued by DOE on November 30, 2016 is accessible via the DOE Web site at: *http://energy.gov/eere/buildings/downloads/issuance-2016-11-30-energy-conservation-program-test-procedures-central-air.*

standards listed in the table below result in less energy consumption than the current standards, which remain in effect until January 1, 2023.

TABLE I–1—AMENDED ENERGY CONSERVATION STANDARDS FOR RESIDENTIAL CENTRAL AIR CONDITIONERS AND HEAT PUMPS BASED ON THE DOE TEST PROCEDURE AT THE TIME OF THE 2015–2016 NEGOTIATIONS (RECOMMENDED TSL)

Product class	National		Southeast *	Southwest **	
	SEER	HSPF	SEER	SEER	EER
Split-System Air Conditioners with a Certified Cooling Capacity <45,000 Btu/h	14		15	15	*** 12.2/10.2
Split-System Air Conditioners with a Certified Cooling Capacity ≥45,000 Btu/h	14		14.5	14.5	*** 11.7/10.2
Split-System Heat Pumps	15	8.8			
Single-Package Air Conditioners †	14				11.0
Single-Package Heat Pumps †	14	8.0			
Space-Constrained Air Conditioners †	12				
Space-Constrained Heat Pumps †	12	7.4			
Small-Duct High-Velocity Systems †	12	7.2			

* Southeast includes: The states of Alabama, Arkansas, Delaware, Florida, Georgia, Hawaii, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, Puerto Rico, South Carolina, Tennessee, Texas, Virginia, the District of Columbia, and the U.S. territories.
** Southwest includes the states of Arizona, California, Nevada, and New Mexico.
*** The 10.2 EER amended energy conservation standard applies to split-system air conditioners with a seasonal energy efficiency ratio greater than or equal to 16.
† The energy conservation standards for single-package, small-duct high-velocity and space-constrained product classes remain unchanged from current levels.

DOE notes that the amended standard levels presented in Table I–1 are in terms of the test procedure that was in place at the time of the CAC/HP Working Group Negotiations. That test procedure did not include the amendments adopted in the November 2016 TP final rule, which are outlined in section III.F. In section V.C, the amended standard levels are translated to and presented in terms of the test procedure established by the November 2016 test procedure final rule. Accordingly, the standard levels included in the regulatory text of this direct final rule are presented in terms of the test procedure established by the November 2016 test procedure final rule.

DOE is not amending the off mode standards for central air conditioners and heat pumps at this time. The June 2011 direct final rule included the first standards for off mode electric power consumption, with a compliance date of January 1, 2015. 76 FR 37408 (June 27, 2011); 10 CFR 430.32(c)(5). However, DOE subsequently issued an enforcement policy statement on July 8, 2014 regarding off mode standards for central air conditioners and heat pumps specifying that DOE would not assert its civil penalty authority for violation of the off mode standard until 180 days following publication of a final rule establishing a test method for measuring off mode electrical power consumption.[4] DOE established this test method in a final rule published on June 8, 2016 (''June 2016 test procedure final rule''). 81 FR 36992. As a result, the standards for off mode will be enforceable beginning on December 5, 2016. DOE finds it is not feasible to consider amending standards for which compliance has yet to begin.

A. Benefits and Costs to Consumers

Table I–2 presents DOE's evaluation of the economic impacts of the energy conservation standards on consumers of central air conditioners and heat pumps, 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 product classes. The PBP for each product class falls well below the average lifetime of the product, which is estimated to be 21 years for central air conditioners and 15 years for heat pumps (see section IV.G of this document).

TABLE I–2—IMPACTS OF AMENDED ENERGY CONSERVATION STANDARDS ON CONSUMERS OF RESIDENTIAL CENTRAL AIR CONDITIONERS AND HEAT PUMPS (RECOMMENDED TSL)

Product class	Average LCC savings (2015$)	Simple payback period (years)
Split-System Air Conditioners *	N: $43	N: 10.5.
	HD: $150	HD: 7.6.
	HH: $39	HH: 7.7.
Split-System Heat Pumps	$131	4.9.
Packaged Air Conditioners **	N/A	N/A.
Packaged Heat Pumps **	N/A	N/A.
Space-Constrained Air Conditioners **	N/A	N/A.
Small-Duct High-Velocity Air Conditioners **	N/A	N/A.

* N = Northern region; HD = Hot-dry region; HH = Hot-humid region.
** The standard levels for Packaged Air Conditioners, Packaged Heat Pumps, Space-Constrained Air Conditioners, and Small-Duct High-Velocity Air Conditioners are at the baseline level in the Recommended TSL, so there is no impact on consumers.

[4] Available at: *http://energy.gov/sites/prod/files/2014/07/f17/EnforcementPolicyStatement-cacoffmode.pdf* (Last accessed July 1, 2016).

[5] The average LCC savings are measured relative to the estimated efficiency distribution in the no-new-standards case, which depicts the market in the compliance year in the absence of amended standards (see section IV.F.3.f). The simple PBP, which is designed to compare specific efficiency levels, is measured relative to the baseline model (see section IV.C.2).

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

B. Impact on Manufacturers

The industry net present value (INPV) is the sum of the discounted cash flows to the industry from the base year through the end of the 30-year analysis period.[6] Using a real discount rate of 11.0 percent,[7] DOE estimates that the INPV for manufacturers of residential central air conditioners and heat pumps is $4,496.1 million in 2015$. Under the amended standards, DOE expects the change in INPV to range from approximately –15.4 percent to –2.5 percent, which corresponds to approximately –$692.3 million to –$114.2 million (in 2015$). In order to bring products into compliance with proposed standards, DOE expects the industry to incur $342.6 million in conversion costs.

DOE's analysis of the impacts of the amended standards on manufacturers is described in further detail in sections IV.J and V.B.2 of this direct final rule.

C. National Benefits and Costs [8]

DOE's analyses indicate that the energy conservation standards being adopted in this direct final rule for central air conditioners and heat pumps would save a significant amount of energy. Relative to the case without amended standards (referred to as the ''no-new-standards case''), the lifetime energy savings for central air conditioners and heat pumps purchased in the 30-year period that begins in the anticipated first full year of compliance with the amended standards (2023–2052) amount to 3.2 quadrillion British thermal units (Btu), or ''quads.'' [9] This represents a savings of 2.6 percent relative to the energy use of these products in the no-new-standards case.

The cumulative national net present value (NPV) of total consumer costs and savings for the amended standards for central air conditioners and heat pumps ranges from $2.5 billion (at a 7-percent discount rate) to $12.2 billion (at a 3-percent discount rate). This NPV expresses the estimated total value of future operating-cost savings minus the estimated increased product and installation costs for central air conditioners and heat pumps purchased in 2023–2052.

In addition, the standards for central air conditioners and heat pumps that are being adopted in this direct final rule are expected to yield significant environmental benefits. DOE estimates the standards to result in cumulative emission reductions (over the same period as for energy savings) of 188.3 million metric tons (Mt) [10] of carbon dioxide (CO_2), 100.8 thousand tons of sulfur dioxide (SO_2), 350.3 thousand tons of nitrogen oxides (NO_X), 842.4 thousand tons of methane (CH_4), 2.114 thousand tons of nitrous oxide (N_2O), and 0.372 tons of mercury (Hg).[11] The cumulative reduction in CO_2 emissions through 2030 amounts to 13.3 Mt, which is equivalent to the emissions resulting from the annual electricity use of 1.2 million homes.

The value of the CO_2 reductions is calculated using a range of values per metric ton of CO_2 (otherwise known as the Social Cost of Carbon, or SCC) developed by a recent Federal interagency process.[12] The derivation of the SCC values is discussed in section IV.L. Using discount rates appropriate for each set of SCC values (see Table I.3), DOE estimates the present monetary value of the CO_2 emissions reduction (not including CO_2-equivalent emissions of other gases with global warming potential) is between $1.1 billion and $16.9 billion with a value of $5.5 billion using the central SCC case represented by $40.6/t in 2015. DOE also estimates the present monetary value of the NO_X emissions reduction to be $0.2 billion at a 7-percent discount rate and $0.5 billion at a 3-percent discount rate.[13] DOE is investigating appropriate valuation of the reduction in other emissions, and did not include any such values in this rulemaking.

Table I–3 summarizes the economic benefits and costs expected to result from the amended energy conservation standards for central air conditioners and heat pumps.

TABLE I–3—SUMMARY OF ECONOMIC BENEFITS AND COSTS OF AMENDED ENERGY CONSERVATION STANDARDS FOR CENTRAL AIR CONDITIONERS AND HEAT PUMPS (RECOMMENDED TSL) *

Category	Present value (billion 2015$)	Discount rate (%)
Benefits		
Consumer Operating Cost Savings	8.6	7

[6] In contrast to the NIA, which uses an end date of 2050 for TSLs 1, 3 and 4, and an end date of 2052 for TSL 2, the MIA maintains the same end date (2050) for all TSLs. This is done to enable clear comparison of INPV impacts across TSLs. See chapter 12 of the direct final rule TSD for a more detailed discussion of this assumption.

[7] DOE estimated preliminary financial metrics, including the industry discount rate, based on publicly available financial information, including Securities and Exchange Commission (''SEC'') filings and S&P bond ratings. DOE presented the preliminary financial metrics to manufacturers in MIA interviews. DOE adjusted those values based on feedback from manufacturers. The complete set of financial metrics and more detail about the methodology can be found in chapter 12 of the final rule TSD. Additionally, DOE provides a sensitivity analysis based on an alternative discount rate in chapter 12 of the TSD. Using an 8% discount rate, the change in INPV ranges from –16.6 to –1.3 percent at the adopted level.

[8] All monetary values in this document are expressed in 2015 dollars and, where appropriate, are discounted to 2016 unless explicitly stated otherwise.

[9] 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.4.

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

[11] DOE calculated emissions reductions relative to the no-new-standards case, which reflects key assumptions in the *Annual Energy Outlook 2015* (*AEO 2015*) Reference case. *AEO 2015* generally represents current legislation and environmental regulations for which implementing regulations were available as of October 31, 2014.

[12] United States Government-Interagency Working Group on Social Cost of Carbon, *Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866* (May 2013; Revised July 2015) (Available at: *https://www.whitehouse.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf*).

[13] DOE estimated the monetized value of NO_X emissions reductions using benefit-per-ton estimates from the *Regulatory Impact Analysis for the Clean Power Plan Final Rule,* published in August 2015 by EPA's Office of Air Quality Planning and Standards. (Available at: *http://www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-regulatory-impact-analysis.*) See section IV.L.2 for further discussion. The U.S. Supreme Court has stayed the rule implementing the Clean Power Plan until the current litigation against it concludes. *Chamber of Commerce, et al.* v. *EPA, et al.,* Order in Pending Case, 577 U.S. ______((2016). However, the benefit-per-ton estimates established in the Regulatory Impact Analysis for the Clean Power Plan are based on scientific studies that remain valid irrespective of the legal status of the Clean Power Plan. DOE is primarily using a national benefit-per-ton estimate for NO_X emitted from the Electricity Generating Unit sector based on an estimate of premature mortality derived from the ACS study (Krewski *et al.,* 2009). If the benefit-per-ton estimates were based on the Six Cities study (Lepuele *et al.,* 2011), the values would be nearly two-and-a-half times larger.

TABLE I–3—SUMMARY OF ECONOMIC BENEFITS AND COSTS OF AMENDED ENERGY CONSERVATION STANDARDS FOR CENTRAL AIR CONDITIONERS AND HEAT PUMPS (RECOMMENDED TSL) *—Continued

Category	Present value (billion 2015$)	Discount rate (%)
	24.4	3
CO_2 Reduction (using mean SCC at 5% discount rate) **	1.1	5
CO_2 Reduction (using mean SCC at 3% discount rate) **	5.5	3
CO_2 Reduction (using mean SCC at 2.5% discount rate) **	8.9	2.5
CO_2 Reduction (using 95th-percentile SCC at 3% discount rate) **	16.9	3
NO_X Reduction †	0.2	7
	0.5	3
Total Benefits ††	14.3	7
	30.5	3
Costs		
Consumer Incremental Installed Costs	6.1	7
	12.3	3
Total Net Benefits		
Including CO_2 and NO_X Emissions Reduction Monetized Value ††	8.2	7
	18.2	3

* This table presents the costs and benefits associated with central air conditioners and heat pumps shipped in 2023–2052. These results include benefits to consumers which accrue after 2052 from the products purchased in 2023–2052. The incremental installed costs include incremental equipment cost as well as installation costs. The CO_2 reduction benefits are global benefits due to actions that occur nationally.

** The interagency group selected four sets of SCC values for use in regulatory analyses. Three sets of values are based on the average SCC from the integrated assessment models, at discount rates of 5%, 3%, and 2.5%. For example, for 2015 emissions, these values are $12.4/t, $40.6/t, and $63.2/t, in 2015$, respectively. The fourth set ($118/t in 2015$ for 2015 emissions), which represents the 95th percentile of the SCC distribution calculated using a 3% discount rate, is included to represent higher-than-expected impacts from temperature change further out in the tails of the SCC distribution. The SCC values are emission year specific. See section IV.L.1 of this document for more details.

† DOE estimated the monetized value of NO_X emissions reductions using benefit-per-ton estimates from the *Regulatory Impact Analysis for the Clean Power Plan Final Rule,* published in August 2015 by EPA's Office of Air Quality Planning and Standards. (Available at: *http://www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-regulatory-impact-analysis.*) See section IV.L.2 for further discussion. *DOE* is primarily using a national benefit-per-ton estimate for NO_X emitted from the Electricity Generating Unit sector based on an estimate of premature mortality derived from the ACS study (Krewski *et al.,* 2009). If the benefit-per-ton estimates were based on the Six Cities study (Lepuele *et al.,* 2011), the values would be nearly two-and-a-half times larger.

†† Total Benefits for both the 3% and 7% cases are derived using the series corresponding to average SCC with a 3-percent discount rate ($40.6/t in 2015).

The benefits and costs of the amended energy conservation standards, for central air conditioners and heat pumps sold in 2023–2052, can also be expressed in terms of annualized values. The monetary values for the total annualized net benefits are the sum of: (1) The national economic value of the benefits in reduced operating costs, minus (2) the increases in product purchase and installation costs, plus (3) the value of the benefits of CO_2 and NO_X emission reductions, all annualized.[14]

The national operating savings are domestic private U.S. consumer monetary savings that occur as a result of purchasing the covered products. The national operating cost savings is measured for the lifetime of central air conditioners and heat pumps shipped in 2023–2052. The CO_2 reduction is a benefit that accrues globally due to decreased domestic energy consumption that is expected to result from this rule. Because CO_2 emissions have a very long residence time in the atmosphere, the SCC values in future years reflect future CO_2-emissions impacts that continue well beyond 2100 through 2300.

Estimates of annualized benefits and costs of the amended standards are shown in Table I–4. The results under the primary estimate are as follows. Using a 7-percent discount rate for benefits and costs other than CO_2 reduction (for which DOE used a 3-percent discount rate along with the average SCC series that uses a 3-percent discount rate ($40.6/t in 2015)),[15] the estimated cost of the central air conditioners and heat pumps standards adopted in this rule is $741 million per year in increased equipment costs, while the estimated benefits are $1,041 million per year in reduced equipment operating costs, $337 million per year in CO_2 reductions, and $22 million per year in reduced NO_X emissions. In this case, the net benefit amounts to $659 million per year. Using a 3-percent discount rate for all benefits and costs and the average SCC series that uses a 3-percent discount rate ($40.6/t in 2015), the estimated cost of the central air conditioners and heat pumps standards being adopted in this rule is $747 million per year in increased equipment costs, while the estimated benefits are $1,488 million per year in reduced equipment operating costs, $337 million per year in CO_2 reductions, and $32 million per year in reduced NO_X emissions. In this case, the net benefit would amount to $1,110 million per year.

[14] To convert the time-series of costs and benefits into annualized values, DOE calculated a present value in 2016, the year used for discounting the NPV of total consumer costs and savings. For the benefits, DOE calculated a present value associated with each year's shipments in the year in which the shipments occur (*e.g.,* 2020 or 2030), and then discounted the present value from each year to 2016. The calculation uses discount rates of 3 and 7 percent for all costs and benefits except for the value of CO_2 reductions, for which DOE used case-specific discount rates, as shown in Table I–4. 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.

[15] DOE used a 3-percent discount rate because the SCC values for the series used in the calculation were derived using a 3-percent discount rate (see section IV.L).

TABLE I–4—ANNUALIZED BENEFITS AND COSTS OF AMENDED ENERGY CONSERVATION STANDARDS FOR CENTRAL AIR CONDITIONERS AND HEAT PUMPS (RECOMMENDED TSL)

	Discount rate (%)	Primary estimate *	Low-net-benefits estimate *	High-net-benefits estimate *
		(million 2015$/year)		
Benefits				
Consumer Operating Cost Savings	7	1,041	1,005	1,147.
	3	1,488	1,425	1,653.
CO_2 Reduction (using mean SCC at 5% discount rate) **	5	100	100	100.
CO_2 Reduction (using mean SCC at 3% discount rate) **	3	337	337	337.
CO_2 Reduction (using mean SCC at 2.5% discount rate) **	2.5	494	494	494.
CO_2 Reduction (using 95th-percentile SCC at 3% discount rate) **	3	1,027	1,027	1,027.
NO_X Reduction †	7	22	22	49.
	3	32	32	73.
Total Benefits ††	7 plus CO_2 range.	1,163 to 2,090	1,127 to 2,054	1,296 to 2,223.
	7	1,400	1,364	1,533.
	3 plus CO_2 range.	1,620 to 2,547	1,557 to 2,484	1,826 to 2,753.
	3	1,857	1,794	2,063.
Costs				
Consumer Incremental Installed Costs	7	741	784	723.
	3	747	799	725.
Net Benefits				
Total ††	7 plus CO_2 range.	422 to 1,349	342 to 1,269	573 to 1,500.
	7	659	580	810.
	3 plus CO_2 range.	873 to 1,800	757 to 1,684	1,100 to 2,028.
	3	1,110	994	1,338.

* This table presents the annualized costs and benefits associated with central air conditioners and heat pumps shipped in 2023–2052. These results include benefits to consumers which accrue after 2052 from the products purchased in 2023–2052. The incremental installed costs include incremental equipment cost as well as installation costs. The CO_2 reduction benefits are global benefits due to actions that occur nationally. The Primary, Low-Net-Benefits, and High-Net-Benefits Estimates utilize projections of energy prices from the *AEO 2015* Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental product costs reflect a modest decline rate for projected product prices in the Primary Estimate, a constant rate in the Low-Net-Benefits Estimate, and a higher decline rate in the High-Net-Benefits Estimate. The methods used to derive projected price trends are explained in section IV.F.1. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

** The CO_2 reduction benefits are calculated using 4 different sets of SCC values. The first three use the average SCC calculated using 5%, 3%, and 2.5% discount rates, respectively. The fourth represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The SCC values are emission year specific. See section IV.L.1 for more details

† DOE estimated the monetized value of NO_X emissions reductions using benefit-per-ton estimates from the *Regulatory Impact Analysis for the Clean Power Plan Final Rule,* published in August 2015 by EPA's Office of Air Quality Planning and Standards. (Available at: *http://www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-regulatory-impact-analysis.*) See section IV.L.2 for further discussion. For the Primary Estimate and Low-Net-Benefits Estimate, DOE used a national benefit-per-ton estimate for NO_X emitted from the Electric Generating Unit sector based on an estimate of premature mortality derived from the ACS study (Krewski *et al.,* 2009). For the High-Net-Benefits Estimate, the benefit-per-ton estimates were based on the Six Cities study (Lepuele *et al.,* 2011); these are nearly two-and-a-half times larger than those from the ACS study.

†† Total Benefits for both the 3% and 7% cases are presented using only the average SCC with a 3-percent discount rate. In the rows labeled "7% plus CO_2 range" and "3% plus CO_2 range," the operating cost and NO_X benefits are calculated using the labeled discount rate, and those values are added to the full range of CO_2 values.

DOE's analysis of the national impacts of the adopted standards is described in further detail in section IV.H of this direct final rule.

D. Conclusion

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

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 residential central air conditioners and heat pumps. Consistent with this authority, DOE is also publishing elsewhere in this **Federal Register** a notice of proposed rulemaking proposing standards that are identical to those contained in this direct final rule. See 42 U.S.C. 6295(p)(4)(A)(i).

II. Introduction

The following sections briefly discuss the statutory authority underlying this direct final rule, as well as the historical background related to the establishment of standards for residential central air conditioners and heat pumps.

A. Authority

Title III, Part B of the Energy Policy and Conservation Act of 1975 (EPCA or the Act), Public Law 94–163 (42 U.S.C. 6291–6309, as codified) established the Energy Conservation Program for Consumer Products Other Than Automobiles, a program covering most major household appliances (collectively referred to as ''covered products''), which includes the residential central air conditioners and heat pumps that are the subject of this rulemaking. (42 U.S.C. 6292(a)(3))

Pursuant to EPCA, DOE's energy conservation program for covered products consists essentially of four parts: (1) Testing; (2) labeling; (3) the establishment of Federal energy conservation standards; and (4) certification and enforcement procedures. The Federal Trade Commission (FTC) is primarily responsible for labeling, and DOE implements the remainder of the program. Subject to certain criteria and conditions, DOE is required to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating cost of each covered product prior to the adoption of a new or amended energy conservation standard. (42 U.S.C. 6295(o)(3)(A) and (r)) Manufacturers of covered products must use the prescribed DOE test procedure as the basis for certifying to DOE that their products comply with the applicable energy conservation standards adopted under EPCA and when making representations to the public regarding the energy use or efficiency of those products. (42 U.S.C. 6293(c) and 6295(s)) Similarly, DOE must use these test procedures to determine whether the products comply with standards adopted pursuant to EPCA. (42 U.S.C. 6295(s)) The DOE test procedures for central air conditioners and heat pumps appear at title 10 of the Code of Federal Regulations (CFR) part 430, subpart B, appendix M and M1.

The National Appliance Energy Conservation Act of 1987 (NAECA; Pub. L. 100–12) included amendments to EPCA that established the original energy conservation standards for central air conditioners and heat pumps. (42 U.S.C. 6295(d)(1)–(2)) EPCA, as amended, also requires DOE to conduct two cycles of rulemakings to determine whether to amend the energy conservation standards for central air conditioners and heat pumps. (42 U.S.C. 6295(d)(3)) The first cycle culminated in a final rule published in the **Federal Register** on August 17, 2004 (the August 2004 Rule), which prescribed energy conservation standards for central air conditioners and heat pumps manufactured or imported on and after January 23, 2006. 69 FR 50997. DOE completed the second of the two rulemaking cycles by issuing a direct final rule on June 6, 2011 (2011 Direct Final Rule), which was published in the **Federal Register** on June 27, 2011. 76 FR 37408. The 2011 Direct Final Rule (June 2011 DFR) amended standards for central air conditioners and heat pumps manufactured on or after January 1, 2015.

EPCA requires DOE to periodically review its already established energy conservation standards for a covered product. Not later than six years after issuance of any final rule establishing or amending a standard, DOE must publish a notice of determination that standards for the product do not need to be amended, or a notice of proposed rulemaking including new proposed standards. (42 U.S.C. 6295(m)(1)) Pursuant to this requirement, the next review that DOE would need to conduct must occur no later than six years from the issuance of the 2011 direct final rule. This direct final rule fulfills that requirement.

DOE must follow specific statutory criteria for prescribing new or amended standards for covered products, including residential central air conditioners and heat pumps. Any new or amended standard for a covered product must be designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A) and (3)(B)) Furthermore, DOE may not adopt any standard that would not result in the significant conservation of energy. (42 U.S.C. 6295(o)(3)) Moreover, DOE may not prescribe a standard: (1) For certain products, including residential central air conditioners and heat pumps, if no test procedure has been established for the product, or (2) if DOE determines by rule that the proposed standard is not technologically feasible or economically justified. (42 U.S.C. 6295(o)(3)(A)–(B)) In deciding whether a proposed standard is economically justified, after receiving comments on the proposed standard, DOE must determine whether the benefits of the standard exceed its burdens. (42 U.S.C. 6295(o)(2)(B)(i)) DOE must make this determination by, to the greatest extent practicable, considering the following seven factors:

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

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

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

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

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

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

(7) Other factors the Secretary of Energy (Secretary) considers relevant. (42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII))

DOE notes that the current energy conservation standards for central air conditioners and heat pumps (set forth at 10 CFR 430.32(c)) contain requirements for seasonal energy efficiency ratio (SEER), heating seasonal performance factor (HSPF), energy efficiency ratio (EER), and average off mode power consumption. Standards based upon the latter two metrics were newly adopted in the June 27, 2011 DFR for the reasons stated in that rulemaking. 76 FR 37408. As discussed below in section II.B.1 and section II.B.3, DOE has chosen to specify performance standards based on EER and SEER for only the southwest region of the country. Pursuant to its mandate under 42 U.S.C. 6295(m)(1), this DOE rulemaking has considered amending the existing energy conservation standards for central air conditioners and heat pumps, and DOE is adopting the amended standards contained in this direct final rule.

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

Further, EPCA, as codified, establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the energy savings during the first year that the consumer will receive as a result of the standard, as calculated under the applicable test procedure. (42 U.S.C. 6295(o)(2)(B)(iii)) DOE generally considers these criteria as part of its analysis but consistently conducts a more thorough analysis of a given standard's projected impacts that extends beyond this presumption.

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

Under 42 U.S.C. 6295(o)(6), which was added to EPCA by section 306(a) of the Energy Independence and Security Act of 2007 (EISA 2007; Public Law. 110–140), DOE may consider the establishment of regional standards for central air conditioners and heat pumps. Specifically, in addition to a base national standard for a product, DOE may for central air conditioners and heat pumps, establish one or two more-restrictive regional standards. (42 U.S.C. 6295(o)(6)(B)) The regions must include only contiguous States (with the exception of Alaska and Hawaii, which may be included in regions with which they are not contiguous), and each State may be placed in only one region (*i.e.,* an entire State cannot simultaneously be placed in two regions, nor can it be divided between two regions). (42 U.S.C. 6295(o)(6)(C)) Further, DOE can establish the additional regional standards only: (1) Where doing so would produce significant energy savings in comparison to a single national standard, (2) if the regional standards are economically justified, and (3) after considering the impact of these standards on consumers, manufacturers, and other market participants, including product distributors, dealers, contractors, and installers. (42 U.S.C. 6295(o)(6)(D))

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

Pursuant to further amendments to EPCA contained in EISA 2007, Pub. L. 110–140, any final rule for new or amended energy conservation standards promulgated after July 1, 2010, is required to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) Specifically, when DOE adopts a standard for a covered product after that date, it must, if justified by the criteria for adoption of standards under EPCA (42 U.S.C. 6295(o)), incorporate standby mode and off mode energy use into a single standard, or, if that is not feasible, adopt a separate standard for such energy use for that product. (42 U.S.C. 6295(gg)(3)(A)-(B)) The SEER and HSPF metrics for central air conditioners and heat pumps already account for standby mode energy use, and the current standards include limits on off mode energy use. Section III.E further discusses standby mode and off mode energy use.

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

A notice of proposed rulemaking (NOPR) that proposes an identical energy efficiency standard must be published simultaneously with the direct final rule, and DOE must provide a public comment period of at least 110 days on this proposal. (42 U.S.C. 6295(p)(4)(A)–(B)) While DOE typically provides a comment period of 60 days on proposed standards, in this case, 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, provide a reasonable basis for withdrawal of the direct final rule under 42 U.S.C. 6295(o) and for DOE to continue this rulemaking under the NOPR. (42 U.S.C. 6295(p)(4)(C)) Receipt of an alternative joint recommendation may also trigger a DOE withdrawal of the direct final rule in the same manner. *Id.*

Typical of other rulemakings, it is the substance, rather than the quantity, of comments that will ultimately determine whether a direct final rule will be withdrawn. To this end, the substance of any adverse comment(s) received will be weighed against the anticipated benefits of the jointly-submitted recommendations and the likelihood that further consideration of the comment(s) would change the results of the rulemaking. DOE notes that, to the extent an adverse comment had been previously raised and addressed in the rulemaking proceeding, such a submission will not typically provide a basis for withdrawal of a direct final rule. Nevertheless, if the Secretary makes such a determination, DOE must withdraw the direct final rule and proceed with the simultaneously-published NOPR. DOE must publish in the **Federal Register** the reason why the direct final rule was withdrawn. *Id.*

B. Background

1. Current Standards

This section briefly summarizes the history leading up to and including the conception of the current standards for residential air conditioners and heat pumps. Congress initially prescribed statutory standard levels for residential central air conditioners and heat pumps through amendments to EPCA included in the National Appliance Energy Conservation Act of 1987 (NAECA), Public Law 100–12. (42 U.S.C. 6295(d)(1)–(2)) DOE was required to subsequently conduct two rounds of rulemaking to consider amended standards for these products. (42 U.S.C. 6295(d)(3)) The first cycle culminated in a final rule published in the **Federal Register** on August 17, 2004 (the August 2004 final rule). The August 2004 final rule prescribed energy conservation standards for central air conditioners and heat pumps manufactured or imported on and after January 23, 2006. 69 FR 50997.

DOE completed the second of the two rulemaking cycles by publishing a direct final rule on June 27, 2011. 76 FR 37408. The June 2011 DFR combined the rulemakings for residential furnaces, central air conditioners, and heat pumps; divided the country into three regions for CAC/HP: Southeast ''hot humid'' region, southwest ''hot-dry'' region, and northern ''rest of country'' (national standard); and amended standards, including different standards for each region, for central air conditioners and heat pumps manufactured on or after January 1, 2015.

On October 31, 2011, DOE published a notice of effective date and compliance dates for the direct final rule responding to comments it received. 76 FR 67037. Ultimately, DOE determined that the comments received in response to the direct final rule for amended energy conservation standards for residential central air conditioners and heat pumps did not provide a reasonable basis for withdrawal of the DFR. *Id.*

The current standards, which differ by region, were published in the June 27, 2011 DFR. 76 FR 37408, 37546–47. These standards are codified in DOE's regulations in the Code of Federal Regulations (CFR) at 10 CFR 430.32(c)(2)–(5). The standards consist of a minimum SEER for each class of air conditioner and a minimum SEER and HSPF for each class of heat pump. 10 CFR 430.32(c)(2)–(3). In addition, the June 2011 DFR also established regional standards on EER for the southwest region [16] for split-system air conditioner and single-package air conditioner product classes. 10 CFR 430.32(c)(4). All covered central air conditioners and heat pumps were also required to meet standards for average off mode electrical power consumption. 10 CFR 430.32(c)(5). DOE's current regulatory requirements for central air conditioners and heat pumps are listed in Table II.1.

TABLE II–1—ENERGY CONSERVATION STANDARDS FOR CENTRAL AIR CONDITIONERS AND HEAT PUMPS MANUFACTURED ON OR AFTER JANUARY 1, 2015 †

Product class	National standard levels	Southeastern region †† standard levels	Southwestern region ‡ standard levels
Split-system air conditioners	SEER = 13	SEER = 14	SEER = 14 EER = 12.2 (for units with a rated cooling capacity less than 45,000 Btu/h) EER = 11.7 (for units with a rated cooling capacity equal to or greater than 45,000 Btu/h)
Split-system heat pumps	SEER = 14 HSPF = 8.2		
Single-package air conditioners	SEER = 14	SEER = 14	SEER = 14 EER = 11.0
Single-package heat pumps	SEER = 14 HSPF = 8.0		
Small-duct, high-velocity systems ‡‡	SEER = 12 HSPF = 7.2		
Space-constrained products—air conditioners ‡‡	SEER = 12		
Space-constrained products—heat pumps ‡‡	SEER = 12 HSPF = 7.4		

† ''SEER'' is Seasonal Energy Efficiency Ratio; ''EER'' is Energy Efficiency Ratio; ''HSPF'' is Heating Seasonal Performance Factor; and ''Btu/h'' is British thermal units per hour.
†† The Southeastern region for central air conditioners contains the following States: Alabama,, Arkansas, Delaware, Florida, Georgia, Hawaii, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia, and the District of Columbia.
‡ The Southwestern region for central air conditioners contains the States of Arizona, California, Nevada, and New Mexico.
‡‡ DOE did not amend energy conservation standards for these product classes.

The June 2011 DFR also established off mode energy conservation standards for residential central air conditioners and heat pumps, as summarized in Table II.2 and described in section III.E.

[16] The 2011 Direct Final Rule divides the United States into three different climate zones based on the number of heating degree days: Southeast region, southwest region, and the north (also referred to as ''rest of the country'') which represents the national standard.

TABLE II–2—OFF MODE ENERGY CONSERVATION STANDARDS FOR CENTRAL AIR CONDITIONERS AND HEAT PUMPS MANUFACTURED ON OR AFTER JANUARY 1, 2015 *

Product class	Off mode standard levels †
Split-system air conditioners	$P_{W,OFF}$ = 30 watts.
Split-system heat pumps	$P_{W,OFF}$ = 33 watts.
Single-package air conditioners	$P_{W,OFF}$ = 30 watts.
Single-package heat pumps	$P_{W,OFF}$ = 33 watts.
Small-duct, high-velocity systems	$P_{W,OFF}$ = 30 watts.
Space-constrained air conditioners	$P_{W,OFF}$ = 30 watts.
Space-constrained heat pumps	$P_{W,OFF}$ = 33 watts.

* "$P_{W,OFF}$" is off mode electrical power consumption for central air conditioners and heat pumps.
† DOE is not adopting a separate standby mode standard level for central air conditioners and heat pumps, because standby mode power consumption for these products is already regulated by SEER and HSPF.

2. History of the Current CAC/HP Rulemaking

This section provides an overview of the history of the current central air conditioner and heat pump rulemaking following the June 2011 DFR up to this direct final rule.

Following DOE's adoption of the June 2011 DFR, the American Public Gas Association (APGA) filed a petition for review with the U.S. Court of Appeals for the District of Columbia Circuit, seeking to invalidate the June 2011 DFR as it pertained to non-weatherized gas furnaces (NWGFs) and mobile home gas furnaces (MHGFs). Petition for Review, *American Public Gas Association, et al.* v. *Department of Energy, et al.,* No. 11–1485 (D.C. Cir. filed Dec. 23, 2011). APGA requested the court to vacate and remand the direct final rule for further notice and comment rulemaking, with its main arguments being that DOE inappropriately banned noncondensing furnaces in the northern region and adopted a standard that would cause significant fuel switching without economic justification.[17]

On April 24, 2014, the Court granted a motion that approved a settlement agreement reached between DOE, APGA, and the various intervenors.[18] Under this settlement agreement, DOE agreed to a court vacatur and remand of the regional standards for non-weatherized natural gas and mobile home furnaces and to use best efforts to complete a new standards rulemaking for those products within two years. Accordingly, the Court's order vacated the June 2011 DFR in part (*i.e.,* those portions relating to NWGFs and MHGFs) and remanded to the agency for further rulemaking. Notwithstanding this litigation, the regional standards for residential central air conditioners and heat pumps contained in the June 27, 2011 DFR went into effect as originally scheduled with a compliance date of January 1, 2015. Around this time, DOE also decided to initiate a negotiated rulemaking with stakeholders on regional standards enforcement for central air conditioners and heat pumps.

On August 26, 2014, DOE published a notice of open meetings for the central air conditioner and heat pump regional standards enforcement working group, which was tasked to discuss and reach consensus on a proposed rule[19] for the enforcement of regional standards for split-system and single-package air conditioners. 79 FR 50856. This working group was scheduled to periodically convene from August through October of 2014. DOE issued a final rule on central air conditioner and heat pump regional standards enforcement on July 14, 2016. 81 FR 45387.

According to the Energy Policy and Conservation Act's 6-year review requirement (42 U.S.C. 6295(m)(1)), DOE must publish a notice of proposed rulemaking to propose new standards for residential central air conditioner and heat pump products or a notice of determination that the existing standards do not need to be amended by June 6, 2017. On November 5, 2014, DOE initiated efforts pursuant to the 6-year lookback requirement by publishing a request for information (RFI) regarding central air conditioners and heat pumps to solicit comments on whether to amend the current energy conservation standards for residential central air conditioner and heat pump products. 79 FR 65603. The November 2014 RFI also described the procedural and analytical approaches that DOE anticipated using in order to evaluate potential amended energy conservation standards for central air conditioners and heat pumps.

On August 28, 2015, DOE published a notice of data availability (NODA) describing analysis to be used in support of the central air conditioners and heat pumps standards rulemaking. 80 FR 52206. The analysis for this notice provided the results of a series of DOE provisional analyses regarding potential energy savings and economic impacts of amending the central air conditioner and heat pump energy conservation standards. These analyses were conducted for the following categories: Engineering, consumer impacts, national impacts, and manufacturer impacts.

In response to the November 2014 RFI, Lennox formally requested that DOE convene a negotiated rulemaking to address potential amendments to the current standards, which would help ensure that all stakeholders have input into the discussion, analysis, and outcome of the rulemaking. (Lennox, No. 22) Other key industry stakeholders made similar suggestions. (American Council for an Energy-Efficient Economy, No. 23; Air Conditioning Contractors of America, No. 25; Heating, Air Conditioning & Refrigeration Distributors International, No. 26) ASRAC carefully evaluated this request, and the Committee voted to charter a working group to support the negotiated rulemaking effort requested by these parties.

Subsequently, DOE determined that the complexity of the CAC/HP rulemaking necessitated a combined effort to address these equipment types to ensure a comprehensive vetting of all issues and related analyses to support any final rule setting standards. To this end, DOE solicited the public for membership nominations to the CAC/HP Working Group that would be formed under the ASRAC charter by issuing a Notice of Intent to Establish the Central Air Conditioners and Heat Pumps Working Group To Negotiate a

[17] Brief for Petitioner, American Public Gas Association, et al. v. Department of Energy, et al., No. 11–1485 (D.C. Cir. filed May 14, 2012). See also: *http://www.achrnews.com/ext/resources/2013/06-2013/06-03-13/APGA-Petition-DC-Cir_11-1485.pdf.*

[18] See: *http://www.acca.org/wp-content/uploads/2014/03/joint-motion-to-vacate-and-remand-2014-to-file.pdf.*

[19] More details on the issues considered can be found in the docket: *http://www.regulations.gov/#!documentDetail;D=EERE-2011-BT-CE-0077-0070.*

Notice of Proposed Rulemaking for Energy Conservation Standards. 80 FR 40938 (July 14, 2015). The CAC/HP Working Group was established under ASRAC in accordance with the Federal Advisory Committee Act (FACA) and the Negotiated Rulemaking Act—with the purpose of discussing and, if possible, reaching consensus on a set of energy conservation standards to propose/finalize for CACs and HPs. The CAC/HP Working Group was to consist of fairly representative parties having a defined stake in the outcome of the proposed standards, and would consult, as appropriate, with a range of experts on technical issues.

DOE received 26 nominations for membership. Ultimately, the CAC/HP Working Group consisted of 15 members, including one member from ASRAC and one DOE representative.[20] The CAC/HP Working Group met ten times (nine times in-person and once by teleconference). The meetings were held on August 26, 2015, September 10, 2015, September 28–29, 2015, October 13–14, 2015, October 26–27, 2015. November 18–19, 2015, December 1–2, 2015, December 16–17, 2015, January 11–12, 2016, and a webinar on January 19, 2016.

During the CAC/HP Working Group discussions, participants discussed setting new standards for single-package air conditioners. Specifically, arguments were made against raising the standard level for single-package systems due to the unavailability of full product lines, which span the entire range of cooling capacities, with efficiencies that are only modestly greater (*i.e.,* 15 SEER) than the current standard level (*i.e.,* 14 SEER). (ASRAC Public Meeting, No. 80 at pp. 75–6) After being informed that the national energy savings from a 15 SEER standard for single-package systems would be small (*i.e.,* approximately 0.1 quads), the Working Group agreed not to recommend raising the standards for these product classes. (ASRAC Public Meeting, No. 80 at pp. 90–91). In addition, some parties wanted the Group to recommend a level for standards for split-system heat pumps that would encourage use of two-speed equipment (*i.e.,* greater than 15 SEER), but the manufacturer representatives objected to this proposal due to two primary concerns: (1) Only a single compressor manufacturer supplies two-stage compressors, thereby creating the possibility of a limited or constrained supply of the most critical component of a two-speed system and (2) the likelihood, in replacement installations, that the utilization of existing thermostat control wiring could result in the use of only high-speed, thereby eliminating the efficiency gain resulting from low-speed operation during part-load conditions.

The CAC/HP Working Group successfully reached consensus on recommended energy conservation standards, as well as test procedure amendments for CACs and HPs. On January 19, 2016, the CAC/HP Working Group submitted the Term Sheet to ASRAC outlining its recommendations, which ASRAC subsequently adopted.[21]

3. 2015–2016 ASRAC CAC/HP Working Group Recommended Standard Levels

This section summarizes the standard levels recommended in the Term Sheet submitted by the CAC/HP Working Group for CAC/HP standards and the subsequent procedural steps taken by DOE. Recommendation #8 of the Term Sheet recommends standard levels based on the test procedure at the time of the 2015–2016 Negotiations. (ASRAC Term Sheet, No. 76 at pp. 4–5) These recommended standard levels are presented in Table II–3. Note that the test procedure at the time of the 2015–2016 Negotiations did not include the amendments adopted in the November 2016 test procedure final rule, which are outlined in section III.F. Recommendation #9 tabulates the translated standard levels based on the amended test procedure (ASRAC Term Sheet, No. 76 at p. 5). Details of the other Term Sheet recommendations can be found in the Term Sheet posted in the docket.[22]

TABLE II–3—RECOMMENDED AMENDED ENERGY CONSERVATION STANDARDS FOR RESIDENTIAL CENTRAL AIR CONDITIONERS AND HEAT PUMPS AS DETERMINED BY THE DOE TEST PROCEDURE AT THE TIME OF THE 2015–2016 ASRAC NEGOTIATIONS

[Recommended TSL]

Product class	National		Southeast *	Southwest **	
	SEER	HSPF	SEER	SEER	EER ***
Split-System Air Conditioners with a Certified Cooling Capacity <45,000 Btu/h	14		15	15	**** 12.2/10.2
Split-System Air Conditioners with a Certified Cooling Capacity ≥45,000 Btu/h	14		14.5	14.5	**** 11.7/10.2
Split-System Heat Pumps	15	8.8			
Single-Package Air Conditioners and Heat Pumps	14	8.0			11.0

* Southeast includes: The states of Alabama, Arkansas, Delaware, Florida, Georgia, Hawaii, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, Puerto Rico, South Carolina, Tennessee, Texas, Virginia, the District of Columbia, and the U.S. territories.
** Southwest includes the states of Arizona, California, Nevada, and New Mexico.
*** EER requirements only apply to air conditioners, not heat pumps within each product class.
**** The 10.2 EER amended energy conservation standard applies to split-system air conditioners with a seasonal energy efficiency ratio greater than or equal to 16.
Note: The energy conservation standards for small-duct high velocity and space-constrained remain unchanged from current levels.

[20] The group members were Tony Bouza (U.S. Department of Energy), Marshall Hunt (Pacific Gas & Electric Company, San Diego Gas & Electric Company, Southern California Edison, and Southern California Gas Company), Andrew deLaski (Appliance Standards Awareness Project and ASRAC representative), Meg Waltner (Natural Resources Defense Council), John Hurst (Lennox), Karen Meyers (Rheem Manufacturing Company), Charles McCrudden (Air Conditioning Contractors of America), Harvey Sachs (American Council for an Energy Efficient Economy), Russell Tharp (Goodman Manufacturing), Karim Amrane (Air-Conditioning, Heating, and Refrigeration Institute), Don Brundage (Southern Company), Kristen Driskell (California Energy Commission), John Gibbons (United Technologies), Steve Porter (Johnstone Supply), and Jim Vershaw (Ingersoll Rand).

[21] Available at (copy and paste into browser): *https://www.regulations.gov/document?D=EERE-2014-BT-STD-0048-0076*.

[22] Available at (copy and paste into browser): *https://www.regulations.gov/document?D=EERE-2014-BT-STD-0048-0076*.

After carefully considering the consensus recommendations for amending the energy conservation standards for CACs and HPs submitted by the CAC/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) for the issuance of a direct final rule.

More specifically, these recommendations comprise a statement submitted by interested persons who are fairly representative of relevant points of view on this matter. In reaching this determination, DOE took into consideration the fact that the CAC/HP Working Group, in conjunction with ASRAC members who approved the recommendations, consisted of representatives of manufacturers of the covered equipment at issue, States, and efficiency advocates—all of which are groups specifically identified by Congress as relevant parties to any consensus recommendation. (42 U.S.C. 6295(p)(4)(A)) As delineated above, the Term Sheet was signed and submitted by a broad cross-section of interests, including the manufacturers who produce the subject products, trade associations representing these manufacturers and installation contractors, environmental and energy-efficiency advocacy organizations, and electric utility companies. Although States were not direct signatories to the Term Sheet, the ASRAC Committee approving the CAC/HP Working Group's recommendations included at least two members representing States—one representing the National Association of State Energy Officials (NASEO) and one representing the State of California.[23] Moreover, DOE does not read the statute as requiring a statement submitted by all interested parties before the Department may proceed with issuance of a direct final rule. By explicit language of the statute, the Secretary has the discretion to determine when a joint recommendation for an energy or water conservation standard has met the requirement for representativeness (*i.e.,* ''as determined by the Secretary''). *Id.*

DOE also evaluated whether the recommendation satisfies 42 U.S.C. 6295(o), as applicable. In making this determination, DOE conducted an analysis to evaluate whether the potential energy conservation standards under consideration achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified and result in significant energy conservation. The evaluation is the same comprehensive approach that DOE typically conducts whenever it considers potential energy conservation standards for a given type of product or equipment.

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

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

III. General Discussion

This section covers subjects that are not explicitly discussed in other sections but provide additional necessary context for understanding this direct final rule.

A. Regulatory Approach

When DOE initiated this rulemaking, DOE had intended to rate and certify split-system central air conditioners based on a blower-coil configuration. This approach was reflected in the August 2015 NODA TSD. However, in the June 2016 test procedure final rule, DOE adopted a different approach based on CAC/HP Working Group recommendations. 81 FR 36992, 37001–03 (June 8, 2016). At its meeting on November 19, 2015, DOE presented two potential regulatory approaches, one based on both coil only and blower-coil configurations (approach 1, similar to the existing regulatory structure) and one based on blower-coil configurations (approach 2), both of which DOE regarded as feasible. During discussion, the CAC/HP Working Group generally supported approach 1 based on concerns with approach 2. Working Group members' primary concern with approach 2 is that the majority of sales are for coil-only installations, so blower-coil only ratings would not be representative of the majority of field installations, which could contribute to consumer confusion. (ASRAC Public Meeting, No. 85 at pp. 6–42)[24] The CAC/HP Working Group ultimately recommended that DOE adopt approach 1 and require rating and certifying split-system central air conditioners based on any configuration (*i.e.,* coil-only or blower-coil). The regulatory approach to split-system central air conditioners is identified as recommendation #7 in the CAC/HP Working Group Term Sheet. (ASRAC Term Sheet, No. 76 at p. 4) The June 2016 test procedure final rule includes a detailed discussion of these recommended changes and DOE's adoption of them. 81 FR 36992, 37001–37003 (June 8, 2016).

For the August 2015 NODA, DOE developed cost-efficiency relationships in the engineering analysis for blower coil systems. Then DOE established a correlation between blower coil system efficiency and coil-only efficiency based on ratings from the AHRI database. DOE used this correlation to calculate the cost-efficiency relationship for coil-only systems. Given the revised regulatory approach for this DFR, DOE analyzed coil-only cost-efficiency directly. Section IV.C describes in detail how DOE determined the cost-efficiency relationship for coil-only systems in this DFR.

B. Compliance Dates

EPCA prescribes a five-year period between the standard's publication date and the compliance date (42 U.S.C. 6295(m)(4)(A)(i)). The compliance date for the 2011 DFR is January 1, 2015. The statute further provides that no manufacturer shall be required to apply new standards to a product to which other new standards have been required during the prior six-year period (42 U.S.C. 6295(m)(4)(B)). Given these statutory provisions, the earliest date that DOE could require compliance with amended standards would be January 1, 2021 (*i.e.,* six years after January 1, 2015, the compliance date of the standards adopted in the June 27, 2011 DFR). Thus, DOE contemplated a compliance date in 2021 in analyzing the impacts of the TSLs other than the Recommended TSL, which represents the recommended standards.

For the Recommended TSL, the CAC/HP Working Group recommended a compliance date of January 1, 2023. While this implies a period between the

[23] These individuals were Deborah E. Miller (NASEO) and David Hungerford (California Energy Commission).

[24] For discussion supporting approach 1, or the approach not based solely on blower coil ratings, see for example, Karen Meyers, pp. 27–28; Rusty Tharp, p. 29; Jim Vershaw, p. 36.

standards final rule's publication date and the compliance date that is longer than five years, DOE understands that EPCA provides some measure of discretion when adopting recommended standards submitted as part of a consensus agreement, provided that DOE determines that the recommended standards are otherwise in accordance with the required provisions. See 42 U.S.C. 6295(p)(4). DOE has made the determination that the rulemaking record in this case supports the adoption of the recommended compliance date.

C. Regional Standards

As described previously, EISA 2007 amended EPCA to allow for the establishment of one or two more-restrictive regional standards in addition to the base national standard for residential central air conditioners and heat pumps. (42 U.S.C. 6295(o)(6)(B)) The regions must include only contiguous States (with the exception of Alaska and Hawaii, which can be included in regions with which they are not contiguous), and each State may be placed in only one region (*i.e.,* a State cannot be divided among or otherwise included in two regions). (42 U.S.C. 6295(o)(6)(C))

Further, EPCA mandates that a regional standard must produce significant energy savings in comparison to a single national standard, and provides that DOE must determine that the additional standards are economically justified and consider the impact of the additional regional standards on consumers, manufacturers, and other market participants, including product distributors, dealers, contractors, and installers. (42 U.S.C. 6295(o)(6)(D)) In the 2011 Direct Final Rule, DOE considered the above-delineated impacts of regional standards in addition to national standards for central air conditioners and heat pumps, and the analyses indicated that regional standards will provide additional positive impacts. See chapter 10 of the 2011 DFR TSD.[25]

Consistent with the consensus agreement[26] submitted to DOE by a number of interested stakeholders on January 15, 2011, the 2011 Direct Final Rule established regional standards on EER for split-system and single-package air conditioners for the southwest region. Pursuant to 42 U.S.C. 6295(o)(1) (*i.e.,* the ''anti-backsliding clause''), DOE may not prescribe any amended standard which increases the maximum allowable energy use or decreases the minimum required energy efficiency of a covered product. As such, DOE intends to maintain the application of a regional standard requirement for the same product classes in the same regions. Accordingly, DOE has addressed the potential impacts from regional standards in the relevant analyses, including the mark-ups to determine product price, the LCC and payback period analysis, the national impact analysis (NIA), and the manufacturer impact analysis (MIA). DOE's approach for addressing regional standards is included in the methodology section corresponding to each individual analysis in section IV of this direct final rule.

D. Alternative Refrigerants

Residential central air conditioners and heat pumps currently on the market primarily utilize R-410A as the refrigerant. R-410A is a mixture of hydrofluorocarbons (HFCs), specifically HFC-32 (R-32) and HFC–125 (R-125) with a 50 percent/50 percent mass ratio. Stakeholders have raised concern that the high global warming potential of HFCs has put pressure on the industry to phase out HFC-containing refrigerants in favor of alternatives with a lower global warming potential (GWP). In response to the November 2014 RFI, ACEEE recommended that DOE consider the potential impact of changes in refrigerants on the standards. (ACEEE, No. 21 at p.3) Lennox suggested that DOE consider equipment redesigns resulting from the transition to alternate refrigerants. (Lennox, No. 10 at p. 4) Southern Co. suggested that DOE also model efficiencies using low-Global Warming Potential (GWP) refrigerants. (Southern Co., No. 11 at p. 2) EIA strongly urged DOE to consider the use of low-GWP refrigerants and alternative refrigerants such as CO2, and indirect evaporative cooling technology. (EIA, No. 12 at p. 1) Rheem suggested that DOE reevaluate the efficacy of design options with respect to the elimination of R410a. (Rheem, No. 17 at p. 3).

In response, DOE is aware that the U.S. Environmental Protection Agency (EPA) has proposed and finalized amendments to its lists of approved refrigerants under its significant new alternatives policy program[27] (SNAP); however, these changes do not address central air conditioners and heat pumps.[28] It would not be appropriate for DOE to speculate on the outcome of a rulemaking in progress or potential proposals that have not yet been issued. Therefore, DOE has not included possible outcomes of a potential EPA SNAP rulemaking affecting central air conditioners and heat pumps in the engineering or LCC analyses. This decision is consistent with past DOE practice, such as in the 2011 direct final rule for room air conditioners. 76 FR 22454 (April 21, 2011). DOE is aware of stakeholder concerns that EPA may broaden the applications for which HFC refrigerants are phased out at some point in the future. DOE is confident that there will be an adequate supply of R-410A for compliance with the standards being adopted in this notice. However, consistent with Executive Order 13563, ''Improving Regulation and Regulatory Review,'' DOE will prioritize its review of the potential effects of any future phase-out of HFCs (should there be one) on the efficiency standards related to this rulemaking. If a manufacturer believes that its design is subjected to undue hardship by regulations, the manufacturer may petition DOE's Office of Hearing and Appeals (OHA) for exception relief or exemption from the standard pursuant to OHA's authority under section 504 of the DOE Organization Act (42 U.S.C. 7194), as implemented at subpart B of 10 CFR part 1003. OHA has the authority to grant such relief on a case-by-case basis if it determines that a manufacturer has demonstrated that meeting the standard would cause hardship, inequity, or unfair distribution of burdens.

As such, DOE did not conduct additional analysis based on alternative

[25] Reference to Technical Support Document for Residential Central Air Conditioners, Heat Pumps, and Furnaces, Chapter 10 National and Regional Impact Analyses (copy and paste into browser): *http://www.regulations.gov/#!documentDetail;D=EERE-2011-BT-STD-0011-0012.*

[26] Reference to Joint Stakeholders Comments on Energy Conservation Standards for Residential Central Air Conditioners, Heat Pumps, and Residential Furnaces (copy and paste into browser): *https://www.regulations.gov/document?D=EERE-2011-BT-STD-0011-0016.*

[27] EPA regulates refrigerants for air conditioning, refrigeration, and other end uses under the stratospheric ozone protection provisions under Section 612(c) the Clean Air Act (CAA). EPA's SNAP Program evaluates and regulates the availability of refrigerants for the U.S. market by identifying and publishing lists of acceptable and unacceptable refrigerant substitutes.

[28] EPA on July 9, 2014 proposed new alternative refrigerants for several applications, but not central air conditioners or heat pumps. 79 FR 38811. On February 27, 2015, EPA issued the final rule for this rulemaking, which was published in the **Federal Register** on April 10, 2015 (see *http://www.epa.gov/ozone/snap/download/SAN_5745-SNAP_Low_GWP_Refrigerants_FRM_Signature_Version-signed-2-27-2015.pdf*). 80 FR 19454. Also, on August 6, 2014, EPA proposed delisting refrigerants for several applications, but not central air conditioners or heat pumps. 79 FR 46126. On July 20, 2015, EPA published the final rule for this rulemaking, which went into effect on August 19, 2015. 80 FR 42870. Refer to the docket (copy and paste into browser): *https://www.regulations.gov/docket?D=EPA-HQ-OAR-2014-0198.*

refrigerants to replace R–410A in this rulemaking.

E. Standby Mode and Off Mode

As noted in section II.A of this document, any final rule for amended or new energy conservation standards for consumer products that is published on or after July 1, 2010 must address standby mode and off mode energy use. (42 U.S.C. 6295(gg))

As set forth in 10 CFR 430.2, *Standby mode* means the condition in which an energy-using product—

(1) Is connected to a main power source; and

(2) Offers one or more of the following user-oriented or protective functions:

(i) To facilitate the activation or deactivation of other functions (including active mode) by remote switch (including remote control), internal sensor, or timer; or

(ii) Continuous functions, including information or status displays (including clocks) or sensor-based functions.

For residential central air conditioners and heat pumps, the standby mode refers to the state when a system is connected to the power supply but the compressor and fans are not running (*i.e.,* the system is not actively cooling or heating but it is primed to be activated by the thermostat). The SEER and HSPF metrics for cooling and heating already account for standby mode energy use. Specifically, the degradation coefficients used to adjust the steady-state efficiency levels to account for cyclic operation of the unit when calculating SEER or HSPF are based on electric energy measurements that include the energy use of the unit during the compressor-off cycles, and they include power input associated with all unit components, including the control system.

As set forth in 10 CFR 430.2, *off mode* means the condition in which an energy using product is connected to a main power source, and is not providing any standby or active mode function. For central air conditioners and heat pumps, off mode generally occurs during all non-cooling seasons for air conditioners, and during the ''shoulder seasons'' (*i.e.,* fall and spring) for heat pumps when consumers neither heat nor cool their homes. Unlike standby mode, off mode energy use is not captured in the SEER and HSPF metrics. As such, the June 2011 Direct Final Rule established off mode energy conservation standards for central air conditioners and heat pumps. In the technology assessment of the June 2011 Direct Final Rule, DOE considered five technologies associated with off mode for central air conditioners and heat pumps: (1) Toroidal transformers; (2) ECM control relays; (3) thermostatically-controlled crankcase heaters; (4) self-regulating crankcase heaters, and (5) compressor insulation covers. DOE continues to screen out the ECM control relay because DOE is not aware of any commercially-available systems that use this technology, and DOE is also not aware of any improvements to the technology that would address the associated reliability issues. DOE did, however, consider the remaining four technologies as design options for establishing the off mode energy conservation standards. The adopted standards were ultimately based upon this list of technologies. 76 FR 37408, 37447–37450 (June 27, 2011).

For the current direct final rule, DOE further researched the four technologies considered as design options in the June 2011 DFR. DOE was able to find thermostatically-controlled and self-regulating crankcase heaters in commercially-available central air conditioners and heat pumps. However, manufacturer specifications do not provide detailed wattage information for DOE to determine if these technologies could lower the off mode energy use for central air conditioners and heat pumps based on the existing off mode standards. Toroidal transformers may have higher efficiencies than conventional laminate transformers, but their savings potential is small compared to the precision of the test procedure as applied to baseline products. Crankcase heater wattage, rather than transformer loss, represents most of the measured off mode power input. DOE also believes that compressor covers can reduce heat loss and, therefore, reduce the off mode energy consumption. However, the existing off mode standards established by the June 2011 Direct Final Rule are already consistent with the energy use achievable using these technologies, and DOE does not have evidence to indicate that further energy savings based on these technologies are achievable.

In addition to the four technologies considered in the June 2011 Direct Final Rule, DOE identified another two technologies that could potentially reduce the off mode energy use for central air conditioners and heat pumps: (1) Hermetic crankcase heaters and (2) integral compressor motor heaters. However, DOE did not find any commercially-available applications of these two technologies in central air conditioners and heat pumps and did not consider these technologies further. More details on these technologies can be found in chapter 3 of the DFR TSD.

As such, DOE concludes that amending the off mode energy conservation standards at this time is not justified. This review satisfies, for off mode energy conservation standards for CAC/HP products, the periodic review of energy conservation standards required by EPCA. (42 U.S.C. 6295(m)(1))

F. Test Procedure

This section provides a brief overview of DOE's requirements with respect to test procedures as well as the history of the most recent central air conditioner and heat pump test procedure rulemakings and an overview of the significant changes adopted.

EPCA sets forth generally applicable criteria and procedures for DOE's adoption and amendment of test procedures. (42 U.S.C. 6293) Manufacturers of covered products must use these test procedures to certify to DOE that their product complies with energy conservation standards and to quantify the efficiency of their product.

DOE notes that Appendix A established procedures, interpretations, and policies to guide DOE in the consideration and promulgation of new or revised appliance efficiency standards under EPCA. (See section 1 of 10 CFR of 430 subpart C, appendix A) These procedures are a general guide to the steps DOE typically follows in promulgating energy conservation standards. The guidance recognizes that DOE can and will, on occasion, deviate from the typical process. (See 10 CFR part 430, subpart C, appendix A, section 14(a)) In this particular instance, DOE deviated from its typical process by conducting a negotiated rulemaking process, per the request of multiple key stakeholders and as chartered by ASRAC. The CAC/HP Working Group met ten times (nine times in-person and once by teleconference) and successfully reached consensus on recommended amended energy conservation standards, as well as test procedure amendments for CACs and HPs. On January 19, 2016, the CAC/HP Working Group submitted the Term Sheet to ASRAC outlining its recommendations, which ASRAC subsequently adopted. As discussed in section II.B.3, the Term Sheet meets the criteria of a consensus recommendation, and DOE has determined that these recommendations are in accordance with the statutory requirements of 42 U.S.C. 6295(p)(4) for the issuance of a direct final rule. DOE ultimately adopted many of the test procedure provisions and recommended standard levels that the CAC/HP Working Group included in the Term Sheet, which illustrates that DOE's deviations from the typical rulemaking process in this instance did not adversely impact the manufacturers' ability to understand and provide input to DOE's rulemaking process. The process that DOE used, in this case, was a more collaborative negotiated rulemaking effort resulting in an agreement on recommended standard levels, which DOE is fully implementing in this direct final rule.

The most recent test procedure rulemaking included the following key rulemaking documents: The June 2016 test procedure final rule (81 FR 36992), the August 2016 test procedure SNOPR (81 FR 58164), and the November 2016 test procedure final rule (Docket No. EERE–2016–BT–TP–0029). This section does not address specific comments received on these test procedure documents, as those comments are addressed in the three notices listed. Rather, the main purpose of this section is to provide context for understanding the efficiency levels used in analyses for this direct final rule and the translated levels following the walkdown analysis. To reiterate, efficiency levels used throughout the analyses for this DFR are based on the test procedure in effect at the time of the CAC/HP Working Group negotiations, which did not include the changes outlined in this section. Standard levels set in this final rule have a compliance date simultaneous with the date that the test procedure as modified by the November 2016 test procedure final rule must be used to represent product efficiency. The translation of these standard levels based on the November 2016 test procedure final rule—which does include the changes outlined in this section—is presented in section V.C.1.

DOE initiated a test procedure rulemaking for central air conditioners and heat pumps in advance of the June 2011 DFR, publishing a NOPR on June 2, 2010 (June 2010 test procedure NOPR). 75 FR 31224. In this NOPR, DOE proposed adding calculations for the determination of sensible heat ratio, incorporating of a method to evaluate off mode power consumption, and also adding parameters for establishing regional measures of energy efficiency. *Id.*

DOE published a supplemental notice of proposed rulemaking (SNOPR) regarding the test procedure for central air conditioners and heat pumps on April 1, 2011. 76 FR 18105. In this SNOPR, DOE proposed to amend the testing requirements for off mode power consumption in response to the comments DOE received on the June 2010 test procedure NOPR. DOE also discussed issues related to low-voltage transformers used when testing coil-only units, and the use of a regional standard efficiency metric. *Id.*

DOE received further comments regarding the off mode testing requirement for central air conditioners and heat pumps after the publication of the April 2011 test procedure SNOPR. In response to these comments, DOE published a second SNOPR on October 24, 2011. 76 FR 65616. In the October 2011 test procedure SNOPR, DOE addressed comments only related to off mode testing for central air conditioners and heat pumps. *Id.*

DOE received comments on the October 2011 test procedure SNOPR, as well as comments relevant to the test procedure in response to the November 2014 RFI. In response to these comments, DOE published a third SNOPR on November 9, 2015. 80 FR 69278. DOE proposed the following in the November 2015 test procedure SNOPR:

• A new basic model definition as it pertains to central air conditioners and heat pumps and revised rating requirements;
• Revised alternative efficiency determination methods;
• Termination of active waivers and interim waivers;
• Revised procedures to determine off mode power consumption;
• Changes to the test procedure that would improve test repeatability and reduce test burden;
• Clarifications to ambiguous sections of the test procedure intended also to improve test repeatability;
• Inclusion of, amendments to, and withdrawals of test procedure revisions proposed in published test procedure notices in the rulemaking effort leading to this SNOPR; and
• Changes to the test procedure that would improve field representativeness.

Some of these proposals also included incorporation by reference of updated industry standards. *Id.*

On June 8, 2016, DOE published a final rule with amendments to the test procedure that did not change the measured energy efficiency of central air conditioners and heat pumps when compared to the test procedure previously in effect. 81 FR 36992. Broadly, amendments included revisions to:

• Definitions, testing, rating, and compliance of basic models;
• Requirements for Alternative Efficiency Determination Methods (AEDMs);
• Procedures for specific products that had been granted test procedure waivers (*e.g.,* multi-circuit products and triple-capacity northern heat pumps);
• Test methods and calculations for off mode power; and
• Specific procedures concerning test repeatability and test burden, including for example, setting fan speeds, determining the maximum speed for variable-speed compressors, charging refrigerant lines, and determining the coefficient of cyclic degradation (C_D), among others.

In the June 2016 test procedure final rule, DOE did not finalize several proposals of the November 2015 SNOPR that were intended to improve field representativeness, opting instead to revise these proposals and obtain further stakeholder input on them. DOE did this by publishing a SNOPR on August 24, 2016, which proposed amendments to the test procedure established by the June 2016 test procedure final rule. 81 FR 58164 DOE indicated that several of these amendments would change the measured energy efficiency of central air conditioners and heat pumps, while others would provide additional improvements for clarity and consistency. Amendments of the August 2016 SNOPR that would change measured efficiency were proposed for a new appendix M1 that would be required for representations coincident with the compliance date of the new efficiency standards These included proposals to:

• Increase minimum external static pressure requirements for most products, but limit the increase for certain products;
• For coil-only systems, introduce a new default fan power based on the new minimum external static pressure, and a unique, lower default fan power for manufactured home coil-only systems;
• Revise the heating load line slope factor and the heating load line zero-load temperature to better reflect field heating loads; and
• Revise certain aspects of the calculation procedures for calculating HSPF, including modified and clarified requirements regarding compressor speeds used for testing variable-speed heat pumps, and allowing use of a 5 °F test as an option for variable-speed heat pumps.

Other proposed changes to improve clarity and consistency, which DOE proposed as amendments to the current appendix M, as well as in sections of 10 CFR part 429, were to take effect 30 days after publication of the final rule. These included:

• Additional changes to definitions and compliance requirements;
• Extending the requirements for no-match testing to other kinds of outdoor units that are predominantly installed as

replacements where the indoor unit is not replaced;

• Revision to the off-mode test procedure for systems with self-regulating crankcase heaters.

• A revised calculation for variable-speed heat pumps for calculating maximum speed performance below 17 °F;

• A revised method for calculating EER and COP for all variable-speed units, when operating at an intermediate compressor speed;

• Modifications to the outdoor air enthalpy method;

• New restrictions on refrigerant pressure measurement system internal volume;

• A new limit on indoor coil surface area; and

• Clarifying amendments addressing break-in periods, multi-split system part load requirements, and cased coil installation requirements.

On November 30, 2016 DOE issued a test procedure final rule that adopted most of the amendments proposed in the August 2016 SNOPR, many of these with revisions addressing stakeholder comments. Changes in final implementation of the amendments as compared to the proposals of the August 2016 SNOPR included:

• No adoption of restrictions on indoor coil surface area;

• Delay in implementation of certain amendments, moving them to appendix M1, including the change to the off-mode test procedure and some of the provisions for testing of variable-speed heat pumps;

• Revisions to specific requirements for determining whether an outdoor unit must be tested using the no-match test procedure;

• For all secondary test methods (not just for the outdoor air enthalpy method as proposed), requiring a match to confirm primary capacity measurements only for certain tests, rather than for all tests;

• Modifications reducing the restrictions on refrigerant pressure system internal volumes;

• A change in the required external static pressure used for testing for one kind of product; and

• Extending optional use of a 5 °F test to single- and two-speed heat pumps in addition to variable-speed.

Note that, as discussed in section I, the analyses conducted to support this direct final rule were based on the test procedure at the time of the 2015–2016 ASRAC negotiations, per the request of the CAC/HP Working Group. Consequently, the efficiency ratings and levels referenced throughout this document are not impacted by the test procedure amendments described above for the November 2016 test procedure final rule. However, central air conditioners and heat pumps will be required to be certified to the efficiency levels selected in this direct final rule and based on the test procedure established by the November 2016 test procedure final rule. The selected efficiency levels—presented throughout this document in terms of the test procedure at the time of the 2015–2016 ASRAC negotiations—are translated to levels in terms of the November 2016 test procedure final rule following the walk down analysis in section V.C.1.

G. 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. (See chapter 3 of the direct final rule Technical Support Document (''TSD'') for a discussion of the list of technology options that DOE identified.) DOE then determines which of those efficiency-improving options are technologically feasible. DOE considers technologies incorporated in commercially-available products or in working prototypes to be technologically feasible. 10 CFR part 430, subpart C, appendix A, section 4(a)(4)(i).

Once DOE has determined that particular technology options are technologically feasible, it further evaluates each technology option in light of the following additional screening criteria: (1) Practicability to manufacture, install, and service; (2) adverse impacts on product utility or availability; and (3) adverse impacts on health or safety. 10 CFR part 430, subpart C, appendix A, section 4(a)(4)(ii)–(iv). Additionally, it is DOE policy not to include in its analysis any proprietary technology that is a unique pathway to achieving a certain efficiency level. Section IV.B of this direct final rule discusses the results of the screening analysis for residential central air conditioners and heat pumps, particularly the designs DOE considered, those it screened out, and those that are the basis for the trial standard levels (TSLs) in this rulemaking. For further details on the screening analysis for this rulemaking, see chapter 4 of this direct final rule's TSD.

DOE notes that these screening criteria do not directly address the proprietary status of design options. As noted previously, DOE only considers efficiency levels achieved with the use of proprietary designs in the engineering analysis if they are not part of a unique path to achieve that efficiency level (*i.e.,* if there are other non-proprietary technologies capable of achieving the same efficiency). DOE believes the amended standards for the products covered in this rulemaking would not mandate the use of any proprietary technologies, and that all manufacturers would be able to achieve the amended levels through the use of non-proprietary designs. The efficiency levels considered in the analysis are all represented by commercially-available technologies that are available to all manufacturers.

2. Maximum Technologically Feasible Levels

When DOE proposes to adopt an amended standard for a type or class of covered product, it must determine the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible for such a product. (42 U.S.C. 6295(p)(1)) Accordingly, in the engineering analysis, DOE determined the maximum technologically feasible (''max-tech'') improvements in energy efficiency for central air conditioners and heat pumps, using the design parameters for the most-efficient products available on the market or in working prototypes (see chapter 5 of the direct final rule TSD). The max-tech levels considered for the analysis represent commercially-available products. For most of the product classes, these max-tech products are listed in the AHRI Directory.[29] For the SDHV and space-constrained air conditioner classes, the max-tech levels are as reported in manufacturers' product literature.

The max-tech levels that DOE determined for this rulemaking are presented in Table III–1. Note that these max-tech levels are in terms of the efficiency metrics measured consistent with the test procedure at the time of the 2015–2016 ASRAC negotiations.

[29] AHRI is the trade association representing manufacturers of heating, ventilation, air conditioning and refrigeration (HVACR) and water heating equipment within the global industry. Products of different manufacturers are certified to AHRI and listed in the AHRI Directory at: *https://www.ahridirectory.org/ahridirectory/pages/home.aspx.* directory:*https://www.ahridirectory.org/ahridirectory/pages/home.aspx.*

The max-tech levels themselves are discussed in more detail in section IV.C of this direct final rule and in chapter 5 of the accompanying TSD.

TABLE III–1—MAX-TECH SEER AND CORRESPONDING EER AND HSPF LEVELS CONSIDERED IN THE CENTRAL AIR CONDITIONER AND HEAT PUMP ANALYSES

Product class	Representative cooling capacity (tons)	Max-tech efficiency levels	
		SEER *	HSPF *
Split-Systems			
Air Conditioners **	2	21.0	N/A
	3	21.0	
	5	20.0	
Heat Pumps	2	19.0	9.9
	3	19.0	9.9
	5	17.5	9.4
Single-Package Systems			
Air Conditioners	All	17.5	N/A
Heat Pumps	All	15.0	8.2
Small-Duct High-Velocity Air Conditioners	All	14.0	N/A
Space-Constrained Air Conditioners	All	14.0	N/A

* SEER and HSPF listed in the table are as measured using the test procedure proposed in the November 9, 2015 TP SNOPR. 80 FR 69278 EER is also measured by the test procedure, but as discussed in section IV.C.2, DOE did not analyze EER-based efficiency levels for this direct final rule.

** Max-Tech SEER levels are based on a blower-coil configuration.

H. Energy Savings

1. Determination of Savings

For each TSL, DOE projected energy savings from the application of the TSL to the central air conditioners and heat pumps that are the subject of this rulemaking purchased in the 30-year period that begins in the year of expected compliance with amended standards (2021–2050 or 2023–2052).[30] The savings are measured over the entire lifetime of central air conditioner and heat pump products purchased in the 30-year analysis period. DOE quantified the energy savings attributable to each TSL as the difference in energy consumption between each standards case and the no-new-standards case. The latter case represents a projection of energy consumption in the absence of amended energy conservation standards, and it considers market forces and policies that may affect future demand for more-efficient products.

DOE used its national impact analysis (NIA) spreadsheet model to estimate national energy savings (NES) from potential amended standards for central air conditioners and heat pumps. The NIA spreadsheet model (described in section IV.H of this direct final rule and chapter 10 of the TSD) calculates energy savings in terms of site energy, which is the energy directly consumed by products at the locations where they are used. For electricity, DOE calculates national energy savings on an annual basis in terms of primary (source) energy savings, which is the savings in the energy that is used to generate and transmit electricity to the site. To calculate primary energy savings from site electricity savings, DOE derives annual conversion factors from data provided in the Energy Information Administration's (EIA) most recent *Annual Energy Outlook* (*AEO*). For natural gas, the primary energy savings are considered to be equal to the site energy savings.

DOE also calculates NES in terms of full-fuel-cycle (FFC) energy savings. As discussed in DOE's statement of policy, the FCC 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. 76 FR 51282 (August 18, 2011), as amended at 77 FR 49701 (August 17, 2012). 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.4.

2. Significance of Savings

To adopt any new or amended standards for a covered product, DOE must determine that such action would result in ''significant'' energy savings. (42 U.S.C. 6295(o)(3)(B)) Although the term ''significant'' is not defined in the Act, the U.S. Court of Appeals for the District of Columbia Circuit, in *Natural Resources Defense Council* v. *Herrington,* 768 F.2d 1355, 1373 (D.C. Cir. 1985), opined that Congress intended ''significant'' energy savings in the context of EPCA to be savings that are not ''genuinely trivial.'' The energy savings for all of the TSLs considered in this rulemaking, including the amended standards (presented in section V.B.3), are nontrivial, and, therefore, DOE considers them ''significant'' within the meaning of section 325 of EPCA.

I. Economic Justification

1. Specific Criteria

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

a. Economic Impact on Manufacturers and Consumers

In quantifying the impacts of a potential amended standard on manufacturers, DOE conducts a manufacturer impact analysis (MIA), as discussed in section IV.J, using an annual cash-flow approach to determine the quantitative impacts. This step includes both a short-term assessment—based on the cost and capital requirements during the period between when a regulation is issued and when entities must comply with the regulation—and a long-term assessment over a 30-year period. The industry-wide impacts analyzed include: (1) Industry net present value (INPV), which values the industry on the basis of expected future cash flows; (2) cash flows by year; (3) changes in revenue

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

and income; and (4) other measures of impact, as appropriate. Second, DOE analyzes and reports the impacts on different types of manufacturers, including impacts on small manufacturers. Third, DOE considers the impact of standards on domestic manufacturer employment and manufacturing capacity, as well as the potential for standards to result in plant closures and loss of capital investment. Finally, DOE takes into account cumulative impacts of various DOE regulations and other regulatory requirements on manufacturers.

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

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

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

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

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

For its LCC and PBP analysis, DOE assumes that consumers will purchase the covered products in the first year of compliance with amended standards. The LCC savings for the considered efficiency levels are calculated relative to a case that reflects projected market trends in the absence of amended standards.

DOE's LCC and PBP analyses are discussed in further detail in section IV.F.

c. Energy Savings

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

d. Lessening of Utility or Performance of Products

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

e. Impact of Any Lessening of Competition

EPCA directs DOE to consider the impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from a proposed standard. (42 U.S.C. 6295(o)(2)(B)(i)(V)) It also directs the Attorney General to determine the impact, if any, of any lessening of competition likely to result from a proposed standard and to transmit such determination to the Secretary within 60 days of the publication of a proposed rule, together with an analysis of the nature and extent of the impact. (42 U.S.C. 6295(o)(2)(B)(ii)) DOE will transmit a copy of this direct final rule to the Attorney General with a request that the Department of Justice (DOJ) provide its determination on this issue. DOE will consider DOJ's comments on the rule in determining whether to proceed with the direct final rule. DOE will also publish and respond to the DOJ's comments in the **Federal Register** in a separate notice.

f. Need for National Energy Conservation

DOE also considers the need for national energy conservation in determining whether a new or amended standard is economically justified. (42 U.S.C. 6295(o)(2)(B)(i)(VI)) The energy savings from the amended 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.

The amended standards also are likely to result in environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases (GHGs) associated with energy production and use. DOE conducts an emissions analysis to estimate how the amended standards may affect these emissions, as discussed in section IV.K the emissions impacts are reported in section V.5 of this document. DOE also estimates the economic value of emissions reductions resulting from the considered TSLs, as discussed in section IV.L.

g. Other Factors

EPCA allows the Secretary of Energy, in determining whether an energy conservation standard is economically justified, to consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6295(o)(2)(B)(i)(VII)) To the extent interested parties submit any relevant information regarding economic justification that does not fit into the other categories described above, DOE could consider such information under ''other factors.''

In developing the direct final rule, DOE has also considered the submission of the jointly-submitted Term Sheet from the CAC/HP Working Group, as approved by ASRAC. In DOE's view, the Term Sheet sets forth a statement by interested persons that are fairly representative of relevant points of view (including representatives of manufacturers of covered equipment, States, and efficiency advocates) and contains recommendations with respect to energy conservation standards that are in accordance with 42 U.S.C. 6295(o), as required by EPCA's direct final rule provision. See 42 U.S.C. 6295(p)(4). DOE has encouraged the submission of agreements such as the one developed and submitted by the CAC/HP Working Group as a way to bring diverse stakeholders together, to develop an independent and probative analysis useful in DOE standard setting, and to expedite the rulemaking process. DOE also believes that standard levels recommended in the Term Sheet may increase the likelihood for regulatory compliance, while decreasing the risk of litigation.

2. Rebuttable Presumption

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

IV. Methodology

This section addresses the analyses DOE has performed for this rulemaking with regard to residential central air conditioners and heat pumps. Each subsection will address a component of DOE's analyses.

DOE used several analytical tools to estimate the impact of the amended standards. The first tool is a spreadsheet that calculates the LCC and PBP of amended energy conservation standards. The national impacts analysis (NIA) requires a second spreadsheet set that provides shipments forecasts and calculates national energy savings and net present value resulting from amended energy conservation standards. DOE used the third spreadsheet tool, the Government Regulatory Impact Model (GRIM), to assess manufacturer impacts of amended standards. These three spreadsheet tools are available on the DOE Web site.[31] Additionally, DOE used output from the latest version of EIA's *Annual Energy Outlook (AEO)* for the emissions and utility impact analyses.[32]

A. Market and Technology Assessment

In conducting a market and technology assessment, DOE develops information that provides an overall picture of the market for covered products. This overall picture includes the purpose of the products, the industry structure, manufacturers, market characteristics, and technologies used. DOE uses both quantitative and qualitative assessments, based primarily on publicly-available information. The market and technology assessment for this residential central air conditioning and heat pump rulemaking covers issues that include: (1) A determination of the scope of the rulemaking and product classes; (2) manufacturers and industry structure; (3) quantities and types of products sold and offered for sale; (4) retail market trends; (5) regulatory and non-regulatory programs; and (6) technologies or design options that could improve the energy efficiency of the product(s) under examination. The key findings of DOE's market assessment are summarized below. For additional detail, see chapter 3 of the DFR TSD.

1. Definition and Scope of Coverage

A residential central air conditioner or heat pump is an important component of a home's central heating and cooling system, providing cooled and/or heated air to the conditioned space, often through ductwork. Split-system air conditioners are comprised of an indoor unit, which contains the indoor coil and may contain the indoor fan (blower); and an outdoor unit, which contains the compressor, outdoor coil, and outdoor fan. The indoor unit either includes its own blower (''blower-coil unit'') or uses the furnace fan (''coil-only unit'') to circulate air over the indoor coil, transferring heat between the circulating air and the refrigerant. The cooled (or heated) air is then distributed via ductwork to the conditioned space. The compressor raises the refrigerant pressure, which raises its saturation temperature so that it is warm enough to transfer heat either to the ambient air (for cooling mode) or the indoor air (for heat-pump mode). Single-package systems contain all of these components in a single-package. A residential central heat pump utilizes the same components as a central air conditioner, but also includes a reversing valve and other components that allow it to reverse the functions of the indoor and outdoor coils, thus operating in heat pump mode.

EPCA defines a central air conditioner as a product, other than a packaged terminal air conditioner,[33] which is powered by single phase electric current, air cooled, rated below 65,000 Btu per hour, not contained within the same cabinet as a furnace, the rated capacity of which is above 225,000 Btu per hour, and is a heat pump or a cooling only unit. (42 U.S.C. 6291(21)) DOE has incorporated this definition in its regulations at 10 CFR 430.2.

EPCA defines a ''heat pump'' as a product, other than a packaged terminal heat pump,[34] which consists of one or more assemblies, powered by single phase electric current, rated below 65,000 Btu per hour, utilizing an indoor conditioning coil, compressor, and refrigerant-to-outdoor air heat exchanger to provide air heating, and may also provide air cooling, dehumidifying, humidifying circulating, and air cleaning. (42 U.S.C. 6291(24)) DOE has incorporated this definition into its regulations at 10 CFR 430.2. These products, also known as unitary air conditioners, do not include room air conditioners.[35]

In this DFR, DOE is amending energy conservation standards for the products covered by DOE's current standards for central air conditioners and heat pumps, specified at 10 CFR 430.32(c)(2), which DOE adopted in the June 2011 DFR.

[31] See: *http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx?ruleid=104.*

[32] All three spreadsheet tools are available online at the rulemaking portion of DOE's Web site: *http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/72.*

[33] ''Packaged terminal air conditioner'' is defined in 10 CFR 430.2 as ''a wall sleeve and a separate unencased combination of heating and cooling assemblies specified by the builder and intended for mounting through the wall. It includes a prime source of refrigeration, separable outdoor louvers, forced ventilation, and heating availability energy.''

[34] ''Packaged terminal heat pump'' is defined in 10 CFR 430.2 as ''a packaged terminal air conditioner that utilizes reverse cycle refrigeration as its prime heat source and should have supplementary heating availability by builder's choice of energy.''

[35] ''Room air conditioner'' is defined in 10 CFR 430.2 as ''a consumer product, other than a 'packaged terminal air conditioner,' which is powered by a single phase electric current which is an encased assembly designed as a unit for mounting in a window or through the wall for the purpose of providing delivery of conditioned air to an enclosed space. It includes a prime source of refrigeration and may include a means for ventilating and heating.''

These products consist of: (1) Split-system air conditioners; (2) split-system heat pumps; (3) single package air conditioners; and (4) single package heat pumps.

DOE's current standards for central air conditioners are expressed as the minimum seasonal energy efficiency ratio (SEER), the minimum heating seasonal performance factor (HSPF) for heat pumps, and the maximum off-mode power ($P_{W,\ OFF}$). SEER is a seasonal efficiency metric that accounts for electricity consumption in active cooling and standby operating modes during the cooling season, while HSPF is a seasonal efficiency metric that accounts for active heating and standby operating modes for heat pumps during the heating season. For the Southwest region of the United States, (four states including Arizona, California, Nevada, and New Mexico) DOE's current standards also include additional requirements for energy efficiency ratio (EER) for both central air conditioners and heat pumps. 10 CFR 430.32(c).

2. Product Classes

When evaluating and establishing energy conservation standards, DOE divides covered products into product classes by the type of energy used, by capacity, or by another performance-related feature that justifies a different standard. In making a determination whether a performance-related feature justifies a different standard, DOE must consider factors such as the utility to the consumer of the feature. (42 U.S.C. 6295(q)). DOE has divided residential central air conditioners and heat pumps into seven product classes: [36]

- Split-system air conditioners
- Split-system heat pumps
- Single-package air conditioners
- Single-package heat pumps
- Small-duct high-velocity systems
- Space-constrained air conditioners
- Space-constrained heat pumps

In the November 2014 RFI, DOE requested feedback on whether it should consider any changes the existing product classes for central air conditioners and heat pumps. 79 FR 65603, 65605 (Nov. 5, 2014). In response, AHRI and Southern Co. commented that they supported retaining the listed product classes used in the previous rulemaking (*i.e.,* the June 2011 Final Rule). (AHRI, No. 13 at p. 3; Southern Co., No. 11 at p. 2) NEEA and NPCC suggested that DOE consider the possibility of a separate product class for variable capacity systems, given their potential increased cost effectiveness relative to fixed capacity systems. (NEEA & NPCC, No. 19 at p. 3) Rheem recommended that a product class be added for combined appliances which contribute to heat recovery for water heating. (Rheem, No. 17 at p. 2).

For this rulemaking, DOE has retained the product classes associated with the 2011 DFR that were listed in the November 2014 RFI. In response to NEEA & NPCC, DOE sees no need for the suggested change because variable capacity products have no difficulty meeting the current standards—or the standards set in this notice. In response to Rheem's comment, DOE has not found evidence that the capability for heat recovery for water heating reduces a product's ability to meet a given efficiency level, and Rheem's comment did not indicate that this is the case, nor did it explain why such product might have a different efficiency level when tested according to the DOE test procedure for central air conditioners and heat pumps (which does not include transfer of heat to water). Hence, DOE believes that the threshold for setting separate product classes for these products under EPCA is not met. 42 U.S.C. 4295(q)(B)

3. Technology Options

As part of the market and technology assessment performed for the November 2014 RFI and for this DFR, DOE developed a comprehensive list of technologies to improve the energy efficiency of central air conditioners and heat pumps. Chapter 3 of the DFR TSD contains a detailed description of each technology that DOE identified.

DOE received comments on the technology options proposed in the November 2014 RFI. ACEEE requested that DOE consider the addition of multi-stage systems to the list of design options. (ACEEE, No. 21 at p.3) Southern Co. also commented that it supported design options associated with variable speed operation because of humidity control considerations. (Southern Co., No. 19 at p. 2) NEEA and NPCC, as well as PG&E, suggested that DOE add a design options for the reduction of off and standby-mode energy use and for control systems. (NEEA & NPCC, No. 19 at p. 10; PG&E, No. 15 at p. 2) Rheem proposed that DOE add combined appliance technology to the list of design options. (Rheem, No. 17 at p. 3) On the other hand, AHRI commented that DOE should consider only design options that DOE included for central air conditioners in the June 2011 DFR. (AHRI, No. 13 at p. 3). ACEEE also suggested that DOE conduct a systematic evaluation of the energy savings potential of products used in the Southeast and Southwest, particularly the benefits of enhanced latent heat work to condition the air. (ACEEE, No. 21 at p. 3)

In response to the comments made by ACEEE and Southern Co., DOE has included both two-stage and variable speed compressors as design options. Regarding the addition of design options for reducing off and standby-mode energy use, DOE conducted a market and technology assessment (as described in section IV.A.3) and has found that the design options used in the June 2011 DFR are the same ones that are viable today. Additionally, DOE refers to discussions during the CAC/HP CAC/HP Working Group Negotiations, in which no objections were raised by stakeholders to the proposed design option list. (ASRAC Public Meeting, No. 88 at p. 188) Further discussion regarding the viability of the technology options is provided in chapter 4 of the TSD. Regarding the NEEA and NPPC comment regarding controls, there are many ways that controls might be employed to improve rated efficiency, but NEEA and NPPC's comment does not specify, nor could DOE infer from the comment, what type of control design option should be considered. DOE notes that it considered a comprehensive scope of technologies in its market and tech assessment, and is confident that its engineering analysis accounts for these controls. In response to Rheem, EPCA defines ''central air conditioner'' as a product that is air-cooled. (42 U.S.C. 6291(21)(B)) In contrast, combination appliances reject heat to water. Hence, water-heating operation of such appliances is not covered by DOE's regulations for central air conditioners and heat pumps. In response to ACEEE's comment about creating a design option for higher or lower latent capacity, any differential benefit for systems designed for a different latent capacity or different return air humidity would also not be captured in DOE's current or amended test procedures, and hence was not considered as part of the analysis to establish amended efficiency levels. Finally, in response to all of the comments suggesting specific design options, DOE conducted an efficiency-level-based engineering analysis based on existing product designs. While DOE has assembled a specific list of design options that reflect known design differences among these existing products, there are other design differences that affect the rated efficiencies used in the analysis that

[36] These product classes were last examined by the June 2011 DFR. 76 FR 37408, 37446 (June 27, 2011), prior to this current round of rulemaking.

represent design options, the use of which is probable but not certain. Some of these would likely be classified as ''controls'' design options, which would address the NEEA & NPPC comment.

These comments, as well as others, were addressed during the CAC/HP Working Group Negotiations. Based on the RFI comments and the 2015–2016 CAC/HP Working Group discussions, DOE constructed a list of technology options for consideration in the analysis for this direct final rule. Table IV–1 compiles this list.

TABLE IV–1 TECHNOLOGY OPTIONS

Component	Technology
Compressor	Higher-EER compressor.
	Two-stage compressor.
	Variable speed compressor.
Heat exchanger	Larger heat exchanger.
Fan Motor	Constant torque permanent-magnet motor.
	Constant air flow permanent-magnet motor.
Fan	Higher-efficiency fan blades, fan wheels, and fan configurations.
Expansion valve	Thermostatic expansion valve.
	Electronic expansion valve.
Controls	Heat pump defrost controls.

DOE expanded the ''higher efficiency compressor'' technology option to indicate that, in addition to consideration of compressors with higher energy efficiency ratio (EER, the compressor capacity divided by its power input at the compressor rating condition expressed in Btu/h-W), manufacturers can also consider use of two-capacity or variable-speed compressors. DOE limited the specific technology options for heat exchangers to only larger-size heat exchangers because most heat exchanger technology (*e.g.* round-tube/flat fin, microchannel, etc.) can be used either in baseline or higher-efficiency products. The list includes the two general types of higher-efficiency fan motors used in products. For fans, the revised list more generally indicates that efficiency improvements can be associated with the fan blades of outdoor fans, the fan wheels of indoor fans, and the general fan configuration, including all details of design that affect efficiency (*e.g.* overall size, inlet and outlet flow transitions, clearance gaps between rotating and stationary components, etc.) The revised list includes two specific examples of higher-efficiency expansion valves. The list does not separately include inverter technology, which would be captured as part of the variable-speed compressor and/or the constant-air-flow permanent magnet motor technology options.

B. Screening Analysis

After identifying potential technology options for improving the efficiency of residential central air conditioners and heat pumps, DOE performed the screening analysis (see section IV.B of this direct final rule or chapter 4 of the DFR TSD) on these technologies to determine which could be considered further in the analysis and which should be eliminated. DOE uses the following four screening criteria to determine which technology options are suitable for further consideration in an energy conservation standards rulemaking:

1. *Technological feasibility.* Technologies that are neither incorporated in commercial products nor in working prototypes will not be considered further.

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

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

4. *Adverse impacts on health or safety.* If DOE determines that a technology would have significant adverse impacts on health or safety, then that technology will not be considered further. (10 CFR part 430, subpart C, appendix A, 4(a)(4) and 5(b))

If DOE determines that a technology, or a combination of technologies, fails to meet one or more of the above four criteria, it will be excluded from further consideration in the engineering analysis. DOE found that all of the identified technologies listed in Table IV–1 met all four screening criteria and consequently, are suitable for further examination in DOE's analysis. For off-mode technologies, DOE determined that there is no commercial application for the hermetic crankcase heater and the integral compressor motor heater in central air conditioners and heat pumps. Therefore, DOE screened out these two technologies. For additional details, please see chapter 4 of the direct final rule TSD.

C. Engineering Analysis

The engineering analysis establishes a relationship between energy efficiency and manufacturing production cost (MPC) for units that will be impacted by amended energy conservation standards. This relationship serves as the basis of cost-benefit analyses for individual consumers, manufacturers, and the Nation.

DOE began the engineering analysis by identifying energy efficiency levels to analyze. The current energy conservation standard served as the baseline efficiency level from which DOE analyzed possible energy efficiency improvements. In addition to the baseline, DOE identified higher efficiency levels that correspond to higher-efficiency products available on the market, including the most efficient, or max-tech, products. Using a variety of data sources, DOE estimated market-weighted MPCs at the baseline efficiency level and the market-weighted incremental MPC increases required to achieve each higher efficiency level, for each product class. Following the quantification of MPCs, DOE estimated the additional costs to residential consumers from markups by the manufacturers, distributors, and contractors. This information was then used in the downstream analyses to examine the costs and benefits associated with increased equipment efficiency.

For the August 2015 NODA, DOE used a top-down analysis approach in which an exponential curve-fit was applied to a database of MPC vs. efficiency values to generate a cost-efficiency relationship for each representative capacity in each product class. 80 FR 52206 (Aug. 28, 2015). DOE did not receive comments on the NODA specifically regarding the NODA engineering analysis methodologies and results. During the CAC/HP Working Group meetings, however, DOE's engineering analysis was discussed in detail. ASRAC Working Group members expressed concern that the approach used in the August 2015 NODA did not reflect critical aspects of the relationship between MPC and efficiency. Ingersoll Rand and Southern Company requested to see efficiency levels differentiated by single speed and two-speed products. (ASRAC Public Meeting, No. 40 at p. 232, 248)

Manufacturers generally agreed that certain efficiency levels could only be achieved by switching from single speed to two-stage compressor designs, which represented a considerable increase in MPC. The manufacturers believed this design path would result in a step function in the cost-efficiency relationship from the perspective of a given manufacturer, which was not reflected in the relationships used by DOE in the August 2015 NODA. (ASRAC Public Meeting, No. 40 at p. 248) AHRI presented its own cost-efficiency data to illustrate this step function at the October 14th CAC/HP Working Group meeting. AHRI's cost-efficiency data showed a $280 increase in manufacturing costs at 16 SEER associated with switching from a single speed to two-speed design for a three-ton system. AHRI was unable to share specific details about its methodology or the components included in the $280 cost difference because of confidentiality concerns. (ASRAC Public Meeting, No. 89 at p. 210)

In response, DOE agrees that switching from a single speed to two-speed design could result in a considerable increase in manufacturer production cost. DOE also understands that not all manufacturers choose to make this switch at the same point in the efficiency range. For example, one manufacturer may be able to achieve 15 SEER with a single speed design and need to switch to a two-stage design to achieve above 15 SEER, while other manufacturers may only be able to achieve 14.5 SEER with a single speed design, which would require them to switch to a two-stage design. DOE's NODA cost-efficiency relationships reflect the industry and therefore, represent multiple manufacturers. Step functions in single manufacturer's cost-efficiency relationship occurring at different points in the range of efficiency resulted in the smoother, continuous industry cost-efficiency curves that DOE used in the NODA. For these reasons, DOE does not believe its NODA cost-efficiency relationships are inappropriate, but does recognize that they may not perfectly represent the increase in cost associated with switching from single speed to two-stage designs in the range of efficiency in which manufacturers are making these design changes. In response to the CAC/HP working group discussions, DOE revised its engineering analysis to better reflect the impacts on manufacturer production cost of switching from a single speed to a two-stage design, which is reflected in this direct final rule. DOE's revised direct final rule engineering analysis is described in more detail in the subsequent paragraphs of this section.

Today's direct final rule engineering analysis is different from the August 2015 NODA analysis in five main ways. First, DOE analyzed single speed and two-stage split systems separately (*i.e.,* DOE developed MPC values at each efficiency level analyzed for single speed and two-stage systems independently). Once combined, this approach resulted in single cost-efficiency relationships that reflected the MPC step associated with switching from a single speed to two-stage design. The second key difference was that DOE analyzed individual manufacturer cost-efficiency relationships independently, then used marketshare information to generate a single marketshare-weighted cost-efficiency relationship. This approach better represented the effect of these cost-efficiency relationships on the total market and better accounted for differences between manufacturers in the design paths they use to achieve higher efficiency.

Third, DOE based the manufacturer-specific cost-efficiency relationships used in this direct final rule analysis on the least-cost units offered at each efficiency level, as opposed to all units offered at each efficiency level. DOE believes this approach results in cost-efficiency relationships that better reflect the design decisions manufacturers will make in response to new standards. The fourth key difference was that DOE analyzed coil-only and blower-coil systems separately for this direct final rule. This approach is aligned with the certification requirements finalized in the June 2016 CAC TP final rule, which require compliance for all indoor/outdoor unit combinations and also require certification of at least one coil-only combination for all single speed and two-stage outdoor units. 81 FR 36992 (June 8, 2016).

The final critical difference was that this engineering analysis was conducted based on efficiencies as measured according to the test procedure in place at the time of the CAC/HP Working Group meetings, the October 2007 CAC TP final rule. 72 FR 59906 (Oct. 22, 2007). Following downstream analyses, DOE translated the chosen efficiency levels to minimum standards based on measurement according to the November 2016 test procedure final rule, which is summarized in section III.F. DOE notes that the August 2015 NODA [37] efficiency levels were presented in terms of efficiency per test procedure amendments being proposed at the time of the August 2015 NODA analysis (*i.e.* using the October 2011 test procedure SNOPR (see section III.F)). 76 FR 65616 (October 24, 2011).

For a more detailed description of the methodology used to determine the efficiency levels and manufacturer production costs as well as the key similarities and differences from the August 2015 NODA, please refer to Chapter 5 of the DFR TSD.

1. Segmentation of Covered Products

For the purpose of the engineering analysis, DOE further divided product classes into many segments to capture important differences in the cost-efficiency relationships. As a primary example, DOE recognizes that the cost-efficiency relationship between central air conditioners and heat pumps varies by capacity. For this direct final rule analysis, DOE performed separate analyses for two-ton, three-ton and five-ton split system air conditioners and heat pumps in order to characterize the efficiency levels at different representative capacities. For single-package air conditioner and heat pump product classes, DOE developed a cost-efficiency relationship based on three-ton capacity units. For space-constrained and small-duct high-velocity (SDHV) air conditioners, DOE used systems in the two to two-and-a-half-ton capacity range.

As described in the introduction to this section, DOE further segmented each split-system air conditioner representative capacity into blower coil and coil-only systems. All split-system product classes were further divided into single speed and two-stage outdoor units.

Within each single-package representative capacity, DOE segmented products according to two heat exchanger types—all-aluminum with microchannel or tube-and-fin geometries or copper-tube aluminum fin heat exchangers. This followed the approach DOE had previously taken in the August 2015 NODA. 80 FR 52206. DOE has found that the reduced cost of aluminum per pound results in significantly different cost-efficiency relationships between products employing the two different heat exchanger types.

2. Determination of Efficiency Levels

This section describes the RFI comments received with regard to and the ultimate methodology adopted for

[37] More specifically, refer to Chapter 5 of the NODA Technical Support Document (copy and paste link into browser): *https://www.regulations.gov/document?D=EERE-2014-BT-STD-0048-0029.*

determining energy efficiency levels within each product class. The levels are tabulated along with the MPC results in section IV.C.4.

In response to the November 2014 RFI, ACEEE suggested that DOE consider technologically feasible and economically justifiable efficiency levels based on capacity. (ACEEE, No. 21 at p. 3) DOE has considered variation of efficiency level with capacity in its analysis for split systems, and has adopted some variation of standard levels with capacity, as recommended by the CAC/HP Working Group.

AHRI suggested DOE consider the impacts of the final rule for residential furnace fans on the baseline and max-tech levels for each product class. (AHRI, No. 13 at pp. 3–4) In response, DOE notes that it has developed default fan power levels for testing of coil-only systems, which reflect the improved efficiency of the furnaces likely to be used with the air conditioners considered in the analysis—the November 2016 test procedure final rule discusses this topic in greater detail. (November 2016 Test Procedure Final Rule, pp. 104, 105). These default fan power levels account for higher efficiency fan motors and increased external static pressure, and thus are higher than the previous default fan power used for testing of coil-only systems.

NEEA & NPCC agreed with the proposed baseline and max-tech levels. They did, however, urge DOE to consider ''high-tech'' design options for small duct high velocity (SDHV) systems. (NEEA & NPCC, No. 19 at p. 3) In response, DOE did evaluate ''high-tech'' design options for SDHV systems, but did not find increased efficiency levels for such systems to be cost-effective, based on review of efficiency levels attained by existing products.

Rheem commented that max-tech efficiency levels proposed for all product classes in the November 2014 RFI could not be economically justified within any climate zone in the US. Rheem also questioned the max-tech efficiency differential between split system CAC/HPs, SDHVs, and space constrained AC/HPs. (Rheem, No. 17 at p. 4) In response, DOE notes that its economic analysis is consistent with Rheem's assertion that max-tech efficiency levels are not economically justified, and has not set standard levels at max-tech efficiency. DOE notes that the max-tech efficiency differentials as reported in the RFI have been adjusted in this DFR analysis based on more a thorough review of available products.

PG&E recommended that DOE account for larger evaporator coil areas when evaluating max tech levels for small duct high velocity systems and space-constrained systems due to the special constraints and limited heat transfer associated with lower volumetric flow rates. (PG&E, No. 15 at p. 2). In response, DOE notes that its efficiency-level-based engineering analysis was based on existing product designs. DOE found that for the higher-efficiency products of these classes, evaporator coil areas were larger. However, as discussed, this analysis did not show that increasing the efficiency level of these products was cost-effective.

First, DOE characterized the baseline efficiency levels. Generally, the baseline unit in each product class: (1) Represents the basic characteristics of equipment in that class; (2) just meets the current Federal energy conservation standards, if any; and (3) provides basic consumer utility. For the covered product classes analyzed in this direct final rule, the baseline efficiency levels are represented by the standards that were set in the June 2011 Direct Final Rule and codified at 10 CFR 430.32(c). 76 FR 37408 (June 27, 2011). The baseline efficiency levels are reference points for each product class, against which changes in product cost and energy use resulting from potential amended energy conservation standards are compared.

Next, DOE established intermediate efficiency levels at 0.5 SEER increments increasing from each baseline efficiency level. DOE did not analyze intermediate efficiency levels for which there are few products available on the market. DOE also determined the maximum improvement in energy efficiency that is technologically feasible (max-tech) for central air conditioners and heat pumps, as required under 42 U.S.C. 6295(p)(1). DOE selected max-tech efficiency levels for most of the product classes equal to the highest efficiency levels reported in the AHRI Directory of Certified Product Performance. For space-constrained air conditioners, DOE selected the max-tech efficiency level based on the efficiency reported in product literature. The resulting efficiency levels for all product classes considered are tabulated with MPCs in section IV.C.4IV.C.4.

As discussed in section II.A, DOE also uses EER to characterize CAC/HP efficiency. During the CAC/HP Working Group meetings, some parties suggested dropping EER as a metric all together. These parties argued that the proposed SEER value would be high enough to ensure that the EER level would be at or above the current standard. They also stated that EER requirements are an additional burden and could discourage two-stage and variable speed product designs for which SEER and EER values have a higher divergence than single speed designs. Other parties were firm about keeping EER because it would mitigate peak load issues and improve the health of the utility grid. They added that EER can be a better descriptor than SEER for energy use in certain regions, such as the Southwest. (ASRAC Public Meeting, No. 81 at pp. 10–73; ASRAC Public Meeting, No. 82 at pp. 10–93; ASRAC Public Meeting, No. 83 at pp. 11, 22, 36, 39–42)

Eventually, the CAC/HP Working Group decided to retain the current minimum EER requirements for split-system air conditioners and single-package air conditioners in the Southwest region with a SEER less than 15.2 and a relaxed EER requirement for split-system air conditioners and single-package air conditioners in the Southwest region with a SEER greater than 15.2. (ASRAC Term Sheet, No. 76 at p. 4, Recommendation #8) The CAC/HP Working Group's decision was based on negotiation rather than any analysis to quantify the impacts of increasing EER along with SEER and/or HSPF or the lower EER level for systems with SEER of 16 or higher. Maintaining an EER requirement in the Southwest region aligns with the position of EER advocates, while not increasing the EER requirement and relaxing it for higher SEER products addresses the concerns of the parties that recommended eliminating the EER requirement. DOE did not explicitly analyze the impact of increasing EER on total installed cost, energy consumption, or life-cycle cost for this direct final rule. Consequently, DOE did not define EER-based efficiency levels.

To set the heating mode efficiency levels for residential heat pumps, DOE developed correlations for split-system and single-package heat pumps relating HSPF to SEER based on ratings in the AHRI Directory of Certified Product Performance. Using the correlations, DOE assigned an HSPF value to each SEER-based efficiency level. For split-system products, DOE based the correlations on pairings of outdoor units with indoor units designated in the AHRI Directory as the highest sales volume indoor units. DOE also conducted the split-system analysis for units with two-ton, three-ton and five-ton capacities. The analysis showed that the relationship between SEER and HSPF does not differ significantly across these capacities. Hence, DOE did not differentiate HSPF standards by capacity in this direct final rule. For single-package units, DOE used all the rated two-ton units to develop the

SEER–HSPF correlations. The development of these correlations is described in more detail in Chapter 5 of the TSD.

During the 2015 CAC/HP Negotiations, the CAC/HP Working Group recommended HSPF standards for both split-system and single package heat pumps—8.8 and 8.0 HSPF, respectively. (ASRAC Term Sheet, Docket No. EERE–2014–BT–STD–0048, No. 0076). For split-system heat pumps, the recommendation was higher than the 8.5 HSPF value determined at 15 SEER by DOE's HSPF/SEER correlation. DOE reviewed available data from the BOMs and specification sheets used for its analysis to assess whether this HSPF differential would impact costs. In this review, DOE looked beyond the least-cost units used for its primary analysis, evaluating costs for 15 SEER split-system heat pumps with HSPF between 8.3 and 9.0. The MPCs calculated for 15 SEER systems within this HSPF range show that the cost differential for the HSPF increase from 8.5 to 8.8 is negligible. Hence, DOE did not in its analysis make an adjustment in its MPCs to reflect this HSPF differential. For single-package heat pumps, the selected standard level, 8.0 HSPF, was only slightly higher than the correlated value, 7.9 HSPF. As for split systems, DOE did not make an adjustment in its MPC to reflect this differential. Section IV.E provides details on how DOE used HSPF levels to analyze the energy use of heat pumps.

3. Estimation of Manufacturer Production Costs

For this DFR analysis, DOE determined a marketshare-weighted MPC at each efficiency level for each representative capacity of each product class and, as described previously in section IV.C.1, separately for split-system air conditioner blower coil and coil-only units as well as single speed and two-stage systems.

To calculate MPCs, DOE first compiled a database of split-system air conditioner and heat pump indoor and outdoor units, single-package air-conditioners and heat pumps, space-constrained air conditioners, and SDHV air conditioners from a variety of manufacturers. For each product class and representative capacity, the database included indoor, outdoor and packaged units from multiple manufacturers that represented a majority of the market and that spanned the range of available efficiencies, to the best extent possible. For split systems, DOE analyzed all possible matches of indoor and outdoor units in its database that are listed in the AHRI Directory of Certified Performance. As such, DOE believes the database of units and systems to be representative of the market.

DOE then performed either a physical teardown or a catalog teardown on each unit in the database. A physical teardown involves reverse-engineering the unit in a laboratory. A catalog teardown involves analyzing manufacturer specification sheets and supplementary component data relative to data collected through a similar physical teardown or other catalog teardown to determine the major physical differences between a product that has been physically disassembled and another similar product for which catalog data are available. The objective of both approaches is to build a ''bottom-up'' manufacturing cost assessment based on a detailed bill of materials.

From the teardowns, DOE generated a bill of materials (BOM) for each unit in the database. The BOM lists all required components and manufacturing steps to describe the product manufacturing in detail. DOE then used the BOM data as inputs to develop a cost model that calculates the MPC for each unit based on its detailed BOM. For split-system air conditioners and heat pumps, DOE generated split-system MPCs by adding the MPC of indoor and outdoor units for matches listed in the AHRI Directory.

DOE then used the cost model outputs to generate marketshare-weighted cost-efficiency relationships for each representative capacity of each product class. The resulting cost-efficiency relationships were used in the downstream analyses and are presented in section IV.C.4.

For product classes other than split-systems—single-package, space-constrained, and small-duct high-velocity—the methodology for calculating MPCs at each efficiency level matched the methodology used in the August 2015 NODA analysis with updated material prices and based on efficiency levels defined by the DOE test procedure at the time of the CAC/HP Working Group Meetings. The results are also tabulated in section IV.C.4.

4. Tabulated Results

DOE's market-weighted cost-efficiency relationships for central air conditioners and heat pumps are shown in Table IV.3 through Table IV.15. DOE used these results as inputs for the LCC and payback period analyses.

TABLE IV–2—MANUFACTURER PRODUCTION COSTS FOR TWO-TON SPLIT-SYSTEM AC BLOWER COIL ($2015)

Efficiency level	SEER	MPC
0–Baseline	13.0	$690
1	13.5	695
2	14.0	714
3	14.5	726
4	15.0	744
5	15.5	762
6	16.0	797
7	16.5	863
8	17.0	1,144
9	17.5	1,171
10*	18.0	1,178
11	19.0	1,314
12	20.0	1,362
13	21.0	1,362

* Efficiency level at which designs are assumed to switch from single speed compressors to two-stage compressors for the remaining higher efficiency levels.

TABLE IV–3—MANUFACTURER PRODUCTION COSTS FOR THREE-TON SPLIT-SYSTEM AC BLOWER COIL

[$2015]

Efficiency level	SEER	MPC
0—Baseline	13.0	$788
1	13.5	815
2	14.0	822
3	14.5	855
4	15.0	887
5	15.5	925
6	16.0	927
7	16.5	1,048
8	17.0	1,310
9	17.5	1,356
10 *	18.0	1,335
11	19.0	1,360
12	20.0	1,360
13	21.0	1,608

* Efficiency level at which designs are assumed to switch from single speed compressors to two-stage compressors for the remaining higher efficiency levels.

TABLE IV–4—MANUFACTURER PRODUCTION COSTS FOR FIVE-TON SPLIT-SYSTEM AC BLOWER COIL

[$2015]

Efficiency level	SEER	MPC
0—Baseline	13.0	$1,063
1	13.5	1,115
2	14.0	1,119
3	14.5	1,168
4	15.0	1,296
5	15.5	1,296
6	16.0	1,365
7 *	16.5	1,459
8	17.0	1,459
9	17.5	1,581
10	18.0	1,631
11	19.0	1,744
12	20.0	1,879

* Efficiency level at which designs are assumed to switch from single speed compressors to two-stage compressors for the remaining higher efficiency levels.

TABLE IV–5—MANUFACTURER PRODUCTION COSTS FOR TWO-TON SPLIT-SYSTEM AC COIL-ONLY

[$2015]

Efficiency level	SEER	MPC
0—Baseline	13.0	$581
1	13.5	598
2	14.0	606
3	14.5	628
4	15.0	676
5	15.5	798
6	16.0	916
7 *	16.5	1,149
8	17.0	1,153

* Efficiency level at which designs are assumed to switch from single speed compressors to two-stage compressors for the remaining higher efficiency levels.

TABLE IV–6—MANUFACTURER PRODUCTION COSTS FOR THREE-TON SPLIT-SYSTEM AC COIL-ONLY

[$2015]

Efficiency level	SEER	MPC
0—Baseline	13.0	$665
1	13.5	698
2	14.0	706
3	14.5	749
4	15.0	883
5 *	15.5	1,048
6	16.0	1,145

TABLE IV–6—MANUFACTURER PRODUCTION COSTS FOR THREE-TON SPLIT-SYSTEM AC COIL-ONLY—Continued

[$2015]

Efficiency level	SEER	MPC
7	16.5	1,155

* Efficiency level at which designs are assumed to switch from single speed compressors to two-stage compressors for the remaining higher efficiency levels.

TABLE IV–7—MANUFACTURER PRODUCTION COSTS FOR FIVE-TON SPLIT-SYSTEM AC COIL-ONLY

[$2015]

Efficiency level	SEER	MPC
0—Baseline	13.0	$908
1	13.5	943
2	14.0	1,087
3	14.5	1,173
4	15.0	1,234
5	15.5	1,287
6*	16.0	1,352
7	16.5	1,423

* Efficiency level at which designs are assumed to switch from single speed compressors to two-stage compressors for the remaining higher efficiency levels.

TABLE IV–8—MANUFACTURER PRODUCTION COSTS FOR TWO-TON SPLIT-SYSTEM HP

[$2015]

Efficiency level	SEER	MPC
0—Baseline	14.0	$881
1	14.5	900
2	15.0	936
3	15.5	991
4	16.0	1,010
5	16.5	1,152
6	17.0	1,303
7	17.5	1,311
8*	18.0	1,353
9	18.5	1,353
10	19.0	1,418

* Efficiency level at which designs are assumed to switch from single speed compressors to two-stage compressors for the remaining higher efficiency levels.

TABLE IV–9—MANUFACTURER PRODUCTION COSTS FOR THREE-TON SPLIT-SYSTEM HP

[$2015]

Efficiency level	SEER	MPC
0—Baseline	14.0	$973
1	14.5	990
2	15.0	1,031
3	15.5	1,132
4	16.0	1,137
5	16.5	1,379
6*	17.0	1,421
7	17.5	1,438
8	18.0	1,459
9	18.5	1,520
10	19.0	1,541

* Efficiency level at which designs are assumed to switch from single speed compressors to two-stage compressors for the remaining higher efficiency levels.

TABLE IV–10—MANUFACTURER PRODUCTION COSTS FOR FIVE-TON SPLIT-SYSTEM HP

[$2015]

Efficiency level	SEER	MPC
0—Baseline	14.0	$1,256
1	14.5	1,324
2	15.0	1,359

TABLE IV–10—MANUFACTURER PRODUCTION COSTS FOR FIVE-TON SPLIT-SYSTEM HP—Continued

[$2015]

Efficiency level	SEER	MPC
3*	15.5	1,543
4	16.0	1,626
5	16.5	1,743
6	17.0	1,883
7	17.5	2,064

* Efficiency level at which designs are assumed to switch from single speed compressors to two-stage compressors for the remaining higher efficiency levels.

TABLE IV–11—MANUFACTURER PRODUCTION COSTS FOR THREE-TON SINGLE-PACKAGE AC

[$2015]

Efficiency level	SEER	MPC
0—Baseline	14.0	$1,050
1	14.5	1,088
2	15.0	1,128
3	15.5	1,169
4	16.0	1,212
5	17.0	1,302
6	17.5	1,350

TABLE IV–12—MANUFACTURER PRODUCTION COSTS FOR THREE-TON SINGLE-PACKAGE HP

[$2015]

Efficiency level	SEER	MPC
0—Baseline	14.0	$1,188
1	14.5	1,233
2	15.0	1,279

TABLE IV–13—MANUFACTURER PRODUCTION COSTS FOR SPACE-CONSTRAINED

[$2015]

Efficiency level	SEER	MPC
0—Baseline	12.0	$1,240
1	12.5	1,276
2	13.0	1,313
3	13.5	1,351
4	14.0	1,390

TABLE IV–14—MANUFACTURER PRODUCTION COSTS FOR SDHV

[$2015]

Efficiency level	SEER	MPC
0—Baseline	12.0	$1,334
1	12.5	1,442
2	13.0	1,558
3	13.5	1,683
4	14.0	1,819

DOE calculated the manufacturer selling price (MSP) for central air conditioners and heat pumps by multiplying the MPC at each efficiency level (determined from the cost model) by the manufacturer markup (to account for non-production costs and profit) and adding the product shipping costs at the given efficiency level. The MSP is the price at which the manufacturer can recover all production and non-production costs and earn a profit.

DOE estimated the manufacturer markup based on publicly available financial information for manufacturers of residential central air conditioners and heat pumps as well as comments from manufacturer interviews. DOE assumed the average manufacturer markup—which includes SG&A expenses, R&D expenses, interest expenses, and profit—to be 1.34 for split-system air conditioners, 1.35 for split-system heat pumps, and 1.32 for single-package air conditioners and single-package heat pumps. Further details on manufacturer markups can be found in section IV.J and in chapter 12 of the direct final rule TSD.

Manufacturers of HVAC products typically pay for the freight (shipping) to the first step in the distribution chain. Freight is not a manufacturing cost, but because it is a substantial cost incurred by the manufacturer, DOE accounts for shipping costs separately from other non-production costs that comprise the manufacturer markup. DOE calculated shipping costs at each efficiency level based on a typical 53-foot straight-frame trailer with a storage volume of roughly 4,000 cubic feet. See chapter 5 of the direct final rule TSD for more details about the methodology DOE used to determine the shipping costs.

D. Markups Analysis

DOE uses distribution channel markups and sales taxes (where appropriate) to convert the manufacturer selling cost estimates from the engineering analysis to consumer prices, which are then used in the LCC, PBP, and the manufacturer impact analyses. The markups are multipliers that are applied to the purchase cost at each stage in the distribution channel.

DOE characterized two distribution channels to describe how central air conditioners and heat pumps pass from manufacturers to residential consumers: replacement market and new construction. The replacement market channel is characterized as follows:

Manufacturer → Wholesaler → Mechanical contractor → Consumer

The new construction distribution channel is characterized as follows:

Manufacturer → Wholesaler → Mechanical contractor → General contractor → Consumer

To develop markups for the parties involved in the distribution of the product, DOE utilized several sources, including: (1) The Heating, Air-Conditioning & Refrigeration Distributors International (HARDI) 2013 Profit Report [38] (to develop wholesaler markups); (2) the Air Conditioning Contractors of America's (ACCA) 2005 financial analysis on the heating, ventilation, air-conditioning, and refrigeration (HVACR) contracting industry [39] (to develop mechanical contractor markups); and (3) U.S. Census Bureau 2007 Economic Census data [40] on the residential and commercial building construction industry (to develop general contractor markups).

For wholesalers and contractors, DOE developed baseline and incremental markups based on the product markups at each step in the distribution chain. The baseline markup relates the change in the manufacturer selling price of baseline models to the change in the consumer purchase price. The incremental markup relates the change in the manufacturer selling price of higher-efficiency models (the incremental cost increase) to the change in the consumer purchase price.

In addition to the markups, DOE derived state and local taxes from data provided by the Sales Tax Clearinghouse.[41] These data represent weighted average taxes that include county and city rates. DOE derived shipment-weighted average tax values for each region considered in the analysis.

Chapter 6 of the direct final rule TSD provides further detail on the estimation of markups.

E. Energy Use Analysis

The purpose of the energy use analysis is to assess the energy requirements of residential central air conditioners and heat pumps at different efficiencies in representative U.S. single-family homes and multi-family residences, and to assess the energy savings potential of increased product efficiency.

DOE estimated the annual energy consumption of central air conditioners and heat pumps at specified energy efficiency levels across a range of climate zones, building characteristics, and cooling applications. DOE's analysis estimated the energy use of central air conditioners and heat pumps in the field (*i.e.*, as they are actually used by consumers). In contrast to the DOE test procedure, which provides standardized results that can serve as the basis for comparing the performance of different appliances used under the same conditions, the energy use analysis seeks to capture the range of operating conditions for central air conditioners and heat pumps.

In its analysis of the recommended TSL, DOE applied a higher HSPF value to split-system heat pumps than indicated by the SEER and HSPF correlations discussed in section IV.C.2. The higher value, 8.8 HSPF, was recommended by the CAC/HP Working Group. At Efficiency Level 2, the recommended TSL for split-system heat pumps, the HSPF should be 8.5 rather than the recommended value of 8.8. Since increasing the HSPF increases the heating efficiency of the equipment, additional energy savings are realized.

As also noted in section IV.C.2, DOE did not analyze EER-based efficiency levels in the engineering analysis. DOE also did not analyze the impact of EER on energy consumption or on life-cycle cost.

In the November 2014 RFI, DOE requested comment on whether it should analyze the use of central air conditioners and heat pumps in commercial buildings in the residential central air conditioning rulemaking. AHRI and Southern Co. commented that they did not recommend considering commercially-used equipment because central air conditioners are not utilized significantly in commercial buildings. (AHRI, No. 13 at p. 4; Southern Co., No. 11 at p. 2) Rheem stated that commercial applications of residential equipment are less than 5 percent of the market, which would not be a significant enough percentage of the market to warrant special consideration of the application in the analysis for this rulemaking. (Rheem, No. 17 at p. 6)

As presented to the CAC/HP Working Group, DOE did not consider commercial-sector applications of residential central air conditioners and heat pumps because these represent a very small share of the overall market.[42] (ASRAC Public Meeting, No. 89 at pp. 7–14)

1. General Approach

To determine the field energy use of residential central air conditioners and heat pumps used in homes, DOE used a subset of 7,283 households using a central air conditioner or heat pump from the Energy Information Administration's (EIA) 2009 Residential Energy Consumption Survey (RECS 2009).[43] These households represent 60 percent of the weighted households in the U.S. The 153 RECS households that also had a room air conditioner, representing two percent of all weighted households with a central air conditioner, were not included. The RECS data provide information on the age of the home, the number of square

[38] Heating, Air Conditioning & Refrigeration Distributors International 2013 Profit Report, available at *http://www.hardinet.org/Profit-Report* (last accessed Aug. 19, 2014).

[39] Air Conditioning Contractors of America (ACCA), Financial Analysis for the HVACR Contracting Industry (2005), available at *http://www.acca.org/store/* (last accessed Aug. 19, 2014).

[40] U.S. Census Bureau, 2007 Economic Census Data, available at: *http://www.census.gov/econ/* (last accessed April 10, 2014).

[41] Sales Tax Clearinghouse Inc., State Sales Tax Rates Along with Combined Average City and County Rates (2014) available at *http://thestc.com/STrates.stm* (last accessed January, 2014).

[42] EIA's Commercial Building Energy Consumption Surveys from 1992, 1995, 1999, and 2003 indicate that the fraction of commercial buildings with a residential central air conditioner or heat pump unit ranges from 1.2 to 2.1 percent.

[43] U.S. Department of Energy: Energy Information Administration, Residential Energy Consumption Survey: 2009 RECS Survey Data (2013), available at: *http://www.eia.gov/consumption/residential/data/2009/* (last accessed July 6, 2016).

feet that are cooled, the age of its cooling equipment, and the 2009 cooling and heating energy use for each household. DOE used the household samples not only to determine annual central air conditioner or heat pump energy consumption, but also as the basis for conducting the LCC and PBP analysis. DOE projected household weights, building characteristics (such as thermal shell efficiency and square footage), and cooling degree days (CDD) in 2021, the first full year of compliance with any amended energy conservation standards for central air conditioners and heat pumps. To characterize new homes in 2021, DOE used a subset of homes that were built after 1994; these new homes represent 23 percent of the homes with central air conditioners, and 45 percent of the homes with heat pumps.

RECS does not provide information on the type of central air conditioner or heat pump, its capacity, or the number of units installed (in particularly hot or humid locations more than one central air conditioner/heat pump unit may be installed in a home). DOE assigned the number and capacity of central air conditioner/heat pump unit(s) based on the assumption of one ton of cooling capacity installed per 500 square feet of cooled floor space. For homes with more than one story and an estimated cooling capacity of between 3 and 5 tons, DOE assigned a 2-ton and a 3-ton unit, under the assumption that home owners installed a second unit to provide separate thermostatic control for each floor. For households with estimated cooling capacity between 5 and 8 tons, DOE assigned a 3-ton and a 5-ton unit, regardless of the number of stories. These assumptions resulted in a distribution of national central air conditioner/heat pump by capacity very similar to that of AHRI shipment data from 2007 to 2013 (30 percent 2-ton, 39 percent 3-ton, and 32 percent 5-ton). DOE's assignment method resulted in just over one-quarter of households having at least two central air conditioner/heat pump units installed, with one RECS household (representing 33,000 national households) assigned five 5-ton units.

For single-package central air conditioners and heat pumps, DOE only used RECS households with 3-ton and 5-ton units because single-package equipment is concentrated in these sizes. To analyze space-constrained central air conditioners, DOE only used RECS multi-family households with air conditioning because this equipment is targeted for multi-family applications. To analyze small-duct high-velocity air conditioners, DOE only used RECS single-family detached homes sized with cooling requirements of 3-tons because this equipment is targeted for single-family residences with moderate cooling requirements.

To estimate the annual energy consumption of central air conditioners and heat pumps meeting the considered efficiency levels, DOE first estimated the SEER of the existing equipment based on its age and the average SEER of new central air conditioner/heat pump shipments by year from AHRI data. For heat pumps, the HSPF of the existing equipment was based on the SEER–HSPF correlation developed in the Engineering Analysis and described in section IV.C.2.

For each sampled household, DOE adjusted the energy use estimated for 2009 to ''normal'' weather by using ten-year CDD and HDD data for each geographical region.[44] As 2009 was a relatively cool year, these adjustments increased CDD on average by eleven percent and decreased HDD on average by five percent. DOE also accounted for the change in climate based on *Annual Energy Outlook 2015* (*AEO 2015*) projections of CDD.[45] This adjustment results in the national average building cooling load increasing nine percent and the national average building heating decreasing five percent from 2014 to 2021.

DOE accounted for change in building shell characteristics and building size (square footage) between 2009 and 2021 by applying separate building shell indexes for existing and new homes in the National Energy Modeling System (NEMS) associated with *AEO 2015.* The indexes consider projected improvements in building thermal efficiency due to improvement in home insulation and other thermal efficiency practices, as well as projected increases in square footage of new homes. Application of the index results in three percent lower building cooling load for all homes, but one percent higher building cooling load for new homes, between 2009 and 2021.

For each sample housing unit, DOE estimated the cooling load, and heating load for heat pumps, in 2021 by multiplying the estimated cooling and heating energy use in 2021 by the SEER and HSPF of the existing central air conditioner or heat pump. The 2021 cooling and heating loads are then used to estimate the energy use from replacing the existing equipment with new central air conditioner or heat pump units conforming to higher efficiency levels.

Chapter 7 of the direct final rule TSD provides further detail on the general approach to the energy use analysis.

2. Split-System Central Air Conditioner: Blower-Coil to Coil-Only Efficiency Adjustment

As discussed in section III.A, DOE had intended to rate and certify split-system central air conditioners based on a blower-coil configuration. However, the CAC/HP Working Group recommended that DOE adopt an approach, similar to the current one, of rating and certifying split-system central air conditioners based on any configuration (*i.e.,* coil-only or blower-coil). (ASRAC Term Sheet, No. 76 at p. 4) As a result, the energy use analysis no longer had to address the field installation of split-system blower coil central air conditioners as coil-only units. In its analysis, DOE analyzed coil-only and blower coil split-system central air conditioners independently.

3. Split-System Central Air Conditioner: Coil-Only Efficiency Adjustment

Coil-only central air conditioner installations consist of the condensing unit and an evaporative coil. For rating purposes, a default fan power consumption is applied to determine the SEER. In the June 8, 2016 test procedure final rule, DOE designated the default fan power for the rating of coil-only central air conditioner split-systems to be 365 Watts per CFM, which is equivalent to a furnace fan using a permanent split capacitor (PSC) motor. Because the energy use analysis had to account for the actual furnace fan in the existing house to properly represent the rated SEER of the coil-only central air conditioner installation, DOE developed ''factory-to-field'' adjustment factors to convert the coil-only rated SEER to a coil-only ''field SEER''.

To develop such factors, DOE used a furnace fan-motor mix of 77-percent PSC, 9-percent constant torque brushless permanent magnet (CT–BPM), and 15-percent constant speed brushless permanent magnet (CS–BPM). The above furnace fan mix is based on data developed for DOE's furnace fan

[44] National Oceanic and Atmospheric Administration, NNDC Climate Data Online (2014), available at *http://www7.ncdc.noaa.gov/CDO/CDODivisionalSelect.jsp* (last accessed July 29, 2014).

[45] U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2015,* available at *http://www.eia.gov/forecasts/aeo/.* Projections of degree days are informed by a 30-year linear trend of each state's degree days, which are then population-weighted to the Census division level. In this way, the projection accounts for projected population migrations across the nation and continues any realized historical changes in degree days at the state level. The LCC and PBP analysis uses the climate projected for 2021 for all TSLs.

standards rulemaking, and characterizes furnace fan types in the housing stock in 2021 (the expected first full year of compliance with any amended central air conditioner efficiency standards). 79 FR 38129 (July 3, 2014). This furnace fan mix was used in the energy use analysis to specify the furnace fan types in the housing stock that use both a central air conditioner and a furnace to space-condition the home. The furnace fan mix was characterized as a custom probability distribution and each of the furnace fan types was probabilistically assigned to RECS households that utilized a central air conditioner and furnace.

After the assignment of the furnace fan type to the RECS household, the ''factory-to-field'' adjustment factor was applied to convert the rated SEER to a ''field SEER.'' The ''factory-to-field'' adjustment factors were developed as a function of the coil-only rated SEER; the central air conditioner cooling capacity; and the type of furnace fan in the existing household. For example, in the case of a 3-ton coil-only central air conditioner unit with a rated SEER of 15 utilizing a PSC indoor blower-motor, if the unit was installed as a coil-only unit into a household with a CT–BPM furnace fan, then the ''factory-to-field'' adjustment factor accounted for the reduction in fan power associated with utilizing a CT–BPM indoor blower-motor instead of a PSC furnace fan.

Table IV–15 shows the ''factory-to-field'' adjustment factors for converting coil-only rated SEER to a coil-only ''field SEER.'' Appendix 7E of the direct final rule TSD provides details on exactly how the ''factory-to-field'' adjustment factors were determined.

TABLE IV–15—''FACTORY-TO-FIELD'' ADJUSTMENT FACTORS TO CONVERT COIL-ONLY CENTRAL AIR CONDITIONER RATED SEER TO COIL-ONLY ''FIELD SEER''

Coil-only rated SEER	Capacity of central air conditioner and the furnace fan type in the existing household								
	2-ton			3-ton			5-ton		
	PSC (%)	CT–BPM (%)	CS–BPM (%)	PSC (%)	CT–BPM (%)	CS–BPM (%)	PSC (%)	CT–BPM (%)	CS–BPM (%)
13.0	0.0	6.9	7.3	0.0	3.5	4.8	0.0	1.8	5.0
13.5	0.0	7.1	7.5	0.0	3.7	5.0	0.0	1.8	5.2
14.0	0.0	7.3	7.8	0.0	3.8	5.2	0.0	1.9	5.3
14.5	0.0	7.6	8.0	0.0	3.9	5.3	0.0	1.9	5.5
15.0	0.0	7.8	8.3	0.0	4.0	5.5	0.0	2.0	5.7
15.5	0.0	8.0	8.5	0.0	4.1	5.6	0.0	2.1	5.8
16.0	0.0	8.3	8.8	0.0	4.2	5.8	0.0	2.1	6.0
16.5	0.0	8.7	9.3	0.0	4.5	6.1	0.0	2.2	6.3
17.0	0.0	9.0	9.5	0.0	4.6	6.3	0.0	2.3	6.5
18.0	0.0	9.2	9.8	0.0	4.7	6.4	0.0	2.3	6.7

4. Split-System Central Air Conditioner: Coil-Only Installations

In the August 2015 NODA, the analysis assumed that coil-only installations would consist of a new condensing unit and a new evaporative coil utilizing the blower of the furnace. Data presented to the CAC/HP Working Group by AHRI showed that there are far more shipments of condensing units than evaporative coils, indicating that new condensing units are not always paired with a new evaporative coil, and instead some installations use the existing evaporative coil. The AHRI data suggested that approximately 25 percent of installations use the existing evaporative coil. (ASRAC Public Meeting, No. 88 at pp. 175–214)

In the analysis for this DFR, DOE assumed that 25 percent of coil-only installations use the existing evaporative coil. Based on a characterization of the stock of evaporative coils, DOE assumed that 25 percent of the existing evaporative coils are from a system rated at 10 SEER (the efficiency standard effective in 1992) and 75 percent are from a system rated at 13 SEER (the efficiency standard effective in 2006). The analysis paired a new condensing unit at each considered efficiency level with an evaporative coil at either 10 or 13 SEER, so the system efficiency is less than would be the case with a new evaporative coil. DOE used an equipment simulation model, the DOE/Oak Ridge National Laboratory (ORNL) Heat Pump Design Model, Mark VI version,[46] along with a manufacturer's central air conditioner system specifications, to estimate the resulting system efficiency. Appendix 7G of the DFR TSD provides details of the analysis, which were also presented to the CAC/HP Working Group. (ASRAC Public Meeting, No. 84 at pp. 59–61) Because 25 percent of coil-only installations use the existing (lower-efficiency) evaporative coil, the overall average energy use of split-system central air conditioners is higher in the DFR analysis than in the August 2015 NODA. (ASRAC Public Meeting, No. 88 at pp. 175–214)

5. Fan Energy Use During Continuous Operation

The SEER and HSPF efficiency metrics account for fan energy use to provide space cooling and space heating, respectively. These metrics do not account for fan energy use in continuous operation.[47] As noted above in section IV.E.3, DOE published a final rule that established energy conservation standards for residential furnace fans. Products addressed in the final rule include furnace fans used in weatherized and non-weatherized gas furnaces, oil furnaces, electric furnaces, and modular blowers, which included capturing the energy use of these products in continuous operation. The rule does not cover furnace fans used in blower-coil indoor units of split-system central air conditioners and heat pumps of any type.[48] As noted above in section IV.E.3, coil-only split-system air conditioners are coupled with non-weatherized furnaces and, as a result, the continuous operation of the fan was already accounted for in the furnace fan final rule. The continuous operation of the fan for single-package air

[46] DOE/ORNL Heat Pump Design Model, Mark VI Version. *http://web.ornl.gov/~wlj/hpdm/MarkVI.shtml.*

[47] Continuous operation is used in homes that require mechanical ventilation because are infiltration is very low.

[48] Reference to Technical Support Document for Residential Furnace Fans Energy Conservation Standard, Chapter 3 Market and Technology Assessment: *http://www.regulations.gov/#!documentDetail;D=EERE-2010-BT-STD-0011-0111.*

conditioners was also already accounted for in the furnace fan final rule as these products are sold within a single package that includes a weatherized furnace. Therefore, DOE needed to account for fan energy use in continuous operation for the following product classes: Split-system central air conditioner product class in a blower coil configuration, split-system heat pumps, single-package heat pumps, and small duct high velocity air conditioners.

To accomplish the accounting of continuous fan operation, DOE relied on inputs from the rulemaking for furnace fans. Specifically, DOE used the wattage reduction from certain fan technologies, the hours of operation in continuous mode for households that use that mode, and the fraction of households that require such continuous operation.[49] The engineering analysis specifies the fan technologies that are associated with specific SEER and HSPF efficiency levels, allowing for calculation of the fan energy savings in continuous operation at each level for split-system and package heat pumps and split-system central air conditioners in a blower coil configuration. Further details are given in chapter 7 of the DFR TSD.

6. Other Issues

Higher-efficiency central air conditioners and heat pumps can reduce the operating costs for a consumer, which DOE understands could lead to greater use of the product. A direct rebound effect occurs when a piece of equipment that is made more efficient is used more intensively, such that the expected energy savings from the efficiency improvement may not fully materialize. In this DFR analysis, DOE examined a 2009 review of empirical estimates of the rebound effect for various energy-using products.[50] However, the review contained relatively few estimates of the direct rebound effect for household cooling. The two studies discussed in the review were old studies (from 1978 and 1981), conducted during a period of rising energy prices and using small sample sizes. One shows a short-run rebound effect of 4 percent,[51] while the other reported a wide range of 1–26 percent.[52] In the NOPR for residential furnaces, DOE chose to use a rebound effect of 15 percent, which is roughly in the center of the range reported for household cooling. 80 FR 13120, 13148 (May 12, 2015). For consistency, DOE used a rebound effect of 15 percent for central air conditioner and heat pump when counting energy savings in the NIA.

In its comments on the November 2014 RFI, NEEA and NPCC stated that DOE's proposed test procedure change for variable-speed units may have a significant impact on energy savings. (NEEA & NPCC, No. 19 at p. 10) As discussed in section III.F, DOE is amending the testing requirement for systems with a variable speed compressor. As noted in section III.F, however, the analyses conducted to support this direct final rule were based on the test procedure at the time of the CAC/HP Working Group negotiations, per the request of the CAC/HP Working Group.

Commenting on the RFI, AHRI urged DOE to evaluate the impact of changes in SEER and EER on cooling energy savings once the 2011 DFR standards are effective (in 2015). AHRI stated that DOE cannot determine whether additional improvements will save energy without evaluating whether the standards that have been adopted have actually resulted in the energy savings predicted in the 2011 DFR analysis. According to AHRI, if those savings are not in fact realized, DOE cannot have a basis for concluding that further changes will result in additional significant energy savings. (AHRI, No. 13 at p. 4)

In response, DOE expects that manufacturers will comply with the 2011 DFR standards and that the units sold at the rated SEER and EER levels will generally perform as expected. DOE's estimation of the energy use of standards-compliant units in representative use in U.S. homes was extensively reviewed in the 2011 DFR rulemaking, and it is reasonable to expect that the efficiency improvements required by the 2011 DFR will yield energy savings roughly in accord with DOE's projections.

F. Life-Cycle Cost and Payback Period Analysis

In determining whether an energy efficiency standard is economically justified, DOE considers the economic impact of potential standards on consumers. The effect of new or amended standards on individual consumers usually includes a reduction in operating cost and an increase in purchase cost. DOE used the following two metrics to measure consumer impacts:

- LCC (life-cycle cost) is the total consumer cost of an appliance or product, generally over the life of the appliance or product, including purchase and operating costs. The latter costs consist of maintenance, repair, and energy costs. Future operating costs are discounted to the time of purchase and summed over the lifetime of the appliance or product.
- PBP (payback period) measures the amount of time it takes consumers to recover the assumed higher purchase price of a more energy-efficient product through reduced operating costs.

For any given efficiency level, DOE measures the change in LCC relative to the efficiency levels estimated for the no-standards case, which reflects the market in the absence of amended energy conservation standards, including market trends for equipment that exceeds the current energy conservation standards.

DOE analyzed the net effect of potential amended central air conditioner and heat pump standards on consumers by calculating the LCC savings and PBP for each household by efficiency level. Inputs to the LCC calculation include the installed cost to the consumer (purchase price, including sales tax where appropriate, plus installation cost), operating costs (energy expenses, repair costs, and maintenance costs), the lifetime of the product, and a discount rate. Inputs to the payback period calculation include the installed cost to the consumer and first-year operating costs.

DOE performed the LCC and PBP analyses using a spreadsheet model combined with Crystal Ball[53] to account for uncertainty and variability among the input variables. Each Monte Carlo simulation consists of 10,000 LCC and PBP calculations using input values that are either sampled from probability

[49] Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Residential Furnace Fans. U.S. Department of Energy. Washington DC. June 2014. Chapter 7. *https://www.regulations.gov/#!documentDetail;D=EERE–2010–BT–STD–0011–0111.*

[50] S. Sorrell, J. Dimitropoulos, and M. Sommerville, 2009. Empirical Estimates of the Direct Rebound Effect: A Review. 37 *Energy Policy* 1356–71.

[51] Hausman, J.A., 1979. Individual discount rates and the purchase and utilization of energy-using durables. *Bell Journal of Economics* 10(1), 33–54.

[52] Dubin, J.A., Miedema, A.K., Chandran, R.V., 1986. Price effects of energy-efficient technologies—a study of residential demand for heating and cooling. *Rand Journal of Economics* 17(3), 310–25.

[53] Crystal Ball is a commercial software program developed by Oracle and used to conduct stochastic analysis using Monte Carlo simulation. A Monte Carlo simulation uses random sampling over many iterations of the simulation to obtain a probability distribution of results. Certain key inputs to the analysis are defined as probability distributions rather than single-point values.

distributions and household samples or characterized with single point values. 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-standards case efficiency distribution. In performing an iteration of the Monte Carlo simulation for a given consumer, product efficiency is chosen based on its probability. If the chosen product efficiency is greater than or equal to the efficiency of the standard level under consideration, the LCC and PBP calculation reveals that a consumer is not impacted by the standard level. By accounting for consumers who already purchase more-efficient products, DOE avoids overstating the potential benefits from increasing product efficiency.

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

As discussed in section IV.E, DOE developed nationally-representative household samples from 2009 RECS. For each sampled building, DOE determined the energy consumption of the central air conditioner or heat pump and the appropriate energy prices in the area where the building is located.

DOE calculated the LCC and PBP for all central air conditioner or heat pump consumers as if the consumers were to purchase the product in the year that compliance with amended standards is required. Because the analysis was conducted when 2021 was the expected first year of compliance, it used that year for all the considered TSLs, including the Recommended TSL.

At the October 14, 2015 CAC/HP Working Group meeting, AHRI presented an LCC sensitivity analysis demonstrating the impact of several inputs, including manufacturer production costs, distribution channel markups, consumer discount rates, and expected time of ownership, on the LCC savings of more-efficient split system CACs and HPs. AHRI's analysis demonstrated that the LCC savings are highly sensitive to the above inputs. (ASRAC Public Meeting, No. 89 at pp. 225–239). Although AHRI did question the above inputs that DOE used in the LCC analysis, the purpose of their analysis was to demonstrate that the LCC savings were highly sensitive to changes in the inputs. As a result of AHRI's analysis, DOE requested feedback and made revisions to the above inputs based on member recommendations during subsequent CAC/HP Working Group meetings. The inputs to the LCC analysis which were the focus of AHRI's sensitivity analysis are described in sections above (manufacturer production costs and markups) or below (discount rates and product lifetime). In the case of the manufacturer production costs, DOE details how stakeholder recommendations were considered in the development of the costs. As a result of the Working Group's efforts to provide meaningful input and insights for all of the input into the LCC analysis, DOE believes the LCC results presented in section V.B.1 accurately represent the consumer impacts of the amended standards for CACs and HPs.

1. Inputs to Installed Cost

The primary inputs for establishing the total installed cost are the baseline consumer product price, standard-level consumer price increases, and installation costs (labor and material cost). Baseline consumer prices and standard-level consumer price increases were determined by applying markups to manufacturer selling price estimates, including sales tax where appropriate. The installation cost is added to the consumer price to produce a total installed cost.

a. Equipment Cost

The manufacturer selling price estimated in the engineering analysis refers to the current price. Economic literature and historical data suggest that the real prices of many products may trend downward over time according to ''learning'' or ''experience'' curves. Experience curve analysis focuses on entire industries and aggregates over many causal factors that may not be well characterized.[54] For example, experience curve analysis implicitly includes factors such as efficiencies in labor, capital investment, automation, materials prices, distribution, and economies of scale at an industry-wide level. An experience curve relates the product price to the cumulative production of the product. Using a given set of historical data, DOE derived an experience rate that expresses the percentage reduction in price for each doubling of cumulative production.

For the default price trend for residential central air conditioner and heat pump, DOE derived an experience rate based on an analysis of long-term historical data. As a proxy for manufacturer price, DOE used Producer Price Index (PPI) data for unitary air conditioners from the Bureau of Labor Statistics for 1978 through 2013.[55] An inflation-adjusted PPI was calculated using the GDP chained price deflators for the same years. To calculate an experience rate, DOE performed a least-squares power-law fit on the inflation-adjusted PPI versus cumulative shipments of residential central air conditioners and heat pumps, based on a corresponding series for historic shipments of these products (see section IV.G of this direct final rule for discussion of shipments data). A detailed discussion of DOE's derivation of the experience rate is provided in appendix 8–C of the direct final rule TSD.

DOE then derived a price factor index, with the price in 2013 equal to 1, to forecast prices in the compliance year for the LCC and PBP analysis, and, for the NIA, for each subsequent year in the 30-year shipments period. The index value in each year is a function of the experience rate and the cumulative production through that year. To derive the latter, DOE combined the historical shipments data with projected shipments from the NIA (see section IV.H of this notice).

As discussed, DOE determined the type, capacity and number of central air conditioner/heat pump units for each RECS household in order to assign the correct equipment price. For packaged systems, DOE only developed manufacturer costs for 3-ton systems, so it used these costs for all packaged systems to arrive at equipment prices.

As discussed, the energy use analysis had to address the field installation of coil-only installations use the existing evaporative coil. For these installations, the equipment price was based solely on the condensing unit.

[54] Margaret Taylor & K. Sydny Fujita, Accounting for Technological Change in Regulatory Impact Analyses: The Learning Curve Technique. (Lawrence Berkeley Nat'l Lab., 2013) available at: *http://eetd.lbl.gov/publications/accounting-for-technological-change-0.*

[55] U.S. Department of Labor, Bureau of Labor Statistics, Produce Price Indices Series ID PCU333415333415E, available at *http://www.bls.gov/ppi/* (last accessed July 28, 2014).

b. Installation Cost

Installation cost includes labor, overhead, and any miscellaneous materials and parts needed to install the equipment.

DOE developed installation labor costs for different central air conditioner and heat pump capacities from *RSMeans Facilities Maintenance & Repair Cost Data 2015.* Based on input from the CAC/HP Working Group, two further actions were taken: The hourly wages were updated and overhead and profit were included using the information from RS Means. (ASRAC Public Meeting, No. 84 at pp. 76–80)

Commenting on the November 2014 RFI, AHRI stated that installation costs are generally scalable with equipment size and weight. (AHRI, No. 13 at p. 4) Southern Co. stated that installation cost scales with weight. (Southern Co., No. 11 at p. 2) In contrast, Rheem does not believe that installation costs scale with equipment weight. According to Rheem, DOE should analyze the installation costs as increasing with efficiency due to duct modifications that are required for larger indoor coils. (Rheem, No. 17 at p. 6)

DOE initially determined that the change in weight from the minimum efficiency unit to maximum efficiency unit is not large enough to require an increase in the number of people in the crew to move and position the unit—two people are sufficient.[56] The labor hours also do not change with the physical size of the unit. Regarding the need for duct modification, air flow volume does not change with efficiency, so duct size does not need to change for the same tonnage unit even if the indoor coil size is bigger. Based on the foregoing, the installation cost was initially estimated to remain the same across the considered efficiency levels. Based on input from the CAC/HP Working Group, however, DOE revised the installation cost for replacement installations to account for the installation of/thermostat wire as well as the increased thermostat costs for 2-speed compressors and indoor fan ECMs. (ASRAC Public Meeting, No. 84 at pp. 76–80) These cost adders were generally applied to units with energy efficiencies at about 16 SEER.

The CAC/HP Working Group requested that ACCA conduct a survey of its members to provide insight regarding the degree to which installation costs are higher for more-efficient equipment. ACAA conducted a survey and presented it to the CAC/HP Working Group. Based on the survey, ACCA concluded that DOE was not fully covering installation costs, including the costs of changing wiring and thermostats, checking ducting, and start-up costs to commission a higher efficiency product. (ASRAC Public Meeting, No. 85 at pp. 43–79) In response, DOE notes that the number of survey respondents was small (44 out of approximately 4,000 member contractors). Therefore, DOE chose to retain its estimates of installation costs.

Commenting on the November 2014 RFI, AHRI suggested that DOE include costs incurred by contractors and consumers associated with installation limitations such as local fire code access restrictions and indoor space constraints. (AHRI, No. 13 at p. 4) In response, DOE notes that it currently has space-constrained central air conditioner and space-constrained heat pump product classes specifically for products that may have installation limitations due to space constraints. Therefore, contractor and consumer costs due to space constraints were not considered for the other non-space-constrained product classes.

2. Inputs to Operating Costs

a. Energy Consumption

For each sample household, DOE determined the energy consumption for a central air conditioner or heat pump at different efficiency levels using the approach described above in section IV.E.

As discussed in section IV.E, DOE is taking into account the rebound effect associated with more-efficient residential central air conditioner and heat pump. The take-back in energy consumption associated with the rebound effect provides consumers with increased value (*e.g.,* enhanced comfort associated with a cooler or warmer indoor environment). The increased comfort has a cost that is equal to the monetary value of the higher energy use. DOE could reduce the energy cost savings to account for the rebound effect, but then it would have to add the value of increased comfort in order to conduct a proper economic analysis. The approach that DOE uses—not reducing the energy cost savings to account for the rebound effect and not adding the value of increased comfort—assumes that the value of increased comfort is equal to the monetary value of the higher energy use. Although DOE cannot measure the actual value of increased comfort to the consumers, the monetary value of the higher energy use represents a lower bound for this quantity.

b. Energy Prices

DOE used marginal and average prices which vary by season, region and household consumption level. DOE estimated these prices using data published with the Edison Electric Institute (EEI) Typical Bills and Average Rates reports for summer and winter 2014.[57] Each report provides, for most of the major investor-owned utilities (IOUs) in the country, the total bill assuming household consumption levels of 500, 750 and 1,000 kWh for the billing period. DOE defined an average price as the ratio of the total bill to the electricity consumption, and a marginal price as the ratio of the change in the bill to the change in energy consumption.

Regional weighted-average values for each type of price were calculated for the nine census divisions and four large States (CA, FL, NY and TX). Each EEI utility in a region was assigned a weight based on the number of residential consumers it serves. Consumer counts were taken from the most recent EIA Form 861 data.[58] DOE adjusted these regional weighted-average prices to account for systematic differences between IOUs and publicly-owned utilities (POUs), as the latter are not included in the EEI data set. For each region, DOE estimated a correction factor based on the ratio of the average electricity price for IOUs to the average price charged by POUs (calculated using EIA Form 861 data), and the percentage of consumers served by POUs.

DOE assigned seasonal average and marginal prices to each household in the LCC sample based on its location and its baseline monthly electricity consumption for an average summer or winter month. For a detailed discussion of the development of seasonal average and marginal energy prices, see appendix 8–F of the direct final rule TSD.

To estimate future prices, DOE used the projected annual changes in average residential electricity prices in the Reference case projection in *AEO 2015.*[59] The AEO price trends do not distinguish between marginal and average prices. DOE reviewed the EEI data for the years 2007 to 2014 and

[56] For example, a 5 ton air conditioner outdoor unit weight changes from 190 lb to 290 lb when efficiency changes from 13 SEER to 18 SEER (data from manufacturer published data).

[57] Edison Electric Institute. Typical Bills and Average Rates Report. Winter 2014 published April 2014, Summer 2014 published October 2014. See *http://www.eei.org/resourcesandmedia/products/Pages/Products.aspx.*

[58] See *http://www.eia.gov/electricity/data/eia861/*.

[59] U.S. Department of Energy, Energy Information Administration, *op.cit.*

determined that there is no systematic difference in the trends for marginal vs. average prices in the data, so DOE used the same *AEO 2015* trend for both.

c. Maintenance and Repair Costs

Maintenance costs are associated with maintaining the proper operation of the equipment, whereas repair costs are associated with repairing or replacing components that have failed.

The maintenance cost for an air conditioner or heat pump unit includes a preventative annual check done by HVAC professionals, and preventative maintenance performed by home owners such as filter changes.

Commenting on the November 2014 RFI, Rheem stated that more efficient products do not require additional maintenance. (Rheem, No. 17 at p. 7) Southern Co. stated that time and cost of routine maintenance should be higher for variable speed units. (Southern Co., No. 11 at p. 3)

DOE reviewed *RSMeans Facilities Maintenance & Repair Cost Data 2015* and determined that the maintenance cost does not change with equipment size and equipment efficiency, even for variable-speed products. Most variable-speed products have intelligent controls, which have certain diagnostic capabilities that would likely reduce the maintained cost of the unit. However, DOE decided not to estimate lower maintenance costs for variable-speed units to be more conservative. Therefore, DOE did not include maintenance costs in the LCC analysis as it would have no impact on the results.

DOE calculated the cost of repair by totaling the cost of replacing the major components in central air conditioner or heat pump that are expected to fail during the life of the equipment. Higher efficiency units have more expensive components, and the estimated repair costs are higher. The major components included in the analysis are the indoor coil, outdoor coil, indoor blower (except for coil-only unit), outdoor fan, indoor TXV, outdoor TXV (heat pump only), reversing valve (heat pump only), and controls. Compressor failures were not considered in the LCC and PBP analysis but, rather, were included in the shipments and national impact analyses. DOE assumed that compressor failure is the principal driver for a consumer to either replace or repair the unit (see section IV.G). For investors, which are often used in variable-speed compressors, manufacturers offer the same warranty term for inverters and compressors together, so DOE assumed inverters have approximately the same reliability as compressors.

DOE developed component failure rates from proprietary industry data. The associated material cost and labor costs were initially developed from *RSMeans Facilities Maintenance & Repair Cost Data 2015,* the 2014 furnace fan final rule TSD,[60] and component vendors. The development of repair costs considered a warranty period, as almost all manufacturers provide warranty coverage for their products. As a result, the costs associated with component repairs occurring during the warranty period were deducted from the total consumer repair cost. Because equipment of different capacities and efficiencies contain different components, repair costs were calculated as a function of efficiency and capacity. Because component failure rates are a function of equipment age, DOE determined failure rates and the associated repair costs during different periods of equipment age.

Commenting on the November 2014 RFI, AHRI stated that higher efficiency products have more complex and expensive components necessitating longer repair times by more experienced technicians, and repair costs are generally directly proportional with equipment price. (AHRI, No. 13 at p. 4–5) Rheem stated that with the exception of evaporator and condenser coils, repair costs vary with replacement component prices and not product price. Rheem noted that with more complex technologies to achieve higher efficiency, the number of components increases and the number of repairs per system is likely to increase. (Rheem, No. 17 at p. 7) Southern Co. stated that inverters tend to have shorter lives than compressors and evaporators, and costs for inverter replacements should be separately modeled. (Southern Co., No. 11 at p. 3)

The cost of replacing the major components in a central air conditioner or heat pump that are expected to fail during the life of the equipment and the component failure rates were presented to the CAC/HP Working Group. Based on input from the CAC/HP Working Group, DOE revised its estimates. (ASRAC Public Meeting, No. 84 at pp. 83–100) Failure rates and material costs were revised based on further discussion with industry experts. All components besides fan motors were marked up with a mechanical contractor markup. Fan motor costs were taken from Grainger.[61] The labor hours for the repair remained the same as what was initially developed but the hourly wages were updated to include overhead and profit based on RS Means. Refer to chapter 7 of the direct final rule TSD for more details on the development of the costs, labor hours, and failure rates.

d. Product Lifetime

Product lifetime is the age at which an appliance is retired from service. DOE estimated the lifetime of central air conditioners and heat pumps as part of the shipments analysis. The method that DOE used to develop lifetime estimates is described in section IV.G. DOE developed separate lifetime distributions for the three considered regions. Table IV–16 shows the average lifetimes.

TABLE IV–16—AVERAGE LIFETIME BY REGION

Product class group	National	North	Hot-humid	Hot-dry
Central Air Conditioners	21.2	24.1	18.0	24.9
Heat Pumps	15.3	16.4	15.1	15.4

e. Discount Rates

In the calculation of LCC, DOE applies discount rates to estimate the present value of future operating costs. The discount rate used in the LCC analysis represents the individual consumer's perspective.

To establish discount rates for residential consumers, DOE identified all relevant household debt or asset classes in order to approximate a consumer's opportunity cost of funds related to appliance operating cost savings. DOE's primary data source was the Federal Reserve Board's *Survey of*

[60] Available at: *http://www.regulations.gov/#!documentDetail;D=EERE-2010-BT-STD-0011-0111.*

[61] W.W. Grainger, Inc. See: *https://www.grainger.com/category/motors/ecatalog/N-bii?analytics=nav.*

Consumer Finances (SCF) for 1995, 1998, 2001, 2004, 2007, and 2010. DOE estimated separate discount rate distributions for six income groups, divided based on income percentile as reported in the SCF. DOE calculated a weighted average discount rate for each household in the SCF using the shares of each type of debt and equity of a household's total combined debt-plus-equity. The household-level discount rates were then aggregated to form discount rate distributions for each of the six income groups, representing the discount rates that may apply in the year in which amended standards would take effect. DOE assigned each sample household a specific discount rate drawn from the appropriate distribution. The average residential discount rate across all types of household debt and equity and income groups, weighted by the shares of each class, is 4.5 percent.

See chapter 8 in the direct final rule TSD for further details on the development of discount rates for the LCC analysis.

f. Product Efficiency in the No-New-Standards Case

To accurately estimate the share of consumers that would be affected by a standard at a particular efficiency level, DOE estimates the distribution of product efficiencies that consumers would purchase in the case without new or amended energy efficiency standards (referred to as the no-new-standards case) in the year compliance with the standard is required. DOE develops such an efficiency distribution for each of the considered product classes.

For the June 2011 DFR, AHRI provided historical shipment-weighted efficiency data by product class through 2009.[62] Absent any recent data, DOE had to make its own estimates of how the efficiency distributions determined for the June 2011 DFR were impacted by the amended standards that became effective in January, 2015 and, in turn, how the distributions would change further from 2015 to 2021, the assumed first full compliance year for any amended central air conditioner and heat pump standards. The estimated efficiency distributions were presented to the CAC/HP Working Group, which recommended that they be revised based on recent data from AHRI. (ASRAC Public Meeting, No. 89 at pp. 163–170)

AHRI submitted data on market share for 2015 by SEER for the three regions for split-systems.[63] DOE then projected the shipment-weighed SEER for 2021 using an efficiency growth rate equal to half of the rate in the 1993–2002 period. The years 1993 to 2002 were a time period when no new central air conditioner and heat pump standards became effective, and, therefore, the efficiency trend represented gains caused solely by non-regulatory market conditions. DOE chose to use half the growth rate observed during the historic period due to potential technological limits on further improving efficiency with single-speed design measures. DOE then allocated market shares to the efficiency levels being analyzed for this rule so that the resultant shipment-weighted SEER matched the value determined from the application of the estimated growth rate from 2015 to 2021.

For package systems, AHRI did not provide recent data on market share by SEER, so DOE retained the approach developed for the August 2015 NODA. First, DOE altered the efficiency distributions it developed for the June 2011 DFR by rolling-up the market shares for products between 13 and 13.99 SEER to 14 SEER, the new standard level effective in 2015. To estimate the efficiency distributions in 2021, DOE applied an efficiency growth rate that was half that observed from 1993 to 2002 to the shipment-weighted SEER estimated in 2015. After determining the shipment-weighed SEER in 2015, DOE then allocated market shares to the efficiency levels being analyzed for this rule so that the resultant shipment-weighted SEER matched the value determined from the application of the estimated growth rate from 2015 to 2021.

3. Inputs to Payback Period Analysis

The payback period is the amount of time it takes the consumer to recover the additional installed cost of more efficient products, compared to baseline products, through energy cost savings. The simple payback period does not account for changes in operating expense over time or the time value of money. Payback periods that exceed the life of the product mean that the increase in total installed cost is not recovered in reduced operating expenses.

The inputs to the PBP calculation are the total installed cost of the equipment to the customer for each efficiency level and the average annual operating expenditures for each efficiency level. The PBP calculation uses the same inputs as the LCC analysis, except that discount rates are not needed. The results of DOE's PBP analysis are presented in section V.B.1.

For the rebuttable presumption PBP, for each considered efficiency level, DOE determined the value of the first year's energy savings by calculating the quantity of those savings in accordance with the applicable DOE test procedure, and multiplying that amount by the average energy price forecast for the year in which compliance with the amended standard would be required.

G. Shipments Analysis

Shipments of covered equipment are a key input to estimates of the national energy savings under a proposed standard. The goal of the shipments model is to provide projections of the total number of units of shipped during the analysis period, and to estimate how those shipments may be affected by the equipment price and operating cost changes induced by a standard.

The shipments model is factored into two segments: Estimation of the total number of shipments of a given product type across all efficiencies available in the market, and distribution of these shipments over efficiency bins. Consumer decisions with respect to repairs and equipment switching only affect the total number of units shipped.

1. Model Structure

The shipments model produces separate projections for each of four equipment classes: Split and packaged central air conditioners (central air conditioners), and split and packaged heat pumps (heat pumps). To capture potential effects of regional standards, a separate shipments projection is calculated for each of the three regions considered in the analysis: North (N), hot-humid (HH) and hot-dry (HD). For each equipment class and each region the total shipments are divided into three market segments: (1) New shipments to new buildings, (2) new shipments to existing buildings, and (3) replacement shipments to existing buildings. Buildings are defined as single-family residences. More detail on the input data to the shipments model is provided in the next section.

[62] These data, along with model data from the Air- Conditioning, Heating, and Refrigeration (ACHR) News, were used to develop base-case efficiency distributions for 2008. DOE projected the central air conditioner and heat pump efficiency distributions to 2011 based on the average growth in shipment-weighted efficiency observed in the AHRI data from 2006 to 2009. DOE then took into account Federal tax credit programs designed to encourage purchase of higher-efficiency products to further adjust the distributions for the year 2016, the assumed compliance date of new standards that was used for the DFR analysis.

[63] AHRI also provided data indicating the market shares of split-system air conditioners in coil-only and blower coil configurations. These fractions (61% and 39%, respectively) were used to establish the shares of projected shipments in the shipments model.

The model is initialized in 1983 using historic shipments from 1953 to 1982 to define the initial distribution of stock by vintage. The model is run from 1983 to 2009, and compared with historical shipments, to calibrate the lifetime distribution parameters. The calibrated model is run from 1983 to 2021 to provide, for each region and product class, an estimate of the distribution of equipment stock by vintage in the start year of the analysis period. DOE's analysis of market saturation data shows slowly increasing heat pump saturations and slowly decreasing central air conditioner saturations, which lead to slight change in the market share of central air conditioners vs. heat pumps in the projections beyond 2021.

New shipments to new buildings are calculated as the product of new housing starts times the new construction market saturation. Shipments to new buildings comprise approximately 20 percent of total central air conditioner shipments and 29 percent of total heat pump shipments in 2021.

New shipments to existing buildings represent new purchases of the equipment by households that did not previously own it. The data show that the market for central air conditioners is essentially saturated, but market penetration is still growing for heat pumps. Shipments to this market segment (*i.e.,* homes that did not previously have a heat pump) comprise approximately 15 percent of total heat pump shipments.

Replacement shipments constitute the largest segment of total shipments. Replacements are determined by using a survival function to calculate the number of units in the stock that fail in each year. The survival function defines the probability that a unit will fail as a function of the unit's age. This analysis uses a Weibull survival function, adjusted to account for the difference in operating hours in the three analysis regions, as described below in section IV.G.2.

Shipments for each product class and market segment are calculated for the no-new-standards case and for each of the considered standard levels. The calculations proceed in three steps.

First, the total shipments across all regions and product classes are calculated for the no-new-standards case, which assumes that the future shipments are driven entirely by new construction, growth in market saturations, and replacements of failed units. This shipments projection is then used to estimate an product price trend using a price-learning approach.

In the second step, within each region and product class, the product distribution model is used to estimate the distribution of shipments across efficiency bins for each TSL. Relative market share is determined using a logit model, which defines the product utility as the sum of total installed cost plus discounted operating costs. The implicit discount rate and product price sensitivity are estimated from historic data as described in the next section. This estimation step uses the average total installed cost, efficiency and annual operating cost calculated for each efficiency level in the LCC. The operating cost depends on the annual operating hours and electricity price, both of which vary by region. The product price trend is applied to the product price, and the electricity price trend (taken from *AEO 2015*) is applied to the operating cost, to obtain time-dependent estimates of the relative market share for each equipment class and for each region.

In the third step, the total shipments are recalculated for each product class, region and TSL to determine the deviation from no-new-standards case shipments. This deviation is caused by the fact that, when the price of new products increases, some consumers will opt to repair rather than replace failed units. These ''excess repairs'' are numerically equal to the drop in shipments. The inputs to the estimation are the market-share weighted product price and annual operating cost for each product class and region, at each TSL. These are used to calculate a market-weighted average utility. The utility is defined as the purchase price plus the discounted operating cost over the lifetime of the product. The consumer discount rate for future operating costs was taken from the decision model used in the residential demand module of NEMS. This utility function is used to estimate the change in shipments, assuming that the percent change in shipments is equal to the percent change in utility times a price elasticity. DOE used a price elasticity equal to −0.34, which is an average value estimated from an analysis of available data for consumer purchases of household appliances (see appendix 9A). The change in shipments is only estimated for replacement shipments, as it is unlikely that shipments to new construction would be affected by the adopted standards. Repaired units are estimated to survive an additional number of years (extended lifetime), which is on average about half of the original lifetime, and then trigger a new replacement shipment.

Commenting on the November 2014 RFI, AHRI stated that there is evidence that the past rulemaking on residential central air conditioners and heat pumps (the 2006 standards) had a negative impact on shipments. It noted that the significant price increase of 13 SEER units (compared to 10 SEER) pushed consumers to find cheaper alternatives including repairing old equipment or switching to room air conditioners. (AHRI, No. 13 at p. 5) Rheem made a similar comment, and stated that currently homeowners are deciding to repair old inefficient air conditioners, and are also replacing central air conditioners with less efficient window air conditioners. (Rheem, No. 17 at pp. 1, 8) During the October 26, 2015 CAC/HP Working Group meeting, several parties expressed concern on how repairs were accounted for in the shipments model (ASRAC Public Meeting, No. 68 at pp. 82–103) One stakeholder mentioned that if DOE made the SEER requirements too high, the market for repairing would grow substantially and DOE needed to account for it. (ASRAC Public Meeting, No. 68 at p. 102)

DOE is aware that some consumers may respond to higher prices for central air conditioners and heat pumps by repairing the unit (compressor replacement) or, in the case of central air conditioners, by purchasing room air conditioners.[64] DOE did not have sufficient data to specifically estimate these practices, however, so it used a price elasticity approach to estimate the consumer responses to higher product prices. DOE assumes that demand in the new construction market is inelastic because the decision to install central air conditioner equipment is made by the builder rather than the consumer.

In response to the August 2015 NODA, the Edison Electric Institute (EEI) commissioned a nationwide builder survey, performed by the NAHB Home Innovation Research Labs, on the fuel and technology impacts of higher residential heat pump energy conservation standards. The survey asked installers to identify the price increase for a heat pump that would lead to switching to a other types of heating systems, including gas and oil furnaces and boilers, and identified the fractions of installations that would switch at different levels of price increase. (EEI, No. 33, NAHB Heat Pump Survey Final Tabulations July 2015) For the price increases associated with heat pumps that comply with the

[64] Purchase of room air conditioners would not be an effective substitute to a new heat pump since they would not provide heating.

adopted standards, the survey suggests that there would be some switching.

In response, DOE notes that since a heat pump provides space cooling and space heating, switching away from a heat pump would require a consumer to purchase and install a central air conditioner as well as another type of heating product. Therefore, a decision to switch would be influenced by the price differential between a heat pump and a combination of a central air conditioner and alternative heating system, not simply the price increase for a heat pump. Because DOE is adopting standards for central air conditioners that have a greater estimated price increase than the increase estimated for heat pumps, DOE reasons that consumers would not switch from heat pumps to a combination of a furnace and a central air conditioner.

2. Inputs and Method

The principal inputs to the shipments model are the projections of housing stock and housing starts, market saturations, price-learning parameters, equipment lifetime (survival function), and logit model parameters.

The American Housing Survey (AHS), conducted every two years, was used to determine the total housing stock and the saturation of central air conditioners and heat pumps, in both new and existing buildings, from 1983 to 2011.[65] The U.S. Census Bureau's Characteristics of New Housing (CNH) report, issued annually, provided the total households built and the amount of central air conditioners or heat pumps installed in newly constructed homes from 1983 to 2013.[66] Both AHS and CNH provide household and equipment saturation data by census region (north, midwest, south, west). DOE used the U.S. Housing Census, which provides the number of households by state, to determine the proportion of homes from each census region that should be allocated to the three regions considered in this analysis (N, HH, HD). Future household projections from *AEO 2015* were available by census division. DOE used average population growth data, by state and census division, from the U.S. Census Bureau to allocate the AEO data into the N, HH, HD regions. The price-learning parameter that DOE applied to future product costs was derived as described in section IV.F.1.

The calibration of the no-new-standards case shipments projection provides an estimate of the Weibull lifetime distribution parameters *s* (shape) and *T* (scale). These represent national average values. Within each region, the scale parameter is adjusted to reflect the differences in average annual operating hours. In general, for mechanical devices the equipment life is defined as the total lifetime operating hours. This can be converted to a service lifetime in years by dividing by the average annual operating hours. Equipment that is operated for fewer hours can therefore be expected to have a longer service lifetime. To account for this effect, DOE estimated the ratio of the average operating hours within each analysis region to the national average value. The estimate was based on a database of simulations of RECS 2009 households[67] that was calibrated to reproduce the same distribution of annual end-use energy consumption as the RECS. Population-weighted average annual operating hours for central air conditioners and heat pumps were calculated for each region, and for the nation as a whole. If equipment failure was perfectly correlated with lifetime operating hours, then the service lifetime would be adjusted proportionally to the operating hours; for example, if the operating hours in the north were half the national average, then the service lifetime in the north would be twice the national average. However, it is likely that some aspects of product failure depend on the actual equipment age. Hence, DOE assumed that half the time the product failure would be related to lifetime operating hours, and half the time it would be related to product age. This approach results in parameter adjustments that lead to average product service lifetime by region shown in Table IV–16.

The product service lifetimes for central air conditioners and heat pumps were presented to the CAC Working Group and were discussed in detail. Members expressed general concern about the long-tailed distribution for central air conditioner and heat pump lifetimes, given that the long lifetimes have a very low probability of occurrence. (ASRAC Public Meeting, No. 68 at pp. 85–103) In response, DOE notes that the Weibull lifetime parameters were estimated to produce a match to historical shipments from 1983 to 2009, which were the most recent data DOE could access. DOE could not find, nor did it receive any other shipments data, and thus DOE used the same Weibull parameters and product service lifetimes presented to the CAC/HP Working Group in the analysis for this DFR.

DOE used the total installed costs and annual operating cost of the products with different efficiency levels, combined with their respective market shares in the no-new-standards case in 2021, to calibrate the logit model parameters (alpha for total installed costs and beta for annual operating cost). These two parameters describe consumers' sensitivities to first costs and operating costs. These costs were then used to project consumer choices among efficiency levels in the analysis period.

DOE presented the results of its latest shipments analysis to the CAC/HP Working Group for discussion. (ASRAC Public Meeting, No. 68 at pp. 77–127) During the meetings, certain members of the CAC Working Group noted that DOE's projected shipments for split-system heat pumps were markedly higher than in the June 2011 DFR. (ASRAC Public Meeting, No. 84 at pp. 103–117) DOE reviewed the two sets of projections and determined that the primary driver for higher forecasted heat pump shipments in the most recent analysis versus the 2011 DFR analysis was the higher saturation of heat pumps in new construction shown in more recent data from the Census' Characteristics of New Housing. The latest data also show a corresponding drop in new construction saturation for central air conditioners. DOE found that, in addition, heat pump shipments were also higher due to the relatively shorter product lifetime in the hot-humid region, where much of the increase in new housing occurs.

For details on DOE's shipments analysis, see chapter 9 of the direct final rule TSD.

H. National Impact Analysis

The national impact analysis (NIA) assesses the national energy savings (NES) and the net present value (NPV) from a national perspective of total consumer costs and savings expected to result from new or amended energy conservation standards at specific efficiency levels. To make the analysis more accessible and transparent to all interested parties, DOE used a spreadsheet model to calculate the energy savings and the national consumer costs and savings from each TSL.[68] The NIA calculations were based

[65] *http://www.census.gov/programs-surveys/ahs.html.*

[66] *https://www.census.gov/construction/chars/.*

[67] Hopkins, A.S., Lekov, A., Lutz, J., Rosenquist, G. and Gu, L. (2011). Simulating a Nationally Representative Housing Sample Using EnergyPlus. LBNL–4420E. Berkeley, CA (US): Ernest Orlando Lawrence Berkeley National Laboratory.

[68] DOE's use of spreadsheet models provides interested parties with access to the models within a familiar context. In addition, the TSD and other documentation that DOE provides during the

on the annual energy consumption and total installed cost data from the energy use analysis and the LCC analysis. In the NIA, DOE forecasted the energy savings, energy cost savings and installed product costs for each product class over the lifetime of products sold from 2021 through 2050 or, for the Recommended TSL, from 2023 through 2052.

1. Efficiency Trends

A key component of the NIA is the trend in energy efficiency forecasted for the no-new-standards case and each of the standards cases. Section IV.F.2.f of this direct final rule describes how DOE developed an energy efficiency distribution for the no-new-standards case for each of the considered product classes for the expected first full year of compliance. To project the efficiency distribution over the 30-year shipments period, DOE used the product distribution model described in section IV.G. This model was calibrated based on product cost information and the efficiency distribution for 2021. The projected efficiency trends vary by product class and region, as illustrated in chapter 10 of the direct final rule TSD.

In the standards cases, the market share of products with efficiencies in the no-new-standards case that do not meet a potential amended standard level is allocated to the particular standard level, and the market shares of products at efficiencies above the standard level under consideration are projected using the consumer choice model. This approach provides a reasonable estimate of the potential energy savings in the standards cases by including consumers' sensitivities to total installed costs and annual operating costs, and accounting for equipment price trend and electricity price trend during the 30-year analysis period.

Details on how the consumer choice model was developed are in chapter 10 of the direct final rule TSD.

2. Product Cost Trend

As discussed in section IV.F.1, DOE used an experience curve method to project future product price trends. Application of the price index results in a decline of 22 percent in central air conditioner and heat pump prices (in real terms) from 2021 to 2050. In addition to the default trend described in section IV.F.1, which shows a modest rate of decline, DOE performed price trend sensitivity calculations in the NIA to examine the dependence of the analysis results on different analytical assumptions. The price trend sensitivity analysis considered a trend with a greater rate of decline than the default trend and a trend with constant prices. The derivation of these trends is described in appendix 10C of the direct final rule TSD.

3. Accounting for Repaired Units

As discussed in section IV.G.1, DOE introduced ''excess repairs'' in the standards cases, assuming that when the price of new equipment increases, some consumers will opt to repair rather than replace broken units. The repair is assumed to consist of replacement of the compressor. The repaired units are assumed to live an additional number of years (extended lifetime), which is on average about half of the original lifetime. For these ''excess repair'' units, the cost of the repair is a one-time replacement cost for the compressor that varies depending on the capacity of the unit. The annual energy use of the repaired units is calculated as the average energy use for all of the units that were installed in the same year as the repaired unit. More details on accounting for repaired units are described in chapter 10 of the direct final rule TSD.

4. National Energy Savings

To develop the NES, DOE calculated annual energy consumption for the no-new-standards case and the standards cases. DOE calculated the annual energy consumption for each case using the appropriate per-unit annual energy use data multiplied by the projected central air conditioner and heat pump shipments for each year. The per-unit annual energy use is adjusted with the building shell improvement index, which results in a decline of 12 percent in the cooling load from 2021 to 2050, and the climate index, which results in an increase of 6.6 percent in the cooling load. In the standards cases, there are fewer shipments of central air conditioners or heat pumps compared to the no-new-standards case because of repair rather than replacement.

As explained in section IV.E, DOE incorporated a rebound effect for central air conditioners and heat pumps by reducing the site energy savings in each year by 15 percent.

To estimate the national primary energy savings from amended central air conditioner and heat pump standards, DOE used a multiplicative factor to convert site electricity consumption (at the home) into primary energy consumption (the energy required to convert and deliver the site electricity). These conversion factors account for the energy used at power plants to generate electricity and energy losses during transmission and distribution. The factors vary over time due to changes in generation sources (*i.e.,* the power plant types projected to provide electricity to the country) projected in *AEO 2015.*[69] The factors that DOE developed are marginal values, which represent the response of the electricity sector to an incremental decrease in consumption associated with potential appliance standards.

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 Science, in 2011 DOE announced its intention to use full-fuel-cycle (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 the **Federal Register** in which DOE explained that NEMS is the most appropriate tool for its FFC analysis and DOE intended to use NEMS for that purpose. 77 FR 49701 (August 17, 2012). The FFC factors incorporates 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 is described in more detail in appendix 10A of the direct final rule TSD.

5. Net Present Value of Consumer Benefit

To develop the national NPV of consumer benefits from potential energy conservation standards, DOE calculated projected annual operating costs (energy costs and repair and maintenance costs) and annual installation costs for the no-new-standards case and the standards cases. DOE calculated annual product expenditures by multiplying the price per unit times the projected shipments in each year.

DOE calculated annual energy expenditures from annual energy consumption using forecasted energy prices in each year. In this direct final rule, DOE used the projected annual changes in national-average residential

rulemaking help explain the models and how to use them, and interested parties can review DOE's analyses by changing various input quantities within the spreadsheet.

[69] U.S. Department of Energy, Energy Information Administration, *op. cit.*

electricity prices in the Reference case projection in *AEO 2015*.[70]

The aggregate difference each year between operating cost savings and increased installation costs is the net savings or net costs. DOE multiplies the net savings in future years by a discount factor to determine their present value. DOE estimates the NPV of consumer benefits using both a 3-percent and a 7-percent real discount rate, in accordance with guidance provided by the Office of Management and Budget (OMB) to Federal agencies on the development of regulatory analysis.[71] 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 ''societal rate of time preference,'' which is the rate at which society discounts future consumption flows to their present value. The discount rates for the determination of NPV differ from the discount rates used in the LCC analysis, which are designed to reflect a consumer's perspective.

As noted, in determining national energy savings, DOE is accounting for the rebound effect estimated for more-efficient central air conditioners and heat pumps.[72] Because consumers have foregone a monetary savings in energy expenses, it is reasonable to conclude that the value of the increased utility is equivalent to the monetary value of the energy savings that would have occurred without the rebound effect. Therefore, the economic impacts on consumers with or without the rebound effect, as measured in the NPV, are the same.

I. Consumer Subgroup Analysis

In analyzing the potential impacts of new or amended standards on consumers, DOE evaluated the impacts on two identifiable subgroups of consumers, low-income consumers and senior citizens, that may be disproportionately affected by amended standards. DOE analyzed the LCC impacts and PBP for those particular consumers from alternative standard levels using subsets of the RECS 2009 sample comprised of households that meet the criteria for the two subgroups for both central air conditioners and heat pumps, along with the appropriate inputs for these groups.

Chapter 11 of the direct final rule TSD describes the consumer subgroup analysis and its results.

J. Manufacturer Impact Analysis

1. Overview

DOE performed a Manufacturer Impact Analysis (MIA) to estimate the impacts of an energy conservation standard on manufacturers. The MIA has both quantitative and qualitative aspects. The quantitative part of the MIA primarily relies on the Government Regulatory Impact Model (GRIM), an industry cash-flow model with inputs specific to this rulemaking. The key GRIM inputs are data on the industry cost structure, manufacturer productions costs, shipments, and assumptions about markups and conversion expenditures. The key output is the industry net present value (INPV). DOE uses the GRIM to calculate cash flows using standard accounting principles and to compare changes in INPV between a scenario in which there is no new standard (the no-new-standards case) and each TSL (the standards case). The difference in INPV between the no-new-standards case and a standards case represents the financial impact of energy conservation standards on central air conditioner and heat pump manufacturers. DOE uses different sets of assumptions (markup scenarios) to represent the uncertainty surrounding potential impacts on prices and manufacturer profitability as a result of standards. Different sets of assumptions produce a range of INPV results. The qualitative part of the MIA addresses the amended standard's potential impacts on manufacturing capacity and industry competition, as well as factors such as product characteristics, impacts on particular subgroups of firms, and important market and product trends.

The MIA for central air conditioners and heat pumps in this direct final rule focuses on split-system air conditioners, split-system heat pumps, single-package air conditioners, and single-package heat pumps. Since this rule does not propose to amend standards for space-constrained air conditioners, space-constrained heat pumps, or small-duct high-velocity systems, these products were not evaluated. 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 residential central air conditioner and heat pump industry. This industry characterization was developed using publicly available information, such as Securities and Exchange Commission (SEC) 10–K reports,[73] market research tools (*e.g.,* Hoovers[74]), corporate annual reports, the U.S. Census Bureau's 2014 Annual Survey of Manufacturers (ASM),[75] and industry trade association membership directories (*e.g.,* AHRI), as well as information obtained through DOE's engineering analysis, life-cycle cost analysis, and market and technology assessment prepared for this rulemaking.

In Phase 2 of the MIA, DOE prepared an industry cash-flow analysis to quantify the potential impacts of amended energy conservation standards on manufacturers. In general, energy conservation standards can affect manufacturer cash flow in three distinct ways: (1) Create a need for increased investment; (2) raise production costs per unit; and (3) alter revenue due to higher per-unit prices and/or possible changes in sales volumes. To quantify these impacts, DOE used the GRIM to perform a cash-flow analysis for the industry using financial values derived during Phase 1 and the shipment scenario used in the NIA.

DOE also conducted interviews with manufacturers. During these interviews, DOE discussed engineering, manufacturing, procurement, and financial topics to validate assumptions used in the GRIM and to identify key issues or concerns. These topics were discussed again during the course of CAC/HP Working Group meetings, which enabled DOE to further refine inputs to the MIA, including MPCs and shipments forecasts.

In Phase 3, DOE evaluated subgroups of manufacturers that may be disproportionately impacted by energy conservation standards or that may not be represented accurately by the average cost assumptions used to develop the industry cash-flow analysis. For example, small manufacturers, niche players, or manufacturers exhibiting a cost structure that largely differs from the industry average could be more negatively affected. DOE identified one subgroup for a separate impact analysis: Small business manufacturers. The small business subgroup is discussed in section VI.B, ''Review under the Regulatory Flexibility Act,'' and in chapter 12 of the direct final rule TSD.

[70] U.S. Department of Energy, Energy Information Administration, *op.cit.*

[71] Office of Management and Budget, OMB Circular A–4, section E, Identifying and Measuring Benefits and Costs (2003), *available at http://www.whitehouse.gov/omb/memoranda/m03-21.html.*

[72] As discussed in section IV.F, the rebound effect provides consumers with increased utility (*e.g.,* a more comfortable indoor environment).

[73] U.S. Securities and Exchange Commission, Annual 10–K Reports (Various Years) (Available at: *www.sec.gov*).

[74] Hoovers Inc., Company Profiles, Various Companies (Available at: *www.hoovers.com/*).

[75] U.S. Census Bureau, Annual Survey of Manufacturers: General Statistics: Statistics for Industry Groups and Industries (2014) (Available at: *http://www.census.gov/manufacturing/asm/index.html*).

2. Government Regulatory Impact Model

DOE uses the GRIM in its standards rulemakings to quantify the changes in cash flow due to amended standards that result in a higher or lower industry value. The GRIM uses a standard, annual discounted cash-flow analysis that incorporates manufacturer costs, 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 2016 (the base year of the analysis) and continuing to 2050.[76] DOE calculated INPVs by summing the stream of annual discounted cash flows during this period. For manufacturers of residential central air conditioners and heat pumps, DOE used a real discount rate of 11.0 percent,[77] which was derived from industry financials and then modified according to feedback received during manufacturer interviews.

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

a. Government Regulatory Impact Model Key Inputs

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 manufacturer production costs (MPCs) of covered products can affect the revenues, gross margins, and cash flow of the industry.

In the MIA, DOE used the MPCs for each considered efficiency level calculated in the engineering analysis, as described in section IV.C and further detailed in chapter 5 of the direct final rule TSD. The engineering analysis developed multiple MPCs for split-system air conditioners based on representative capacities (*i.e.,* 2-ton, 3-ton, and 5-ton) and configurations (*i.e.,* blower-coil versus coil only). Similarly, MPCs for split-system heat pumps were broken out by representative capacities. In addition, DOE used information from the engineering teardown analysis to disaggregate MPCs into material, labor, overhead, and depreciation costs. Both MPCs and cost breakdowns were validated and revised with manufacturers during manufacturer interviews. The MPCs used in the GRIM are presented in chapter 12 of the direct final rule TSD along with the methodology used to develop weighted average MPCs for split-system air conditioners using blower-coil and coil only shipment weights.

Shipments Forecasts

The GRIM estimates manufacturer revenues based on total unit shipment forecasts and the distribution of those shipments by efficiency level. Changes in sales volumes and efficiency mix over time can significantly affect manufacturer finances. For this analysis, the GRIM uses the NIA's annual shipment forecasts derived from the shipments analysis from 2016 (the base year) to 2050 (the end year of the analysis period). See chapter 9 of the direct final rule TSD for additional details.

Product and Capital Conversion Costs

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

To evaluate the level of capital conversion expenditures manufacturers would likely incur to comply with amended energy conservation standards, DOE used manufacturer interviews to request feedback on the anticipated level of capital investment that would be required at each efficiency level. However, DOE received very limited feedback on likely capital investments from manufacturers. As a result, DOE developed conversion cost estimates based on estimates of capital expenditure requirements derived from the product teardown analysis and engineering analysis described in chapter 5 of the DFR TSD.

To evaluate the level of product conversion costs manufacturers would likely incur to comply with amended energy conservation standards, DOE integrated data from quantitative and qualitative sources. As with capital conversion costs, DOE requested feedback from manufacturers regarding potential product conversion costs. Based on feedback received, DOE applied a scaling factor to estimate product conversion costs based on the magnitude of capital conversion costs. DOE estimated that product conversion costs account for 40 percent of total conversion costs.

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

b. Government Regulatory Impact Model Scenarios

Markup Scenarios

MSPs include direct manufacturing production costs (*i.e.,* labor, materials, and overhead estimated in DOE's MPCs)

[76] In contrast to the NIA, which uses an end date of 2050 for TSLs 1, 3, and 4, and an end date of 2052 for TSL 2, the MIA maintains the same end date (2050) for all TSLs. This is done to enable clear comparison of INPV impacts across TSLs. See chapter 12 of the direct final rule TSD for a more detailed discussion of this assumption.

[77] DOE estimated preliminary financial metrics, including the industry discount rate, based on publicly available financial information, including Securities and Exchange Commission (''SEC'') filings and S&P bond ratings. DOE presented the preliminary financial metrics to manufacturers in MIA interviews. DOE adjusted those values based on feedback from manufacturers. The complete set of financial metrics and more detail about the methodology can be found in chapter 12 of the final rule TSD. Additionally, DOE provides a sensitivity analysis based on an alternative discount rate in chapter 12 of the TSD.

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

Under the preservation of gross margin percentage scenario, DOE applied a single uniform ''gross margin percentage'' markup across all efficiency levels, which assumes that manufacturers would be able to maintain the same amount of profit as a percentage of revenues at all efficiency levels within a product class. As production costs increase with efficiency, this scenario implies that the absolute dollar markup will increase as well. Based on publicly available financial information for manufacturers of residential central air conditioners and heat pumps as well as comments from manufacturer interviews, DOE assumed the average non-production cost baseline markup—which includes SG&A expenses, R&D expenses, interest, and profit—to be 1.34 for split-system air conditioners, 1.35 for split-system heat pumps, and 1.32 for single-package air conditioners and single-package heat pumps. Because the preservation of gross margin percentage markup scenario assumes manufacturers would be able to maintain their gross margin percentage markups as production costs increase in response to amended energy conservation standards, it represents a high bound to industry profitability.

Under the tiered markup scenario, DOE modeled a situation in which manufacturers set markups based on three tiers of products. These tiers can be described as ''good, better, best'' or ''value, standard, premium.'' Under this tiered structure, high-volume ''value'' product lines typically offer fewer features, lower efficiency, and lower markups, while ''premium'' product lines offer more features, higher efficiency, and higher markups. The tiered markup scenario evaluates impacts on manufacturers when the breadth of their product portfolios shrinks as higher energy conservation standards ''demote'' higher-tier products to lower tiers. In this scenario, higher-efficiency products that previously commanded ''standard'' and ''premium'' markups are reassigned ''value'' and ''standard'' markups respectively. This markup scenario represents the low bound to industry profitability under an amended energy conservation standard.

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

3. Discussion of Comments

Cumulative Regulatory Burden

During the RFI stage, Lennox commented that manufacturers of central air conditioners and heat pumps face a significant cumulative regulatory burden and urged DOE both to consider the impact on manufacturers of multiple regulations and to take action to minimize the associate economic burden. (Lennox, No.10 at p. 4) In response, DOE has performed an analysis of cumulative regulatory burden (CRB) in section V.B.2.e of this notice. The CRB analysis is intended to identify rulemakings that could be aligned or combined to minimize total burden. As such, the CRB section focuses on regulations that take effect within three years of the effective date of this rulemaking. Rulemakings addressed in the CRB include those for: Commercial Packaged Air Conditioners and Heat Pumps (Air-Cooled) (81 FR 2420), Residential Boilers (81 FR 2320), Commercial and Industrial Pumps (80 FR 17826), Portable Room Air Conditioners (81 FR 38398), Residential Furnace Fans (80 FR 13120), and Commercial Warm Air Furnaces (81 FR 2420).

Additionally, Lennox commented that given the complexities associated with regional standards and regulating central air conditioners and heat pumps, DOE should utilize a negotiated rulemaking approach. Lennox requested that DOE consider the pace and timing of rulemakings to ensure stakeholders can provide meaningful comments and analysis. (Lennox, No.10 at p. 3) As discussed throughout this document, DOE established a CAC/HP Working Group to negotiate amended standards for central air conditioners and heat pumps. The recommendations made by the CAC/HP Working Group are presented in this direct final rule.

K. Emissions Analysis

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

The analysis of power sector emissions uses marginal emissions factors calculated using a methodology based on results published for the *AEO 2015* reference case and a set of side cases that implement a variety of efficiency-related policies. The methodology is described in chapter 15 of the direct final rule TSD.

Combustion emissions of CH_4 and N_2O are estimated using emissions intensity factors published by the EPA, GHG Emissions Factors Hub.[78] The FFC upstream emissions are estimated based on the methodology described in chapter 15. The upstream emissions include both emissions from fuel combustion during extraction, processing and transportation of fuel, and ''fugitive'' emissions (direct leakage to the atmosphere) of CH_4 and CO_2.

The emissions intensity factors are expressed in terms of physical units per MWh or MMBtu of site energy savings. Total emissions reductions are estimated using the energy savings calculated in the national impact analysis.

For CH_4 and N_2O, DOE calculated emissions reduction in tons and also in terms of units of carbon dioxide equivalent (CO_2eq). Gases are converted to CO_2eq by multiplying each ton of the greenhouse gas by the gas's global warming potential (GWP) over a 100-year time horizon. Based on the Fifth Assessment Report of the Intergovernmental Panel on Climate Change,[79] DOE used GWP values of 28 for CH_4 and 265 for N_2O.

The *AEO* incorporates the projected impacts of existing air quality regulations on emissions. *AEO 2015* generally represents current legislation and environmental regulations,

[78] Available at *http://www2.epa.gov/climateleadership/center-corporate-climate-leadership-ghg-emission-factors-hub.*

[79] IPCC, Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (Cambridge University Press, 2013).

including recent government actions, for which implementing regulations were available as of October 31, 2014. DOE's estimation of impacts accounts for the presence of the emissions control programs discussed in the following paragraphs.

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 28 eastern States and DC were also limited under the Clean Air Interstate Rule (CAIR; 70 FR 25162 (May 12, 2005)), which created an allowance-based trading program that operates along with the Title IV program. CAIR was remanded to the U.S. Environmental Protection Agency (EPA) by the U.S. Court of Appeals for the District of Columbia Circuit, but it remained in effect.[80] In 2011, EPA issued a replacement for CAIR, the Cross-State Air Pollution Rule (CSAPR). 76 FR 48208 (August 8, 2011). On August 21, 2012, the D.C. Circuit issued a decision to vacate CSAPR.[81] The court ordered EPA to continue administering CAIR. On April 29, 2014, the U.S. Supreme Court reversed the judgment of the D.C. Circuit and remanded the case for further proceedings consistent with the Supreme Court's opinion.[82] On October 23, 2014, the D.C. Circuit lifted the stay of CSAPR.[83] Pursuant to this action, CSAPR went into effect (and CAIR ceased to be in effect) as of January 1, 2015.[84]

EIA was not able to incorporate CSAPR into *AEO 2015,* so it assumes implementation of CAIR. Although DOE's analysis used emissions factors that assume that CAIR, not CSAPR, is the regulation in force, the difference between CAIR and CSAPR is not significant for the purpose of DOE's analysis of emissions impacts from energy conservation standards.

The attainment of emissions caps is typically flexible among EGUs and is enforced through the use of emissions allowances and tradable permits. Under existing EPA regulations, any excess SO_2 emissions allowances resulting from the lower electricity demand caused by the adoption of an efficiency standard could be used to permit offsetting increases in SO_2 emissions by any regulated EGU. In past rulemakings, DOE recognized that there was uncertainty about the effects of efficiency standards on SO_2 emissions covered by the existing cap-and-trade system, but it concluded that negligible reductions in power sector SO_2 emissions would occur as a result of standards.

Beginning in 2016, however, SO_2 emissions will decline as a result of the Mercury and Air Toxics Standards (MATS) for power plants. 77 FR 9304 (February 16, 2012). In the final MATS rule, EPA established a standard for hydrogen chloride as a surrogate for acid gas hazardous air pollutants (HAP), and also established a standard for SO_2 (a non-HAP acid gas) as an alternative equivalent surrogate standard for acid gas HAP. The same controls are used to reduce HAP and non-HAP acid gas; thus, SO_2 emissions will be reduced as a result of the control technologies installed on coal-fired power plants to comply with the MATS requirements for acid gas. *AEO 2015* assumes that, in order to continue operating, coal plants must have either flue gas desulfurization or dry sorbent injection systems installed by 2016. Both technologies, which are used to reduce acid gas emissions, also reduce SO_2 emissions. Under the MATS, emissions will be far below the cap established by CAIR, so 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 any regulated EGU.[85] Therefore, DOE believes that energy conservation standards will generally reduce SO_2 emissions in 2016 and beyond.

CAIR established a cap on NO_X emissions in 28 eastern States and the District of Columbia.[86] Energy conservation standards are expected to have little effect on NO_X emissions in those States covered by CAIR because excess NO_X emissions allowances resulting from the lower electricity demand could be used to permit offsetting increases in NO_X emissions from other facilities. However, standards would be expected to reduce NO_X emissions in the States not affected by the caps, so DOE estimated NO_X emissions increases for these States.

The MATS limit mercury emissions from power plants, but they do not include emissions caps and, as such, the increase in electricity demand associated with the residential furnace efficiency levels would be expected to increase mercury emissions. DOE estimated mercury emissions using emissions factors based on *AEO 2015,* which incorporates the MATS.

L. Monetizing Carbon Dioxide and Other Emissions Impacts

As part of the development of this proposed rule, DOE considered the estimated monetary benefits from the reduced emissions of CO_2 and NO_X that are expected to result from each of the TSLs considered. In order to make this calculation similar 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 forecast period for each TSL. This section summarizes the basis for the monetary values used for each of these emissions and presents the values considered in this direct final rule.

1. Social Cost of Carbon

The social cost of carbon (SCC) is an estimate of the monetized damages associated with an incremental increase

[80] See *North Carolina* v. *EPA,* 531 F.3d 896 (D.C. Cir. 2008), modified on rehearing, 550 F.3d 1176 (D.C. Cir. 2008).

[81] See *EME Homer City Generation, L.P.* v. *EPA,* 696 F.3d 7 (D.C. Cir. 2012).

[82] *See EPA* v. *EME Homer City Generation,* L.P., 134 S.Ct. 1584 (U.S. 2014). The Supreme Court held in part that EPA's methodology for quantifying emissions that must be eliminated in certain States due to their impacts in other downwind States was based on a permissible, workable, and equitable interpretation of the Clean Air Act provision that provides statutory authority for CSAPR.

[83] *See EME Homer City Generation, L.P.* v. *EPA,* Order *(D.C. Cir. filed October 23, 2014)* (*No. 11–1302).*

[84] On July 28, 2015, the D.C. Circuit issued its opinion regarding the remaining issues raised with respect to CSAPR that were remand by the Supreme Court. The D.C. Circuit largely upheld CSAPR, but remanded to EPA without *vacatur* certain States' emission budgets for reconsideration. *EME Homer City Generation, LP* v. *EPA,* 795 F.3d 118 (D.C. Cir. 2015).

[85] DOE notes that on June 29, 2015, the U.S. Supreme Court ruled that the EPA erred when the agency concluded that cost did not need to be considered in the finding that regulation of hazardous air pollutants from coal- and oil-fired electric utility steam generating units (EGUs) is appropriate and necessary under section 112 of the Clean Air Act (CAA). *Michigan* v. *EPA,* 135 S. Ct. 2699 (2015). The Supreme Court did not vacate the MATS rule, and DOE has tentatively determined that the Court's decision on the MATS rule does not change the assumptions regarding the impact of energy conservation standards on SO_2 emissions. Further, the Court's decision does not change the impact of the energy conservation standards on mercury emissions. The EPA, in response to the U.S. Supreme Court's direction, has now considered cost in evaluating whether it is appropriate and necessary to regulate coal- and oil-fired EGUs under the CAA. EPA concluded in its final supplemental finding that a consideration of cost does not alter the EPA's previous determination that regulation of hazardous air pollutants, including mercury, from coal- and oil-fired EGUs is appropriate and necessary. 79 FR 24420 (April 25, 2016). The MATS rule remains in effect, but litigation is pending in the D.C. Circuit Court of Appeals over EPA's final supplemental finding MATS rule.

[86] CSAPR also applies to NO_X, and it would supersede the regulation of NO_X under CAIR. As stated previously, the current analysis assumes that CAIR, not CSAPR, is the regulation in force. The difference between CAIR and CSAPR with regard to DOE's analysis of NO_X is slight.

in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services. Estimates of the SCC are provided in dollars per metric ton of carbon dioxide. A domestic SCC value is meant to reflect the value of damages in the United States resulting from a unit change in carbon dioxide emissions, while a global SCC value is meant to reflect the value of damages worldwide.

Under section 1(b)(6) of Executive Order 12866, ''Regulatory Planning and Review,'' 58 FR 51735 (October 4, 1993), agencies must, to the extent permitted by law, ''assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs.'' The purpose of the SCC estimates presented here is to allow agencies to incorporate the monetized social benefits of reducing CO2 emissions into cost-benefit analyses of regulatory actions. The estimates are presented with an acknowledgement of DOE acknowledges that there are many uncertainties involved in the estimates and with a clear understanding that they should be updated over time to reflect increasing knowledge of the science and economics of climate impacts.

As part of the interagency process that developed the SCC estimates, technical experts from numerous agencies met on a regular basis to consider public comments, explore the technical literature in relevant fields, and discuss key model inputs and assumptions. The main objective of this process was to develop a range of SCC values using a defensible set of input assumptions grounded in the existing scientific and economic literatures. In this way, key uncertainties and model differences transparently and consistently inform the range of SCC estimates used in the rulemaking process.

a. Monetizing Carbon Dioxide Emissions

When attempting to assess the incremental economic impacts of carbon dioxide emissions, the analyst faces a number of challenges. A recent report from the National Research Council [87] points out that any assessment will suffer from uncertainty, speculation, and lack of information about: (1) Future emissions of greenhouse gases; (2) the effects of past and future emissions on the climate system; (3) the impact of changes in climate on the physical and biological environment; and (4) the translation of these environmental impacts into economic damages. As a result, any effort to quantify and monetize the harms associated with climate change will raise questions of science, economics, and ethics, and should be viewed as provisional.

Despite the limits of both quantification and monetization, SCC estimates can be useful in estimating the social benefits of reducing carbon dioxide emissions. The agency can estimate the benefits from reduced (or costs from increased) emissions in any future year by multiplying the change in emissions in that year by the SCC value appropriate for that year. The net present value of the benefits can then be calculated by multiplying each of these future benefits by an appropriate discount factor and summing across all affected years.

It is important to emphasize that the interagency process is committed to updating these estimates as the science and economic understanding of climate change and its impacts on society improves over time. In the meantime, the interagency group will continue to explore the issues raised by this analysis and consider public comments as part of the ongoing interagency process.

b. Development of Social Cost of Carbon Values

In 2009, an interagency process was initiated to offer a preliminary assessment of how best to quantify the benefits of reducing carbon dioxide emissions. To ensure consistency in how benefits were evaluated across agencies, the Administration sought to develop a transparent and defensible method, specifically designed for the rulemaking process, to quantify avoided climate change damages from reduced CO_2 emissions. The interagency group did not undertake any original analysis. Instead, it combined SCC estimates from the existing literature to use as interim values until a more comprehensive analysis could be conducted. The outcome of the preliminary assessment by the interagency group was a set of five interim global SCC estimates for 2007 (in 2006 dollars) of $55, $33, $19, $10, and $5 per metric ton of CO_2. These interim values represented the first sustained interagency effort within the U.S. government to develop an SCC for use in regulatory analysis. The results of this preliminary effort were presented in several proposed and final rules.

c. Current Approach and Key Assumptions

After the release of the interim values, the interagency group reconvened on a regular basis to calculate improved SCC estimates. Specifically, the group considered public comments and further explored the technical literature in relevant fields. The interagency group relied on three integrated assessment models commonly used to estimate the SCC: The FUND, DICE, and PAGE models. These models are frequently cited in the peer-reviewed literature and were used in the last assessment of the Intergovernmental Panel on Climate Change (IPCC). Each model was given equal weight in the SCC values that were developed.

Each model takes a slightly different approach to model how changes in emissions result in changes in economic damages. A key objective of the interagency process was to enable a consistent exploration of the three models, while respecting the different approaches to quantifying damages taken by the key modelers in the field. An extensive review of the literature was conducted to select three sets of input parameters for these models: Climate sensitivity, socio-economic and emissions trajectories, and discount rates. A probability distribution for climate sensitivity was specified as an input into all three models. In addition, the interagency group used a range of scenarios for the socio-economic parameters and a range of values for the discount rate. All other model features were left unchanged, relying on the model developers' best estimates and judgments.

In 2010, the interagency group selected four sets of SCC values for use in regulatory analyses. Three sets of values are based on the average SCC from three integrated assessment models, at discount rates of 2.5 percent, 3 percent, and 5 percent. The fourth set, which represents the 95th-percentile SCC estimate across all three models at a 3-percent discount rate, is included to represent higher-than-expected impacts from climate change further out in the tails of the SCC distribution. The values grow in real terms over time. Additionally, the interagency group determined that a range of values from 7 percent to 23 percent should be used to adjust the global SCC to calculate domestic effects, although preference is given to consideration of the global benefits of reducing CO_2 emissions.[88]

[87] National Research Council. *Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use* (2009).

[88] It is recognized that this calculation for domestic values is approximate, provisional, and highly speculative. There is no *a priori* reason why

Table IV–17 presents the values in the 2010 interagency group report,[89] which is reproduced in appendix 14–A of the NOPR TSD.

TABLE IV–17—ANNUAL SCC VALUES FROM 2010 INTERAGENCY REPORT, 2010–2050

[In 2007 dollars per metric ton CO_2]

Year	Discount rate			
	5%	3%	2.5%	3%
	Average	Average	Average	95th Percentile
2010	4.7	21.4	35.1	64.9
2015	5.7	23.8	38.4	72.8
2020	6.8	26.3	41.7	80.7
2025	8.2	29.6	45.9	90.4
2030	9.7	32.8	50.0	100.0
2035	11.2	36.0	54.2	109.7
2040	12.7	39.2	58.4	119.3
2045	14.2	42.1	61.7	127.8
2050	15.7	44.9	65.0	136.2

The SCC values used for this document were calculated using the most recent versions of the three integrated assessment models that have been published in the peer-reviewed literature, as described in the 2013 update from the interagency working group (revised July 2015).[90]

Table IV–18 shows the updated sets of SCC estimates from the latest interagency update in five-year increments from 2010 to 2050. Appendix 14–B of the direct final rule TSD provides the full set of values. The central value that emerges is the average SCC across models at a 3-percent discount rate. However, for purposes of capturing the uncertainties involved in regulatory impact analysis, the interagency group emphasizes the importance of including all four sets of SCC values.

TABLE IV–18—ANNUAL SCC VALUES FROM 2013 INTERAGENCY UPDATE (REVISED JULY 2015), 2010–2050

[In 2007 dollars per metric ton CO_2]

Year	Discount rate			
	5%	3%	2.5%	3%
	Average	Average	Average	95th Percentile
2010	10	31	50	86
2015	11	36	56	105
2020	12	42	62	123
2025	14	46	68	138
2030	16	50	73	152
2035	18	55	78	168
2040	21	60	84	183
2045	23	64	89	197
2050	26	69	95	212

It is important to recognize that a number of key uncertainties remain, and that current SCC estimates should be treated as provisional and revisable since they will evolve with improved scientific and economic understanding. The interagency group also recognizes that the existing models are imperfect and incomplete. The National Research Council report describes tension between the goal of producing quantified estimates of the economic damages from an incremental ton of carbon and the limits of existing efforts to model these effects. There are a number of analytical challenges that are being addressed by the research community, including research programs housed in many of the Federal agencies participating in the interagency process to estimate the SCC. The interagency group intends to periodically review and reconsider those estimates to reflect increasing knowledge of the science and economics of climate impacts, as well as improvements in modeling.[91]

In summary, in considering the potential global benefits resulting from reduced CO_2 emissions, DOE used the

domestic benefits should be a constant fraction of net global damages over time.

[89] Interagency Working Group on Social Cost of Carbon, *Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866* (2010), *available at http://www.whitehouse.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf.*

[90] United States Government-Interagency Working Group on Social Cost of Carbon. *Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866.* May 2013. Revised July 2015. *https://www.whitehouse.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf.*

[91] In November 2013, OMB announced a new opportunity for public comment on the interagency technical support document underlying the revised SCC estimates. 78 FR 70586 (Nov. 26, 2013). In July 2015 OMB published a detailed summary and formal response to the many comments that were received. *https://www.whitehouse.gov/blog/2015/07/02/estimating-benefits-carbon-dioxide-emissions-reductions.* It also stated its intention to seek independent expert advice on opportunities to improve the estimates, including many of the approaches suggested by commenters.

values from the 2013 interagency report, adjusted to 2015$ using the Gross Domestic Product price deflator. For each of the four SCC cases specified, the values used for emissions in 2015 were $12.4, $40.6, $63.2, and $118 per metric ton avoided (values expressed in 2015$). DOE derived values after 2050 based on the trend in 2010–2050 in each of the four cases.

DOE multiplied the CO_2 emissions reduction estimated for each year by the SCC value for that year in each of the four cases. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the four cases using the specific discount rate that had been used to obtain the SCC values in each case.

2. Social Cost of Other Air Pollutants

As noted previously, DOE has estimated how the considered energy conservation standards would reduce power sector NO_X emissions in those 22 States not affected by the CAIR.

DOE estimated the monetized value of NO_X emissions reductions using benefit per ton estimates from the *Regulatory Impact Analysis for the Clean Power Plan Final Rule,* published in August 2015 by EPA's Office of Air Quality Planning and Standards.[92] The report includes high and low values for NO_X (as $PM_{2.5}$) for 2020, 2025, and 2030 discounted at 3 percent and 7 percent; these values are presented in appendix 14C of the direct final rule TSD. DOE primarily relied on the low estimates to be conservative.[93] The national average low values for 2020 (in 2015$) are $3,187/ton at 3-percent discount rate and $2,869/ton at 7-percent discount rate. DOE assigned values after 2030 using the value for 2030. DOE developed values specific to the end-use category for residential air conditioners and heat pumps using a method described in appendix 14C. For this analysis DOE used linear interpolation to define values for the years between 2020 and 2025 and between 2025 and 2030; for years beyond 2030 the value is held constant.

DOE multiplied the emissions reduction (in tons) in each year by the associated $/ton values, and then discounted each series using discount rates of 3 percent and 7 percent as appropriate. DOE will continue to evaluate the monetization of avoided NO_X emissions and will make any appropriate updates in energy conservation standards rulemakings.

DOE is evaluating appropriate monetization of avoided SO_2 and Hg emissions in energy conservation standards rulemakings. DOE has not included monetization of those emissions in the current analysis.

M. Utility Impact Analysis

The utility impact analysis estimates several effects on the electric power generation industry that would result from the adoption of new or amended energy conservation standards. The utility impact analysis estimates the changes in installed electrical capacity and generation that would result for each TSL. The analysis is based on published output from the NEMS associated with *AEO 2015.* 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. DOE uses published side cases to estimate the marginal impacts of reduced energy demand on the utility sector. These marginal factors are estimated based on the changes to electricity sector generation, installed capacity, fuel consumption and emissions in the *AEO* Reference case and various side cases. Details of the methodology are provided in the appendices to chapters 13 and 15 of the DFR 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 new or amended energy conservation standards.

N. Employment Impact Analysis

Employment impacts from new or amended energy conservation standards include direct and indirect impacts. Direct employment impacts are any changes in the number of employees of manufacturers of the products subject to standards; the MIA addresses those impacts. Indirect employment impacts are changes in national employment that occur due to the shift in expenditures and capital investment caused by the purchase and operation of more-efficient appliances. Indirect employment impacts from standards consist of the jobs created or eliminated in the national economy, other than in the manufacturing sector being regulated, due to: (1) Reduced spending by end users on energy; (2) reduced spending on new energy supply by the utility industry; (3) increased consumer spending on the purchase of new products; and (4) the effects of those three factors throughout the economy.

One method for assessing the possible effects on the demand for labor of such shifts in economic activity is to compare sector employment statistics developed by the Labor Department's Bureau of Labor Statistics (BLS). BLS regularly publishes its estimates of the number of jobs per million dollars of economic activity in different sectors of the economy, as well as the jobs created elsewhere in the economy by this same economic activity. Data from BLS indicate that expenditures in the utility sector generally create fewer jobs (both directly and indirectly) than expenditures in other sectors of the economy.[94] 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 because of shifts in economic activity resulting from amended standards for central air conditioners and heat pumps.

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

[92] Available at: *http://www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-regulatory-impact-analysis.* See Tables 4A–3, 4A–4, and 4A–5 in the report. The U.S. Supreme Court has stayed the rule implementing the Clean Power Plan until the current litigation against it concludes. *Chamber of Commerce, et al.* v. *EPA, et al.,* Order in Pending Case, 577 U.S. ___(2016). However, the benefit-per-ton estimates established in the Regulatory Impact Analysis for the Clean Power Plan are based on scientific studies that remain valid irrespective of the legal status of the Clean Power Plan.

[93] For the monetized NO_X benefits associated with $PM_{2.5}$, the related benefits are primarily based on an estimate of premature mortality derived from the ACS study (Krewski et al. 2009), which is the lower of the two EPA central tendencies. Using the lower value is more conservative when making the policy decision concerning whether a particular standard level is economically justified. If the benefit-per-ton estimates were based on the Six Cities study (Lepuele et al. 2012), the values would be nearly two-and-a-half times larger. (See chapter 14 of the direct final rule TSD for further description of the studies mentioned above.)

[94] *See* Bureau of Economic Analysis, ''Regional Multipliers: A Handbook for the Regional Input-Output Modeling System (RIMS II),'' U.S. Department of Commerce (1992).

Technologies, Version 3.1.1 (ImSET).[95] 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 the 187 sectors. ImSET's national economic I–O structure is based on a 2002 U.S. benchmark table, specially aggregated to the 187 sectors most relevant to industrial, commercial, and residential building energy use. DOE notes that ImSET is not a general equilibrium forecasting model, and understands the uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Because ImSET does not incorporate price changes, the employment effects predicted by ImSET may over-estimate actual job impacts over the long run. For this DFR, DOE used ImSET only to estimate short-term (through 2023) employment impacts, where these uncertainties are reduced.

For more details on the employment impact analysis, see chapter 16 of the DFR TSD.

V. Analytical Results and Conclusions

This section addresses the results from DOE's analyses with respect to amended energy conservation standards for central air conditioners and heat pumps. It addresses the trial standard levels examined by DOE, the projected impacts of each of these levels if adopted as energy conservation standards for central air conditioners and heat pumps, and the standards levels that DOE is adopting in this direct final rule.

A. Trial Standard Levels

For this DFR, DOE analyzed the benefits and burdens of seven TSLs for central air conditioners and heat pumps. These TSLs were developed using combinations of efficiency levels for each of the product classes analyzed by DOE. DOE presents the results for those TSLs in this document. 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 for the central air conditioner and heat pump product classes. TSL 4 represents the maximum technologically feasible (''max-tech'') for all product classes. TSL 3 represents the maximum energy savings, considering a national standard. TSL 2, the Recommended TSL, represents the maximum national NPV, considering regional standards. TSL 1 represents a minimal increase in SEER for split-system product classes only, considering regional standards.

TABLE V–1—TRIAL STANDARD LEVELS FOR CENTRAL AIR CONDITIONERS AND HEAT PUMPS

TSL	Region	Efficiency metric	Product class					
			Split-system AC	Split-system heat pumps	Single-package AC	Single-package heat pumps	Small-duct high-velocity	Space-constrain. AC
1	National	SEER	14.0	14.5	14.0	14.0	12.0	12.0
		HSPF	n/a	8.4	n/a	8.0	n/a	n/a
	Hot-Humid **	SEER	14.5	n/a	n/a	n/a	n/a	n/a
	Hot-Dry ***	SEER	14.5	n/a	n/a	n/a	n/a	n/a
Recommend *	National	SEER	14.0	15.0	14.0	14.0	12.0	12.0
		HSPF	n/a	8.8	8.0	8.0	n/a	n/a
	Hot-Humid **	SEER	† 15.0/14.5	n/a	n/a	n/a	n/a	n/a
	Hot-Dry ***	SEER	† 15.0/14.5	n/a	n/a	n/a	n/a	n/a
3	National	SEER	16.0	16.0	15.0	15.0	12.0	12.0
		HSPF	n/a	8.9	n/a	8.2	n/a	n/a
4	National	SEER	# 17.0/16.5	## 19.0/17.5	17.5	15.0	14.0	14.0
		HSPF	n/a	## 9.9/9.4	n/a	8.2	n/a	n/a

* The Recommended TSL includes energy conservation standards based on EER in addition to SEER for split-system and single-package air conditioners in the Hot-Dry region. For split-system air conditioners the EER standards are: 12.2 EER for cooling capacities less than 45,000 Btu/hr; 11.7 EER for cooling capacities equal to or greater than 45,000 Btu/hr; and 10.2 EER for split-system air conditioners with a seasonal energy efficiency ratio greater than or equal to 16.0. For single-package air conditioners, the EER standard is 11.0.

** Hot-Humid includes: The states of Alabama, Arkansas, Delaware, Florida, Georgia, Hawaii, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, Puerto Rico, South Carolina, Tennessee, Texas, Virginia, the District of Columbia, and the U.S. territories.

*** Hot-Dry includes the states of Arizona, California, Nevada, and New Mexico.

† The 15.0 SEER energy conservation standard applies to cooling capacities less than 45,000 Btu/hr; the 14.5 SEER energy conservation standard applies to cooling capacities equal to or greater than 45,000 Btu/hr.

The 17.0 SEER energy conservation standard applies to cooling capacities less than 30,000 Btu/hr; the 16.5 SEER energy conservation standards applies to cooling capacities equal to or greater than 30,000 Btu/hr.

The 19.0 SEER and 9.9 HSPF energy conservation standards apply to cooling capacities less than 45,000 Btu/hr; the 17.5 SEER and 9.4 HSPF energy conservation standards apply to cooling capacities equal to or greater than 45,000 Btu/hr.

n/a—Not applicable.

B. Economic Justification and Energy Savings

1. Economic Impacts on Individual Consumers

DOE analyzed the economic impacts on central air conditioner and heat pump consumers by looking at the effects 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 below.

a. Life-Cycle Cost and Payback Period

In general, higher-efficiency products affect consumers in two ways: (1) Purchase price increases, and (2) annual operating costs decrease. Inputs used for calculating the LCC and PBP include total installed costs (*i.e.,* product price plus installation costs), and operating

[95] M.J. Scott, *et. al., ImSET 3.1: Impact of Sector Energy Technologies,* PNNL–18412, (2009), *available at www.pnl.gov/main/publications/external/technical_reports/PNNL-18412.pdf.*

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

Table V–2 through show the LCC and PBP results for the TSLs considered for each product class. In the first of each pair of tables, the simple payback is measured relative to consumer use of the baseline product. In the second table, the LCC impacts are measured relative to the consumer LCCs projected for the no-new-standards case in the compliance year (see section IV.F.2.f). Because some consumers purchase products with higher efficiency in the no-new-standards case, the average savings are less than the difference between the average LCC of EL 0 and the average LCC at each TSL. The savings refer only to consumers who are affected by a standard at a given TSL. Those who already purchase a product with an 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 SPLIT-SYSTEM CENTRAL AIR CONDITIONERS

TSL	Region	SEER	Average costs (2015$)				Simple payback (years)	Average lifetime (years)
			Installed cost	First year's operating cost	Lifetime operating cost	LCC		
Baseline	North	13	$3,966	$172	$3,875	$7,841	N/A	24.1
	Hot-Dry	14	4,392	279	5,639	10,031	5.0	24.9
	Hot-Humid	14	4,011	320	5,044	9,054	5.0	18.0
1	North	14	4,092	161	3,696	7,787	10.5	24.1
	Hot-Dry	14.5	4,475	263	5,387	9,862	5.4	24.9
	Hot-Humid	14.5	4,086	308	4,884	8,969	5.5	18.0
Recommended	North	14	4,092	161	3,696	7,787	10.5	24.1
	Hot-Dry *	15/14.5	4,584	256	5,269	9,853	7.6	24.9
	Hot-Humid *	15/14.5	4,183	302	4,812	8,995	7.7	18.0
3	National	16	4,638	224	4,216	8,854	15.2	21.2
4	National **	17/16.5/16.5	4,906	217	4,130	9,036	19.2	21.2

Note: The results for each TSL are calculated assuming that all consumers use products with that efficiency level. The PBP is measured relative to use of the baseline product.
* 15 SEER for 2 and 3 ton units, 14.5 SEER for 5 ton units.
** Max-Tech SEER is different for 2, 3, and 5 ton units.

TABLE V–3—LCC IMPACTS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR SPLIT-SYSTEM CENTRAL AIR CONDITIONERS

TSL	Region	SEER	Average LCC savings	% of net cost
Baseline	North	13	N/A	N/A
	Hot-Dry	14	N/A	N/A
	Hot-Humid	14	N/A	N/A
1	North	14	$43	25
	Hot-Dry	14.5	169	14
	Hot-Humid	14.5	82	15
Recommended	North	14	43	25
	Hot-Dry *	15/14.5	150	42
	Hot-Humid *	15/14.5	39	45
3	National	16	(122)	63
4	National **	17/16.5/16.5	(304)	75

* 15 SEER for 2 and 3 ton units, 14.5 SEER for 5 ton units.
** Max-Tech SEER is different for 2, 3, and 5 ton units.

TABLE V–4—AVERAGE LCC AND PBP RESULTS FOR SPLIT-SYSTEM CENTRAL HEAT PUMPS

TSL	Region	SEER	HSPF	Average costs (2015$)				Simple payback (years)	Average lifetime (years)
				Installed cost	First year's operating cost	Lifetime operating cost	LCC		
Baseline	National	14	8.2	$5,246	$468	$6,396	$11,642	N/A	15.3
1	National	14.5	8.4	5,318	455	6,253	11,570	5.2	15.3
Recommended	National	15	8.5	5,391	439	6,081	11,472	4.9	15.3
3	National	16	8.9	5,720	420	5,906	11,627	9.4	15.3
4	National *	19/19/17.5	9.9/9.3	6,572	378	5,476	12,047	14.9	15.3

Note: The results for each TSL are calculated assuming that all consumers use products with that efficiency level. The PBP is measured relative to the baseline product.
* Max-Tech SEER is different for 2, 3, and 5 ton unit.

TABLE V–5—LCC IMPACTS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR SPLIT-SYSTEM CENTRAL HEAT PUMPS

TSL	Region	SEER	HSPF	Average LCC savings	% of net cost
Baseline	National	14	8.2	N/A	N/A
1	National	14.5	8.4	$72	9
Recommended	National	15	8.5	131	20
3	National	16	8.9	(25)	54
4	National*	19/19/17.5	9.9/9.3	(425)	79

*Max-Tech SEER is different for 2, 3, and 5 ton units.

TABLE V–6—AVERAGE LCC AND PBP RESULTS FOR PACKAGED CENTRAL AIR CONDITIONERS

TSL	Region	SEER	Average costs (2015$)				Simple payback (years)	Average lifetime (years)
			Installed cost	First year's operating cost	Lifetime operating cost	LCC		
Baseline	National	14	$4,779	$294	$5,452	$10,231	N/A	21.2
1	National	14	4,779	294	5,452	10,231	N/A	21.2
Recommended	National	14	4,779	294	5,452	10,231	N/A	21.2
3	National	15	4,935	275	5,225	10,160	8.9	21.2
4	National	17.5	5,427	237	4,855	10,281	12.3	21.2

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

TABLE V–7—LCC IMPACTS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR PACKAGED CENTRAL AIR CONDITIONERS

TSL	Region	SEER	Average LCC savings	% of net cost
Baseline	National	14	N/A	N/A
1	National	14	N/A	N/A
Recommended	National	14	N/A	N/A
3	National	15	$43	53
4	National	17.5	(80)	69

TABLE V–8—AVERAGE LCC AND PBP RESULTS FOR PACKAGED CENTRAL HEAT PUMPS

TSL	Region	SEER	HSPF	Average costs (2015$)				Simple payback (years)	Average lifetime (years)
				Installed cost	First year's operating cost	Lifetime operating cost	LCC		
Baseline	National	14	8.0	$5,361	$517	$6,998	$12,359	N/A	15.3
1	National	14	8.0	5,361	517	6,998	12,359	N/A	15.3
Recommended	National	14	8.0	5,361	517	6,998	12,359	N/A	15.3
3	National	15	8.2	5,545	479	6,584	12,129	5.2	15.3
4	National	15	8.2	5,545	479	6,584	12,129	5.2	15.3

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

TABLE V–9—LCC IMPACTS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR PACKAGED CENTRAL HEAT PUMPS

TSL	Region	SEER	HSPF	Average LCC savings	% of net cost
Baseline	National	14	8.0	N/A	N/A
1	National	14	8.0	N/A	N/A
Recommended	National	14	8.0	N/A	N/A
3	National	15	8.2	$115	39
4	National	15	8.2	115	39

TABLE V–10—AVERAGE LCC AND PBP RESULTS FOR SPACE-CONSTRAINED AIR CONDITIONERS

TSL	Region	SEER	Average costs (2015$)				Simple payback (years)	Average lifetime (years)
			Installed cost	First year's operating cost	Lifetime operating cost	LCC		
Baseline	National	12	$4,736	$190	$3,779	$8,515	N/A	21.2
1	National	12	4,736	190	3,779	8,515	N/A	21.2
Recommended	National	12	4,736	190	3,779	8,515	N/A	21.2
3	National	12	4,736	190	3,779	8,515	N/A	21.2
4	National	14	5,040	164	3,417	8,458	11.6	21.2

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

TABLE V–11—LCC IMPACTS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR SPACE-CONSTRAINED AIR CONDITIONERS

TSL	Region	SEER	Average LCC savings	% of net cost
Baseline	National	12	N/A	N/A
1	National	12	N/A	N/A
Recommended	National	12	N/A	N/A
3	National	12	N/A	N/A
4	National	14	$58	60

TABLE V.12—AVERAGE LCC AND PBP RESULTS FOR SMALL-DUCT HIGH-VELOCITY AIR CONDITIONERS

TSL	Region	SEER	Average costs (2015$)				Simple payback (years)	Average lifetime (years)
			Installed cost	First year's operating cost	Lifetime operating cost	LCC		
Baseline	National	12	$5,544	$197	$4,035	$9,579	N/A	21.2
1	National	12	5,544	197	4,035	9,579	N/A	21.2
Recommended	National	12	5,544	197	4,035	9,579	N/A	21.2
3	National	12	5,544	197	4,035	9,579	N/A	21.2
4	National	14	6,478	170	3,648	10,126	34.3	21.2

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

TABLE V.13—LCC IMPACTS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR SMALL-DUCT HIGH-VELOCITY AIR CONDITIONERS

TSL	Region	SEER	Average LCC savings	% of net cost
Baseline	National	12	N/A	N/A
1	National	12	N/A	N/A
Recommended	National	12	N/A	N/A
3	National	12	N/A	N/A
4	National	14	($540)	90

b. Consumer Subgroup Analysis

In the consumer subgroup analysis, DOE estimated the impacts of the considered TSLs on low-income households and senior-only households. The average LCC savings and simple payback periods for low-income and senior-only households are compared to the results for all consumers of split air conditioners and split heat pumps in Table V–12 and Table V–13. In most cases, the average LCC savings and PBP for low-income households and senior-only households at the considered efficiency levels are not substantially different from the average for all households. Chapter 11 of the direct final rule TSD presents detailed results of the consumer subgroup analysis.

TABLE V–12—SPLIT-SYSTEM CENTRAL AIR CONDITIONERS: IMPACTS FOR SENIOR-ONLY AND LOW-INCOME CONSUMER SUBGROUPS COMPARED TO ALL HOUSEHOLDS

TSL	Region	SEER	Average LCC savings			Simple payback period		
			Senior	Low-income	All consumers	Senior	Low-income	All consumers
Baseline	North	13	N/A	N/A	N/A	N/A	N/A	N/A
	Hot-Dry	14	N/A	N/A	N/A	4.9	6.8	5.0
	Hot-Humid	14	N/A	N/A	N/A	5.0	5.0	5.0
1	North	14	$32	$28	$43	11.3	11.7	10.5
	Hot-Dry	14.5	171	105	169	5.5	7.3	5.4
	Hot-Humid	14.5	74	62	82	5.8	6.1	5.5
Recommended	North	14	32	28	43	11.3	11.7	10.5
	Hot-Dry	15/14.5	149	71	150	7.9	10.0	7.6
	Hot-Humid	15/14.5	30	16	39	8.1	8.4	7.7
3	National	16	(122)	(179)	(122)	16.1	15.3	15.2
4	National	17/16.5/16.5	(306)	(368)	(304)	20.4	19.3	19.2

* 15 SEER for 2 and 3 ton units, 14.5 SEER for 5 ton units.
** Max-Tech SEER is different for 2, 3, and 5 ton units.

TABLE V–13—SPLIT-SYSTEM HEAT PUMPS: IMPACTS FOR SENIOR-ONLY AND LOW-INCOME CONSUMER SUBGROUPS COMPARED TO ALL HOUSEHOLDS

TSL	Region	SEER	HSPF	Average LCC savings			Simple payback period		
				Senior	Low-income	All consumers	Senior	Low-income	All consumers
Baseline	National	14	8.2	N/A	N/A	N/A	N/A	N/A	N/A
1	National	14.5	8.4	$76	$70	$72	5.0	5.1	5.2
Recommended	National	15	8.5	140	125	131	4.8	5.0	4.9
3	National	16	8.9	(6)	(33)	(25)	9.1	9.5	9.4
4	National	19\19\17.5	9.9/9.3	(398)	(450)	(425)	14.7	15.1	14.9

* Max-Tech SEER is different for 2, 3, and 5 ton units.

c. Rebuttable Presumption Payback Period

As discussed in section III.J.2, EPCA establishes a rebuttable presumption that an energy conservation standard is economically justified if the increased purchase cost for a product that meets the standard is less than three times the value of the first-year energy savings resulting from the standard. In calculating a rebuttable presumption payback period for each of the considered TSLs, DOE used discrete values rather than distributions for input values, and, as required by EPCA, based the energy use calculation on the DOE test procedures for central air conditioners and heat pumps. In contrast, the PBPs presented in section V.B.1.a were calculated using distributions that reflect the range of energy use in the field.

Table V–14 presents the rebuttable-presumption payback periods for the considered TSLs. While DOE examined the rebuttable-presumption criterion, it considered whether the standard levels considered for this rule are economically justified through a more detailed analysis of the economic impacts of those levels, pursuant to 42 U.S.C. 6295(o)(2)(B)(i), that considers the full range of impacts to the consumer, manufacturer, Nation, and environment. The results of that analysis serve as the basis for DOE to definitively evaluate the economic justification for a potential standard level, thereby supporting or rebutting the results of any preliminary determination of economic justification.

TABLE V–14 REBUTTABLE PRESUMPTION PAYBACK PERIOD FOR CENTRAL AIR CONDITIONERS AND HEAT PUMPS

Product class	Trial standard level			
	1	Recommended	3	4
Split Air Conditioners *	N/A	N/A	6.2	12.5
Split Heat Pumps	2.2	1.8	4.2	6.5
Package Air Conditioners **	N/A	N/A	5.5	7.7
Package Heat Pumps **	N/A	N/A	3.9	3.9
Space-Constrained Air Conditioners **	N/A	N/A	N/A	6.2
Small-Duct High-Velocity Air Conditioners **	N/A	N/A	N/A	16.1

* The rebuttable presumption payback period uses a national calculation so there are no results for TSL 1 and the Recommended TSL because split-system central air conditioners have regional standards.
** The TSL is set at the baseline level so payback period is not relevant.

2. Economic Impacts on Manufacturers

DOE performed a manufacturer impact analysis (MIA) to estimate the impact of amended energy conservation standards on central air conditioner and heat pump manufacturers. The following 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

Table V–15 and Table V–16 depict the estimated financial impacts (represented by changes in industry net present value, or INPV) of amended energy conservation standards on manufacturers of central air conditioners and heat pumps, as well as the conversion costs that DOE expects manufacturers would incur at each TSL.

As discussed in section 2.b, DOE modeled two different markup scenarios to evaluate the range of cash flow impacts on the central air conditioner and heat pump industry: (1) The preservation of gross margin percentage markup scenario; and (2) the tiered markup scenario.

To assess the less severe end of the range of potential impacts on industry profitability, DOE modeled a preservation of gross margin percentage markup scenario, in which a uniform ''gross margin percentage'' markup is applied across all potential efficiency levels. In this scenario, DOE assumed that a manufacturer's absolute dollar markup would increase as production costs increase in the standards case.

To assess the more severe end of the range of potential impacts on industry profitability, DOE modeled a tiered markup scenario. In this scenario, the breadth of manufacturers' product portfolios shrinks as higher energy conservation standards increase the efficiency of baseline products. In this scenario, products in more efficient tiers that previously commanded higher markups are ''demoted'' to lower efficiency tiers that command lower markups. The contraction in markups in this scenario reduces manufacturers' per-unit revenues.

Each of the markup scenarios results in a unique set of cash flows and corresponding industry values 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 that result from the sum of discounted cash flows from the base year (2016) through the end of the analysis period (2050). 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 amended standards would take effect. This figure provides an understanding of the magnitude of required conversion costs relative to cash flows calculated by the industry in the no-new-standards case.

TABLE V–15—MANUFACTURER IMPACT ANALYSIS RESULTS FOR CENTRAL AIR CONDITIONERS AND HEAT PUMPS: PRESERVATION OF GROSS MARGIN PERCENTAGE MARKUP SCENARIO

	Units	No-new-standard case	Trial standard level *			
			1	2 **	3	4
INPV	2015$M	4,496.1	4,466.2	4,381.9	4,512.2	4,889.6
Change in INPV	2015$M		(29.9)	(114.2)	16.1	393.5
	%		(0.7)	(2.5)	(0.4)	8.8
Product Conversion Costs	2015$M		40.7	137.0	225.2	248.7
Capital Conversion Costs	2015$M		61.0	205.6	337.9	373.0
Total Conversion Costs	2015$M		101.7	342.6	563.1	621.6
Free Cash Flow	2015$M	416.0 (429.6 for TSL 2)	376.2	278.8	195.7	172.8
	%		(9.6)	(35.1)	(53.0)	(58.5)

* Parentheses indicate negative values. All values have been rounded to the nearest tenth. M = millions.
** TSL recommended by the CAC/HP Working Group with 2023 compliance date. All other TSLs have a modeled compliance date of 2021, which is six years after the compliance date of the standards adopted in the June 27, 2011 DFR.

TABLE V–16—MANUFACTURER IMPACT ANALYSIS RESULTS FOR CENTRAL AIR CONDITIONERS AND HEAT PUMPS: TIERED MARKUP SCENARIO

	Units	No-new-standard case	Trial standard level *			
			1	2 **	3	4
INPV	2015$M	4,496.1	3,852.0	3,803.9	3,382.0	3,360.6
Change in INPV	2015$M		(644.1)	(692.3)	(1,114.2)	(1,135.6)
	%		(14.3)	(15.4)	(24.8)	(25.3)
Product Conversion Costs	2015$M		40.7	137.0	225.2	248.7
Capital Conversion Costs	2015$M		61.0	205.6	337.9	373.0
Total Conversion Costs	2015$M		101.7	342.6	563.1	621.6
Free Cash Flow	2015$M	411.9 (426.8 for TSL 2).	372.1	276.1	191.6	168.7
	%		(9.7)	(35.3)	(53.5)	(59.0)

* Parentheses indicate negative values. All values have been rounded to the nearest tenth. M = millions.
** TSL recommended by the CAC/HP Working Group with 2023 compliance date. All other TSLs have a modeled compliance date of 2021, which is six years after the compliance date of the standards adopted in the June 27, 2011 DFR.

At TSL 1, DOE estimates impacts on INPV to range from −$644.1 million to −$29.9 million, or a change of −14.3 percent to −0.7 percent. DOE projects that in the absence of new standards, 57 percent of central air conditioner and heat pump shipments would already meet or exceed the efficiency levels prescribed by TSL 1 in the compliance year (2021). DOE estimates total industry conversion costs of $101.7 million would be required to bring the balance of shipments into compliance with a new standard. These conversion costs drive an estimated decrease in industry free cash flow in the year before the compliance date (2020). In the more severe tiered markup scenario, DOE estimates a decrease in industry free cash flow in the year prior to compliance of $39.8 million, or a change of −9.7 percent relative to the no-new-standards case value of $411.9 million. At TSL 1, DOE also projects higher unit prices will result in a slight decrease in total shipments over the period beginning with the compliance year (2021) and ending in 2050. DOE estimates a change in shipments of −0.04 percent relative to the no-new-standards case.

At TSL 1, under the preservation of gross margin percentage scenario, the shipment-weighted average price per unit increases by 1.8 percent relative to the no-new-standards-case price per unit in the year of compliance (2021). This slight price increase would mitigate a portion of the $101.7 million in conversion costs estimated at TSL 1, resulting in slightly negative INPV impacts under this scenario. Under the tiered markup scenario, the industry markup structure is compressed as the least efficient products are eliminated from the market. Under amended standards, products in higher efficiency tiers that previously commanded higher markups are demoted to lower efficiency tiers that command lower markups. At TSL 1, this markup scenario results in a weighted average price increase of 0.3 percent. This relatively modest price increase is outweighed by the expected conversion costs and slight decrease in total shipments, resulting in more severe INPV impacts at TSL 1.

At TSL 2, the TSL recommended by the ASRAC CAC/HP Working Group, DOE estimates impacts on INPV to range from −$692.3 million to −$114.2 million, or a change in INPV of −15.4 percent to −2.5 percent. DOE projects that in the absence of new standards, 32 percent of central air conditioner and heat pump shipments would already meet or exceed the efficiency levels prescribed by TSL 2 in the compliance year (2023). DOE estimates total industry conversion costs of $342.6 million would be required to bring the balance of shipments into compliance with a new standard. These conversion costs drive an estimated decrease in industry free cash flow in the year before the compliance date (2022). In the more severe tiered markup scenario, DOE estimates a decrease in industry free cash flow of up to $150.8 million, or a change of −35.3 percent relative to the no-new-standards case value of $426.8 million in the year before compliance (2022). At TSL 2, DOE also projects higher unit prices will result in a slight decrease in total shipments over the period beginning with the compliance year (2023) and ending in 2050. DOE estimates a change in shipments of −0.03 percent relative to the no-new-standards case.

At TSL 2, under the preservation of gross margin percentage scenario, the shipment-weighted average price per unit increases by 4.4 percent relative to the no-new-standards-case price per unit in the year of compliance (2023). In this scenario, manufacturers are able to fully pass on the increase in MPC to consumers. However, this price increase is outweighed by the $342.6 million in conversion costs estimated at TSL 2, resulting in slightly negative INPV impacts under this scenario. Under the tiered markup scenario, the weighted average price per unit increases by 2.9 percent. This price increase is offset by the expected conversion costs and slight decrease in total shipments, resulting in more severe INPV impacts at TSL 2.

At TSL 3, DOE estimates impacts on INPV to range from −$1,114.2 million to $16.1 million, or a change in INPV of −24.8 percent to 0.4 percent. DOE projects that in the absence of new standards, 8 percent of central air conditioner and heat pump shipments would meet or exceed the efficiency levels prescribed by TSL 3 in the compliance year (2021). DOE estimates total industry conversion costs of $563.1 million would be required to bring the balance of shipments into compliance with a new standard. These conversion costs drive an estimated decrease in industry free cash flow in the year before the compliance date (2020). In the more severe tiered markup scenario, DOE estimates a decrease in industry free cash flow in the year prior to compliance of $220.3 million, or a change of −53.5 percent relative to the no-new-standards case. At TSL 3, DOE also projects higher unit prices will result in a slight decrease in total shipments over the period beginning with the compliance year (2021) and ending in 2050. DOE estimates a change in shipments of −0.24 percent relative to the no-new-standards case.

At TSL 3, under the preservation of gross margin percentage scenario, the shipment-weighted average price per unit increases by 20.9 percent relative to the no-new-standards-case price per unit in the year of compliance (2021). Under this scenario, the higher unit price offsets conversion costs and the slight decrease in shipments to produce slightly positive INPV impacts. Under the tiered markup scenario, the weighted average price increases by 17.9 percent. This price increase is not sufficient to offset the expected conversion costs and slight decrease in total shipments, resulting in negative INPV impacts at this level.

At TSL 4, DOE estimates impacts on INPV to range from −$1,135.6 million to $393.5 million, or a change in INPV of −25.3 percent to 8.8 percent. DOE projects that in the absence of new standards, 3 percent of central air conditioner and heat pump shipments would meet or exceed the efficiency levels prescribed by TSL 4 in the compliance year (2021). DOE estimates total industry conversion costs of $621.6 million would be required to bring the balance of shipments into compliance with a new standard. These conversion costs drive an estimated decrease in industry free cash flow in the year before the compliance date (2020). In the more severe tiered markup scenario, DOE estimates a decrease in industry free cash flow in the year prior to compliance of approximately $243.2 million, or a change of −59.0 percent relative to the no-new-standards case. At this level, DOE also projects higher prices will result in a slight decrease in total shipments over the period beginning with the compliance year (2021) and ending in 2050. DOE estimates a change in shipments of −0.29 percent relative to the no-new-standards case.

At TSL 4, under the preservation of gross margin percentage scenario, the shipment-weighted average price per unit increases by 43.2 percent relative to the no-new-standards-case price per unit in the year of compliance (2021). Under this scenario, the higher unit price offsets conversion costs and the slight decrease in shipments to produce positive INPV impacts. Under the tiered markup scenario, the weighted average price per unit increases by 39.2 percent. This increase is outweighed by the expected conversion costs and a decrease in total shipments, resulting in negative INPV impacts at TSL 4.

b. Direct Impacts on Employment

To quantitatively assess the potential impacts of amended energy conservation standards on direct employment, DOE used the GRIM to estimate the domestic labor expenditures and number of direct employees in the no-new-standards case and at each TSL from the base year of the analysis (2016) through the end of the analysis (2050). DOE used statistical data from the U.S. Census Bureau's 2014 Annual Survey of Manufacturers, the results of the engineering analysis, and interviews with manufacturers to determine the inputs necessary to calculate industry-wide labor expenditures and domestic direct employment levels. Labor expenditures related to producing the equipment are a function of the labor intensity of producing 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 MPCs by the labor percentage of MPCs. DOE estimates that 50 percent of residential central air conditioner and heat pump units are produced domestically.

The total labor expenditures in the GRIM were then converted to domestic production employment levels by dividing production labor expenditures by the annual payment per production worker (production worker hours times the labor rate found in the U.S. Census Bureau's 2014 Annual Survey of Manufacturers). The production worker estimates in this section only cover workers up to the line-supervisor level who are directly involved in fabricating and assembling a product within an OEM facility. Workers performing services that are closely associated with production operations, such as materials handling tasks using forklifts, are also included as production labor. DOE's estimates only account for production workers who manufacture the specific products covered by this rulemaking.

To estimate an upper bound to employment change, DOE assumes all domestic manufacturers would choose to continue producing products in the U.S. and would not move production to foreign countries. To estimate a lower bound to employment, DOE considers the case where all manufacturers choose to relocate production overseas rather than make the necessary conversions at domestic production facilities. A complete description of the assumptions used to calculate these upper and lower bounds can be found in chapter 12 of the direct final rule TSD.

In the absence of amended energy conservation standards, DOE estimates that the residential central air conditioner and heat pump industry would employ 10,379 and 10,708 domestic production workers in 2021 and 2023, respectively. Table V–17 shows the range of impacts of potential amended energy conservation standards on U.S. production workers of central air conditioners and heat pumps.

TABLE V–17—POTENTIAL CHANGES IN THE TOTAL NUMBER OF CENTRAL AIR CONDITIONER AND HEAT PUMP PRODUCTION WORKERS IN IN COMPLIANCE YEAR *

	No-new-standard †	Trial standard level **			
		1	2	3	4
Potential Changes in Domestic Production Workers in Compliance Year.	....	(10,379) to 139	(10,708) to 642	(10,379) to 886	(10,379) to 1,878.

* The compliance year for TSL 2 is 2023, as recommended by the CAC/HP Working Group; all other TSLs have a compliance year of 2021.
** Parentheses indicate negative values.
† The no-new-standard case assumes 10,379 domestic production workers in 2021 and 10,708 in 2023.

The upper end of the range estimates the maximum increase and/or minimum decrease in the estimated number of domestic production workers in the residential central air conditioner and heat pump industry after implementation of amended energy conservation standards. It assumes manufacturers would continue to produce the same scope of covered products within the United States.

The lower end of the range represents the maximum decrease in the total number of U.S. production workers that could result from an amended energy conservation standard. In interviews, manufacturers stated that the residential HVAC industry has seen increasing migration to foreign production facilities, often located in Mexico. Many manufacturers of central air conditioners and heat pumps already have foreign production facilities. Some manufacturers indicated a change in standard would lead to a re-evaluation of production in other countries, where it may be possible to mitigate capital investments and/or to reduce the cost of labor inputs. As a result, the lower bound of direct employment impacts assumes domestic production of covered products ceases as manufacturers shift production abroad in search of reduced manufacturing costs.

This conclusion is independent of any conclusions regarding indirect employment impacts in the broader United States economy, which are documented in chapter 15 of the direct final rule TSD.

c. Impacts on Manufacturing Capacity

In interviews and in discussions during the CAC/HP Working Group meetings, manufacturers of residential central air conditioners and heat pumps did not indicate that amended energy conservation standards would significantly constrain manufacturing production capacity.

d. Impacts on Subgroups of Manufacturers

As discussed above, using average cost assumptions to develop an industry cash flow estimate is not adequate for assessing differential impacts among subgroups of manufacturers. Small manufacturers, niche players, or manufacturers exhibiting a cost structure that differs largely from the industry average could be affected differently. DOE used the results of the industry characterization to group manufacturers exhibiting similar characteristics. Specifically, DOE identified small business manufacturers as a subgroup for a separate impact analysis.

For the small business subgroup analysis, DOE applied the small business size standards published by the Small Business Administration (SBA) to determine whether a company is considered a small business. The size standards are codified at 13 CFR part 121. To be categorized as a small business under North American Industry Classification System (NAICS) code 333415, ''Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing,'' a residential central air conditioner and heat pump manufacturer and its affiliates may employ a maximum of 1,250 employees. The 1,250-employee threshold includes all employees in a business's parent company and any other subsidiaries. The small business subgroup analysis is discussed in section VI.B of this notice and in chapter 12 of the direct final rule TSD.

e. Cumulative Regulatory Burden

While any one regulation may not impose a significant burden on manufacturers, the combined effects of several 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. Multiple regulations affecting the same manufacturer can strain profits and can lead companies to abandon product lines or markets with lower expected future returns than competing products. For these reasons, DOE conducts an analysis of cumulative regulatory burden as part of its rulemakings pertaining to appliance efficiency.

For the cumulative regulatory burden analysis, DOE looks at other regulations that could affect manufacturers of central air conditioners and heat pumps during the compliance period, from 2017 to 2023, or those that will take effect approximately three years after the 2023 compliance date of amended energy conservation standards for central air conditioners and heat pumps. In interviews, manufacturers cited federal regulations on equipment other than central air conditioners and heat pumps that contribute to their cumulative regulatory burden. The compliance years and expected industry conversion costs of relevant amended energy conservation standards are indicated in Table V–18.

TABLE V–18—COMPLIANCE DATES AND EXPECTED CONVERSION EXPENSES OF FEDERAL ENERGY CONSERVATION STANDARDS AFFECTING RESIDENTIAL CENTRAL AIR CONDITIONER AND HEAT PUMP MANUFACTURERS

Federal energy conservation standard	Number of manufacturers*	Number of manufacturers affected from today's rule**	Approximate compliance date	Estimated total industry conversion expenses (millions $)	Industry conversion costs/revenue †
Commercial Packaged Air Conditioners and Heat Pumps (Air-Cooled) 81 FR 2420 (January 15, 2016).	13	11	2018 and 2023	520.8 (2014$)	4.4%.
Residential Boilers*** 81 FR 2320 (January 15, 2016).	36	5	2020	2.5 (2014$)	Less than 1%.
Commercial and Industrial Pumps 80 FR 17826 (January 26, 2016).	86	1	2020	81.2 (2014$)	5.6%.
Portable Room Air Conditioners*** 81 FR 38398 (June 13, 2016).	29	5	2021	302.8 (2014$)	10.8%.
Residential Furnaces*** 80 FR 13120 (March 12, 2015).	12	12	2021	55.0 (2013$)	1%.
Commercial Packaged Boilers*** 81 FR 158836 (March 24, 2016).	45	4	2022	27.5 (2014$)	2.3%.
Commercial Warm Air Furnaces 81 FR 2420 (January 15, 2016).	14	10	2023	7.5 to 22.2 (2014$) ††	1.7% to 5.2% ††.

* The number of manufacturers listed in the final rule or notice of proposed rulemaking for the energy conservation standard that is contributing to cumulative regulatory burden.
** The number of manufacturers producing central air conditioners and heat pumps that are affected by the listed energy conservation standards.
*** The final rule for this energy conservation standard has not been published. The compliance date and analysis of conversion costs have not been finalized at this time. (If a value is provided for total industry conversion expense, this value represents an estimate from the NOPR.)
† This column presents conversion costs as a percentage of cumulative revenue for the industry during the conversion period. The conversion period is the timeframe over which manufacturers must make conversion cost investments and lasts from the announcement year of the final rule to the standards year of the rule. This period typically ranges from 3 to 5 years, depending on the energy conservation standard.
†† Low and high conversion cost scenarios were analyzed as part of this Direct Final Rule. The range of estimated conversion expenses presented here reflects those two scenarios.

DOE also identified federal energy conservation standards for residential water heaters, residential room air conditioners, and commercial packaged air conditioners and heat pumps (water and evaporative cooled) as sources of cumulative regulatory burden for manufacturers of central air conditioners and heat pumps. However, NOPRs have not yet been published for those standards so information on manufacturer impacts is not yet available.

In addition to the energy conservation standards listed, manufacturers cited increasing ENERGY STAR[96] standards as a source of regulatory burden. In response, DOE does not consider ENERGY STAR in its presentation of cumulative regulatory burden, because ENERGY STAR is a voluntary program and is not federally mandated.

Manufacturers also cited the U.S. EPA Significant New Alternatives Policy (SNAP) Program as a source of regulatory burden. The SNAP Program evaluates and regulates substitutes for ozone-depleting chemicals (such as air conditioning refrigerants) that are being phased out under the stratospheric ozone protection provisions of the Clean Air Act. On April 10, 2015, the EPA issued a final rule allowing the use of three flammable refrigerants (HFC-32 (R-32), Propane (R-290), and R-441A) as new acceptable substitutes, subject to use conditions, for refrigerant in the Household and Light Commercial Air Conditioning class of equipment. 80 FR 19454 (April 10, 2015). However, DOE notes that the use of alternate refrigerants by manufacturers of residential central air conditioners and heat pumps would not be required as a direct result of this rule. Hence, alternate refrigerants were not considered in this analysis.

More information on the cumulative regulatory burden can be found in chapter 12 of the direct final rule TSD.

3. National Impact Analysis

a. Significance of Energy Savings

To estimate the energy savings attributable to potential standards for central air conditioners and heat pumps, DOE compared the energy consumption of those products under the base case to

[96] ENERGY STAR is a U.S. EPA voluntary program designed to identify and promote energy-efficient products to reduce greenhouse gas emissions. For more information on the ENERGY STAR program, please visit *www.energystar.gov.*

their anticipated energy consumption under each TSL. The savings are measured over the entire lifetime of products purchased in the 30-year period that begins in the first full year of anticipated compliance with amended standards (2021–2050 or, for the recommended TSL, 2023–2052). Table V–19 presents the estimated national energy savings for each considered TSL disaggregated by product class. Because TSL 1 and the Recommended TSL are comprised of regional standards for split system central air conditioners, the national energy savings results for this product class are disaggregated by region. The approach for estimating national energy savings is described in section IV.H.

TABLE V–19—CENTRAL AIR CONDITIONERS AND HEAT PUMPS: CUMULATIVE NATIONAL ENERGY SAVINGS FOR POTENTIAL STANDARDS

[Units sold in 30-year period]

Product class	TSL 1*			Recommended TSL*			TSL 3	TSL 4
	North	Hot-humid	Hot-dry	North	Hot-humid	Hot-dry	National	National
Primary Energy Use								
Split AC	0.3	0.4	0.1	0.4	0.8	0.2	4.6	5.7
Split HP	0.4			1.7			3.2	7.0
Packaged AC	0.0			0.0			0.2	0.7
Packaged HP	0.0			0.0			0.3	0.3
Total	1.2			3.1			8.2	13.6
Full Fuel Cycle Energy Use								
Split AC	0.4	0.4	0.1	0.4	0.8	0.2	4.8	5.9
Split HP	0.5			1.8			3.4	7.3
Packaged AC	0.0			0.0			0.2	0.7
Packaged HP	0.0			0.0			0.3	0.3
Total	1.3			3.2			8.6	14.2

* National results for all product classes with exception of split system central air conditioners.

OMB Circular A–4 [97] 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, rather than 30, years of product 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.[98] The review timeframe established in EPCA is generally not synchronized with the product lifetime, product manufacturing cycles, or other factors specific to central air conditioners and heat pumps. Thus, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology. The NES sensitivity analysis results based on a nine-year period of shipments are presented in Table V–20.

TABLE V–20—CUMULATIVE NATIONAL ENERGY SAVINGS FOR POTENTIAL STANDARDS FOR CENTRAL AIR CONDITIONERS AND HEAT PUMPS

[Units sold in 9-year period]

Product class	TSL 1*			Recommended TSL*			TSL 3	TSL 4
	North	Hot-humid	Hot-dry	North	Hot-humid	Hot-dry	National	National
Primary Energy Use								
Split AC	0.1	0.1	0.0	0.1	0.2	0.0	1.2	1.5
Split HP	0.1			0.4			0.8	1.7
Packaged AC	0.0			0.0			0.0	0.2
Packaged HP	0.0			0.0			0.1	0.1

[97] U.S. Office of Management and Budget, ''Circular A–4: Regulatory Analysis'' (Sept. 17, 2003) (Available at: *http://www.whitehouse.gov/omb/circulars_a004_a-4/*).

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

TABLE V–20—CUMULATIVE NATIONAL ENERGY SAVINGS FOR POTENTIAL STANDARDS FOR CENTRAL AIR CONDITIONERS AND HEAT PUMPS—Continued

[Units sold in 9-year period]

Product class	TSL 1*			Recommended TSL*			TSL 3	TSL 4
	North	Hot-humid	Hot-dry	North	Hot-humid	Hot-dry	National	National
Total	0.3			0.8			2.1	3.5
Full Fuel Cycle Energy Use								
Split AC	0.1	0.1	0.0	0.1	0.2	0.1	1.3	1.6
Split HP	0.1			0.5			0.8	1.8
Packaged AC	0.0			0.0			0.0	0.2
Packaged HP	0.0			0.0			0.1	0.1
Total	0.4			0.9			2.2	3.6

* National results for all product classes with exception of split system central air conditioners.

b. Net Present Value of Consumer Costs and Benefits

Table V–21 shows the consumer NPV of the total costs and savings for consumers that would result from each TSL considered for central air conditioners and heat pumps disaggregated by product class. As noted above in the presentation of national energy savings results, because TSL 1 and the Recommended TSL are comprised of regional standards for split system central air conditioners, the national energy savings results for this product class are disaggregated by region. The impacts cover the lifetime of products purchased in 2021–2050. In accordance with OMB's guidelines on regulatory analysis,[99] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate.

TABLE V–21—CENTRAL AIR CONDITIONERS AND HEAT PUMPS: CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR POTENTIAL STANDARDS

[Units sold in 30-year period]

Product class	TSL 1*			Recommended TSL*			TSL 3	TSL 4
	North	Hot-humid	Hot-dry	North	Hot-humid	Hot-dry	National	National
3-percent discount rate								
Split AC	1.0	1.6	1.0	1.0	1.2	1.5	(4.5)	(18.2)
Split HP	2.1			8.5			3.9	(11.5)
Packaged AC	0.0			0.0			0.6	0.4
Packaged HP	0.0			0.0			1.1	1.1
Total	5.7			12.2			1.1	(28.1)
7-percent discount rate								
Split AC	(0.1)	0.4	0.3	0.0	(0.3)	0.3	(9.2)	(18.1)
Split HP	0.7			2.5			(1.2)	(13.1)
Packaged AC	0.0			0.0			0.1	(0.6)
Packaged HP	0.0			0.0			0.3	0.3
Total	1.3			2.5			(10.0)	(31.4)

* National results for all product classes with exception of split system central air conditioners.

The NPV results based on the aforementioned nine-year analytical period are presented in Table V–22. The impacts are counted over the lifetime of products purchased in 2021–2029. As mentioned previously, such results are presented for informational purposes only and is not indicative of any change in DOE's analytical methodology or decision criteria.

[99] OMB Circular A–4, section E (Sept. 17, 2003) (Available at: *http://www.whitehouse.gov/omb/circulars_a004_a-4*).

TABLE V–22—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR POTENTIAL STANDARDS FOR CENTRAL AIR CONDITIONERS AND HEAT PUMPS

[Units sold in 9-year period]

Product class	TSL 1 *			Recommended TSL *			TSL 3	TSL 4
	North	Hot-humid	Hot-dry	North	Hot-humid	Hot-dry	National	National
3-percent discount rate								
Split AC	0.2	0.5	0.3	0.3	0.2	0.5	(3.7)	(9.6)
Split HP	0.7			2.5			0.3	(6.4)
Packaged AC	0.0			0.0			0.2	(0.1)
Packaged HP	0.0			0.0			0.3	0.3
Total	1.7			3.5			(2.9)	(15.7)
7-percent discount rate								
Split AC	(0.1)	0.1	0.1	(0.1)	(0.2)	0.1	(5.5)	(10.3)
Split HP	0.3			1.0			(1.0)	(7.2)
Packaged AC	0.0			0.0			0.0	(0.4)
Packaged HP	0.0			0.0			0.1	0.1
Total	0.5			0.8			(6.4)	(17.8)

* National results for all product classes with exception of split system central air conditioners.

The above results reflect the use of the default decreasing price trend (see section IV.H.2) to estimate the change in price for central air conditioners and heat pumps over the analysis period. DOE also conducted a sensitivity analysis that considered one scenario with a constant price trend and one scenario with a slightly higher rate of price decline than the reference case. The results of these alternative cases are presented in appendix 10–C of the direct final rule TSD.

c. Indirect Impacts on Employment

DOE expects amended energy conservation standards for central air conditioners and heat pumps to reduce energy costs for consumers, with the resulting net savings being redirected to other forms of economic activity. Those shifts in spending and economic activity could affect the demand for labor. As described in section IV.N, DOE used an input/output model of the U.S. economy to estimate indirect employment impacts of the TSLs that DOE considered in this rulemaking. DOE understands that there are uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Therefore, DOE calculated results for near-term time frames (2021 to 2026), where these uncertainties are reduced.

The results suggest that the amended 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 results regarding anticipated indirect employment impacts.

4. Impact on Product Utility or Performance

DOE has concluded that the amended standards it is adopting in this direct final rule would not lessen the utility or performance of central air conditioners and heat pumps. Manufacturers of these products currently offer central air conditioner and heat pump that meet or exceed the amended standards.

5. Impact of Any Lessening of Competition

As discussed in section III.I.1.e, EPCA directs DOE to consider any lessening of competition that is likely to result from standards. It also 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 provided the Department of Justice (DOJ) with copies of the NOPR and the TSD for review. In its assessment letter responding to DOE, DOJ concluded that the proposed energy conservation standards for central air conditioners and heat pumps are unlikely to have a significant adverse impact on competition. DOE is publishing the Attorney General's assessment at the end of this direct final rule.

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 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. As a measure of this reduced demand, chapter 15 in the direct final rule TSD presents the estimated reduction in generating capacity, relative to the base case, for the TSLs that DOE considered in this rulemaking.

Energy conservation resulting from amended standards for central air conditioners and heat pumps are expected to yield environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases. Table V–23 provides DOE's estimate of cumulative reductions in air pollutant emissions resulting from each of the TSLs. The tables include both power sector emissions and upstream emissions. The emissions were calculated using the multipliers discussed in section IV.K. DOE reports annual emissions impacts for each TSL in chapter 13 of the direct final rule TSD.

TABLE V–23—CUMULATIVE EMISSIONS REDUCTION ESTIMATED FOR CENTRAL AIR CONDITIONER AND HEAT PUMP POTENTIAL STANDARDS

[Units sold in 30-year period]

	Trial standard level			
	1	Recommended	3	4
Power Sector Emissions				
CO_2 (million metric tons)	72.45	177.9	480.7	794.7
SO_2 (thousand tons)	40.16	98.84	267.3	443.8
NO_X (thousand tons)	81.71	200.5	541.6	894.3
Hg (tons)	0.149	0.368	0.994	1.651
CH_4 (thousand tons)	5.82	14.33	38.71	64.25
N_2O (thousand tons)	0.820	2.019	5.456	9.058
Upstream Emissions				
CO_2 (million metric tons)	4.230	10.44	28.06	46.34
SO_2 (thousand tons)	0.780	1.923	5.176	8.546
NO_X (thousand tons)	60.68	149.8	402.6	664.8
Hg (tons)	0.002	0.004	0.011	0.019
CH_4 (thousand tons)	335.4	828.0	2,225	3,674
N_2O (thousand tons)	0.039	0.095	0.256	0.422
Total Emissions				
CO_2 (million metric tons)	76.68	188.3	508.7	841.0
SO_2 (thousand tons)	40.94	100.8	272.4	452.4
NO_X (thousand tons)	142.4	350.3	944.2	1,559
Hg (tons)	0.151	0.372	1.005	1.669
CH_4 (thousand tons)	341.2	842.4	2,264	3,738
CH_4 (thousand tons CO_2eq) *	9,553	23,586	63,387	104,677
N_2O (thousand tons)	0.858	2.114	5.711	9.481
N_2O (thousand tons CO_2eq) *	227.5	560.3	1,514	2,512

* CO_2eq is the quantity of CO_2 that would have the same global warming potential (GWP).

As part of the analysis for this rule, DOE estimated monetary benefits likely to result from the reduced emissions of CO_2 and NO_X that DOE estimated for each of the TSLs considered for central air conditioners and heat pumps. As discussed in section IV.L, for CO_2, DOE used the most recent values for the SCC developed by an interagency process. The four sets of SCC values for CO_2 emissions reductions in 2015 resulting from that process (expressed in 2014$) are represented by $12.4/metric ton (the average value from a distribution that uses a 5-percent discount rate), $40.6/metric ton (the average value from a distribution that uses a 3-percent discount rate), $63.2/metric ton (the average value from a distribution that uses a 2.5-percent discount rate), and $118/metric ton (the 95th-percentile value from a distribution that uses a 3-percent discount rate). The values for later years are higher due to increasing damages (emissions-related costs) as the projected magnitude of climate change impacts increases.

Table V–24 presents the global value of CO_2 emissions reductions at each TSL. For each of the four cases, DOE calculated a present value of the stream of annual values using the same discount rate as was used in the studies upon which the dollar-per-ton values are based. DOE calculated domestic values as a range from 7 percent to 23 percent of the global values, and these results are presented in chapter 14 of the direct final rule TSD.

TABLE V–24—ESTIMATES OF GLOBAL PRESENT VALUE OF CO_2 EMISSIONS REDUCTION FOR CENTRAL AIR CONDITIONER AND HEAT PUMP POTENTIAL STANDARDS

[Units sold in 30-year period]

TSL	SCC Case *			
	5% discount rate, average	3% discount rate, average	2.5% discount rate, average	3% discount rate 95th percentile
	(billion 2015$)			
Power Sector Emissions				
1	456	2,171	3,487	6,614
Recommended	1,081	5,225	8,420	15,927
3	3,016	14,387	23,110	43,835
4	5,010	23,869	38,322	72,741

TABLE V–24—ESTIMATES OF GLOBAL PRESENT VALUE OF CO_2 EMISSIONS REDUCTION FOR CENTRAL AIR CONDITIONER AND HEAT PUMP POTENTIAL STANDARDS—Continued

[Units sold in 30-year period]

TSL	SCC Case*			
	5% discount rate, average	3% discount rate, average	2.5% discount rate, average	3% discount rate 95th percentile
	(billion 2015$)			
Upstream Emissions				
1	26	126	202	383
Recommended	63	305	491	929
3	174	833	1,340	2,539
4	288	1,381	2,220	4,209
Total FFC Emissions				
1	482	2,297	3,689	6,997
Recommended	1,143	5,530	8,912	16,855
3	3,190	15,220	24,450	46,375
4	5,298	25,249	40,542	76,950

* For each of the four cases, the corresponding SCC value for emissions in 2015 is $12.4, $40.6, $63.2, and $118 per metric ton (2015$). The values are for CO_2 only (*i.e.,* not CO_{2eq} of other greenhouse gases).

DOE is well aware that scientific and economic knowledge about the contribution of CO_2 and other greenhouse gas (GHG) emissions to changes in the future global climate and the potential resulting damages to the world economy continues to evolve rapidly. Thus, any value placed on reducing CO_2 emissions in this rulemaking is subject to change. DOE, together with other Federal agencies, will continue to review various 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. However, consistent with DOE's legal obligations, and taking into account the uncertainty involved with this particular issue, DOE has included in this direct final rule the most recent values and analyses resulting from the interagency review process.

DOE also estimated the cumulative monetary value of the economic benefits associated with NO_X emissions reductions anticipated to result from amended standards for central air conditioners and heat pumps. The dollar-per-ton values that DOE used are discussed in section IV.L.2. Table V–25 presents the cumulative present values for NO_X emissions reductions for each TSL calculated using seven-percent and three-percent discount rates. This table presents values that use the low dollar-per-ton values, which reflect DOE's primary estimate. Results that reflect the range of NO_X dollar-per-ton values are presented in Table V–25.

TABLE V–25—ESTIMATES OF PRESENT VALUE OF NO_X EMISSIONS REDUCTION FOR CENTRAL AIR CONDITIONER AND HEAT PUMP POTENTIAL STANDARDS

[Units sold in 30-year period]

TSL	3% Discount rate	7% Discount rate
	(million 2015$)	
Power Sector Emissions		
1	123	45
Recommended	292	100
3	814	294
4	1,358	490
Upstream Emissions		
1	99	35
Recommended	236	79
3	657	232
4	1,090	385
Total FFC Emissions*		
1	222	80
Recommended	528	179
3	1,472	525
4	2,448	875

* Components may not sum to total due to rounding.

7. Other Factors

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

8. Summary of National Economic Impacts

The NPV of the monetized benefits associated with emissions reductions can be viewed as a complement to the NPV of the consumer savings calculated for each TSL considered in this rulemaking. Table V–26 presents the NPV values that result from adding the estimates of the potential economic benefits resulting from reduced CO_2 and NO_X emissions in each of four valuation scenarios to the NPV of consumer savings calculated for each TSL for the central air conditioners and heat pumps considered in this rulemaking, at both a seven-percent and three-percent discount rate. The CO_2 values used in the columns of each table correspond to the 2015 values in the four sets of SCC values discussed above.

TABLE V–26—CENTRAL AIR CONDITIONERS AND HEAT PUMPS: NET PRESENT VALUE OF CONSUMER SAVINGS COMBINED WITH PRESENT VALUE OF MONETIZED BENEFITS FROM CO_2 AND NO_X EMISSIONS REDUCTIONS FOR POTENTIAL STANDARDS

TSL	Consumer NPV at 3% discount rate added with:			
	SCC case $12.4/metric ton and 3% low NO_X values	SCC case $40.6/metric ton and 3% low NO_X values	SCC case $63.2/metric ton and 3% low NO_X values	SCC case $118/metric ton and 3% low NO_X values
	(billion 2015$)			
1	6.4	8.3	9.7	13.0
Recommended	13.8	18.2	21.6	29.5
3	5.8	17.8	27.0	48.9
4	(20.3)	(0.4)	14.9	51.3
TSL	Consumer NPV at 7% Discount Rate added with:			
	SCC case $12.4/metric ton and 7% low NO_X values	SCC case $40.6/metric ton and 7% low NO_X values	SCC case $63.2/metric ton and 7% low NO_X values	SCC case $118/metric ton and 7% low NO_X values
	(billion 2015$)			
1	1.8	3.7	5.0	8.4
Recommended	3.8	8.2	11.6	19.5
3	(6.3)	5.8	15.0	36.9
4	(25.3)	(5.3)	10.0	46.4

The national operating cost savings are domestic U.S. monetary savings that occur as a result of purchasing the covered products. The CO_2 reduction is a benefit that accrues globally due to decreased domestic energy consumption that is expected to result from this rule. Because CO_2 emissions have a very long residence time in the atmosphere, the SCC values in future years reflect future climate-related impacts that continue beyond 2100 through 2300.

C. Conclusion

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

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

To aid the reader in understanding the benefits and/or burdens of each TSL, tables in this section summarize the quantitative analytical results 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 standard and impacts on employment.

DOE also notes that the economics literature provides a wide-ranging discussion of how consumers trade off upfront costs and energy savings in the absence of government intervention. Much of this literature attempts to explain why consumers appear to undervalue energy efficiency improvements. There is evidence that consumers undervalue future energy savings as a result of: (1) A lack of information; (2) a lack of sufficient salience of the long-term or aggregate benefits; (3) a lack of sufficient savings to warrant delaying or altering purchases; (4) excessive focus on the short term, in the form of inconsistent weighting of future energy cost savings relative to available returns on other investments; (5) computational or other difficulties associated with the evaluation of relevant tradeoffs; and (6) a divergence in incentives (for example, renter versus owner or builder versus purchaser). Other literature indicates that with less than perfect foresight and a high degree of uncertainty about the future, consumers may trade off at a higher than expected rate between current consumption and uncertain future energy cost savings. This undervaluation suggests that regulation that promotes energy efficiency can produce significant net private gains (as well as producing social gains by, for example, reducing pollution).

In DOE's current regulatory analysis, potential changes in the benefits and costs of a regulation due to changes in consumer purchase decisions are included in two ways. First, if consumers forego a purchase of a product in the standards case, this decreases sales for product manufacturers, and the cost to manufacturers is included in the MIA. Second, DOE accounts for energy savings attributable only to products actually used by consumers in the standards case; if a standard decreases the number of products purchased by consumers, this decreases the potential energy savings from an energy conservation standard. DOE provides estimates of changes in the volume of product purchases in chapter 9 of the direct final rule TSD. DOE's current analysis does not explicitly control for heterogeneity in consumer preferences,

preferences across subcategories of products or specific features, or consumer price sensitivity variation according to household income.[100]

While DOE is not prepared at present to provide a fuller quantifiable framework for estimating the benefits and costs of changes in consumer purchase decisions due to an energy conservation standard, DOE is committed to developing a framework that can support empirical quantitative tools for improved assessment of the consumer welfare impacts of appliance standards. DOE has posted a paper that discusses the issue of consumer welfare impacts of appliance standards, and potential enhancements to the methodology by which these impacts are defined and estimated in the regulatory process.[101] DOE welcomes comments on how to more fully assess the potential impact of energy conservation standards on consumer choice and how to quantify this impact in its regulatory analysis in future rulemakings.

1. Benefits and Burdens of TSLs Considered for Central Air Conditioner and Heat Pump Standards

Table V–27 and Table V–28 summarize the quantitative impacts estimated for each TSL for central air conditioners and heat pumps. The national impacts are measured over the lifetime of central air conditioners and heat pumps purchased in the 30-year period that begins in the anticipated first year of compliance with any amended standards (2021–2050 or, in the case of the recommended TSL, 2023–2052). The energy savings, emissions reductions, and value of emissions reductions refer to full-fuel-cycle results. The efficiency levels contained in each TSL are described in section V.A.

TABLE V–27—SUMMARY OF RESULTS FOR CENTRAL AIR CONDITIONER AND HEAT PUMP TSLS: NATIONAL IMPACTS

Category	TSL 1	Recommended TSL	TSL 3	TSL 4
FFC National Energy Savings				
Quads	1.3	3.2	8.6	14.2.
NPV of Consumer Costs and Benefits (2015$ billion)				
3% discount rate	5.7	12.2	1.1	(28.1).
7% discount rate	1.3	2.5	(10.0)	(31.4).
Cumulative Emissions Reduction (Total FFC Emissions)				
CO_2 (million metric tons)	76.68	188.3	508.7	841.0.
SO_2 (thousand tons)	40.94	100.8	272.4	452.4.
NO_X (thousand tons)	142.4	350.3	944.2	1,559.
Hg (tons)	0.151	0.372	1.005	1.669.
CH_4 (thousand tons)	341.2	842.4	2,264	3,738.
CH_4 (million tons CO_2eq) *	9,553	23,586	63,387	104,677.
N_2O (thousand tons)	0.858	2.114	5.711	9.481.
N_2O (thousand tons CO_2eq) *	227.5	560.3	1,514	2,512.
Value of Emissions Reduction (Total FFC Emissions)				
CO_2 (2015$ billion) **	0.482 to 6.997	1.143 to 16.855	3.190 to 46.375	5.298 to 76.950.
NO_X—3% discount rate (2015$ million)	222.2 to 506.6	528.1 to 1204.1	1471.5 to 3355.0	2448.1 to 5581.5.
NO_X—7% discount rate (2015$ million)	80.0 to 180.4	178.6 to 402.6	525.4 to 1184.5	875.0 to 1972.9.

* CO_2eq is the quantity of CO_2 that would have the same global warming potential (GWP).
** Range of the economic value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions.
Note: Parentheses indicate negative values.

TABLE V–28—SUMMARY OF RESULTS FOR CENTRAL AIR CONDITIONERS AND HEAT PUMPS BY TSL: MANUFACTURER AND CONSUMER IMPACTS

Category	TSL 1	Recommended TSL *	TSL 3	TSL 4
Manufacturer Impacts				
Industry NPV (2015$ million)				
No-new-standards case INPV = $4,496.1	3,852.0 to 4,466.2	3,803.9 to 4,381.9	3,382.0 to 4,512.2	3,360.6 to 4,889.6
Change in Industry NPV (%)	(14.3) to (0.7)	(15.4) to (2.5)	(24.8) to 0.4	(25.3) to 8.8
Consumer Average LCC Savings (2015$)				
Split Air Conditioners	N: $43 HD: $169 HH: $82	N: $43 HD: $150 HH: $39	($122).	($304)
Split Heat Pumps	$72	$131	($25)	($425)
Package Air Conditioners	N/A	N/A	$43	($80)
Package Heat Pumps	N/A	N/A	$115	$115

[100] P.C. Reiss and M.W. White, Household Electricity Demand, Revisited, *Review of Economic Studies* (2005) 72, 853–883.

[101] Alan Sanstad, Notes on the Economics of Household Energy Consumption and Technology Choice. Lawrence Berkeley National Laboratory (2010) (Available at: *http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/consumer_ee_theory.pdf* (Last accessed May 3, 2013).

TABLE V–28—SUMMARY OF RESULTS FOR CENTRAL AIR CONDITIONERS AND HEAT PUMPS BY TSL: MANUFACTURER AND CONSUMER IMPACTS—Continued

Category	TSL 1	Recommended TSL *	TSL 3	TSL 4
Space-Constrained Air Conditioners	N/A	N/A	N/A	$58
Small-Duct High-Velocity	N/A	N/A	N/A	($540)
Shipment-Weighted Average **	$68	$75	($71)	($315)
Consumer Simple PBP (years)				
Split Air Conditioners	N: 10.5 HD: 5.4 HH: 5.5	N: 10.5 HD: 7.6 HH: 7.7	15.2.	19.2
Split Heat Pumps	5.2	4.9	9.4	14.9
Package Air Conditioners	N/A	N/A	8.9	12.3
Package Heat Pumps	N/A	N/A	5.2	5.2
Space-Constrained Air Conditioners	N/A	N/A	N/A	11.6
Small-Duct High-Velocity	N/A	N/A	N/A	34.3
Shipment-Weighted Average **	6.0	6.7	12.5	16.8
% of Consumers That Experience Net Cost				
Split Air Conditioners	N: 25% HD: 14% HH: 15%	N: 25% HD: 42% HH: 45%	63%.	75%
Split Heat Pumps	9%	20%	54%	79%
Package Air Conditioners	N/A	N/A	53%	69%
Package Heat Pumps	N/A	N/A	39%	39%
Space-Constrained Air Conditioners	N/A	N/A	N/A	60%
Small-Duct High-Velocity	N/A	N/A	N/A	90%
Shipment-Weighted Average *	14%	28%	59%	74%

Note: Parentheses indicate negative values. N = North region. HD = Hot-dry region; HH = Hot-humid region.

* There are no impacts for Package Air Conditioners. Package Heat Pumps, Space-Constrained Air Conditioners, and Small-Duct High-Velocity because the standard levels are at the baseline efficiency.

** Weighted by shares of each product class in total projected shipments in 2021. Does not include shipments for SCAC and SDHV.

First, DOE considered TSL 4, which would save an estimated total of 14.2 quads of energy, an amount DOE considers significant. TSL 4 has an estimated NPV of consumer benefit of −$31.4 billion using a 7-percent discount rate, and −$28.1 billion using a 3-percent discount rate.

The cumulative emissions reductions at TSL 4 are 841 Mt of CO_2, 452.4 thousand tons of SO_2, 1,559 thousand tons of NO_X, 1.669 tons of Hg, 3,738 thousand tons of CH_4, and 9.481 thousand tons of N_2O. The estimated monetary value of the CO_2 emissions reductions at TSL 4 ranges from $5.298 billion to $76.950 billion.

At TSL 4, the average LCC savings is −$304 for split air conditioners, −$425 for split heat pumps, −$80 for package air conditioners, $115 for package heat pumps, $58 for space-constrained air conditioners, and −$540 for small-duct high-velocity air conditioners. The simple PBP is 19.2 years for split air conditioners, 14.9 years for split heat pumps, 12.3 years for package air conditioners, 5.2 years for package heat pumps, 11.6 years for space-constrained air conditioners, and 34.3 years for small-duct high-velocity air conditioners. The share of consumers experiencing a net LCC cost is 75 percent for split air conditioners, 79 percent for split heat pumps, 69 percent for package air conditioners, 39 percent for package heat pumps, 60 percent for space-constrained air conditioners, and 90 percent for small-duct high-velocity air conditioners.

At TSL 4, the projected change in INPV ranges from a decrease of $1,135.6 million to an increase of $393.5 million. If the more severe range of impacts is reached, TSL 4 could result in a net loss of up to 25.3 percent of INPV for manufacturers.

After considering the analysis and weighing the benefits and the burdens, the Secretary has concluded that, at TSL 4 for central air conditioner and heat pump standards, the benefits of energy savings and emissions reductions would be outweighed by the negative NPV of total consumer benefits at a 3-percent and 7-percent discount rate, negative average consumer LCC savings for most product classes, and the reduction in industry value.

Next, DOE considered TSL 3, which would save an estimated total of 8.6 quads of energy, an amount DOE considers significant. TSL 3 has an estimated NPV of consumer benefit of −$10 billion using a 7-percent discount rate, and $1.1 billion using a 3-percent discount rate.

The cumulative emissions reductions at TSL 3 are 508.7 Mt of CO_2, 272.4 thousand tons of SO_2, 944.2 thousand tons of NO_X, 1.005 tons of Hg, 2,264 thousand tons of CH_4, and 5.711 thousand tons of N_2O. The estimated monetary value of the CO_2 emissions reductions at TSL 3 ranges from $3.190 billion to $46.375 billion.

At TSL 3, the average LCC savings is −$122 for split air conditioners, −$25 for split heat pumps, $43 for package air conditioners, and $115 for package heat pumps. The simple PBP is 15.2 years for split air conditioners, 9.4 years for split heat pumps, 8.9 years for package air conditioners, and 5.2 years for package heat pumps. The share of consumers experiencing a net LCC cost is 63 percent for split air conditioners, 54 percent for split heat pumps, 53 percent for package air conditioners, and 39 percent for package heat pumps. There are no impacts on space-constrained air conditioners or small-duct high-velocity air conditioners at TSL 3.

At TSL 3, the projected change in INPV ranges from a decrease of $1,114.2 million to an increase of $16.1 million. If the more severe range of impacts is reached, TSL 3 could result in a net loss of up to 24.8 percent of INPV for manufacturers.

After considering the analysis and weighing the benefits and the burdens, the Secretary has concluded that at TSL 3 for central air conditioner and heat pump standards, the benefits of energy savings, positive NPV of consumer benefit at a 3-percent discount rate, and emissions reductions would be outweighed by the negative NPV of consumer benefit at a 7-percent discount rate, negative average LCC savings for most product classes, and the potential reduction in INPV for manufacturers.

Next, DOE considered the Recommended TSL, which would save an estimated total of 3.2 quads of energy, an amount DOE considers significant. The Recommended TSL has an estimated NPV of consumer benefit of $2.5 billion using a 7-percent discount rate, and $12.2 billion using a 3-percent discount rate.

The cumulative emissions reductions under the Recommended TSL are 188.3 Mt of CO_2, 100.8 thousand tons of SO_2, 350.3 thousand tons of NO_X, 0.372 tons of Hg, 842.4 thousand tons of CH_4, and 2.114 thousand tons of N_2O. The estimated monetary value of the CO_2 emissions reductions ranges from $1.143 billion to $16.855 billion.

Under the Recommended TSL, the average LCC savings for split air conditioners is $43 in the north region, $150 in the hot dry region, $39 in the hot humid region, and $131 for split heat pumps. The simple payback period for split air conditioners is 10.5 years in the north region, 7.6 years in the hot dry region, 7.7 years in the hot humid region, and 4.9 years for split heat pumps. The share of consumers experiencing a net LCC cost for split air conditioners is 25 percent in the north region, 42 percent in the hot dry region, 45 percent in the hot humid region, and 20 percent for split heat pumps. There are no impacts to packaged air conditioners, packaged heat pumps, space-constrained air conditioners, and small-duct high-velocity air conditioners under the Recommended TSL.

Under the Recommended TSL, the projected change in INPV ranges from a decrease of $692.3 million to a decrease of $114.2 million. If the more severe range of impacts is reached, TSL 3 could result in a net loss of up to 15.4 percent of INPV for manufacturers.

After considering the analysis and weighing the benefits and the burdens, the Secretary has concluded that under the Recommended TSL for central air conditioner and heat pump standards, the benefits of energy savings, positive NPV of consumer benefit, positive impacts on consumers (as indicated by positive average LCC savings and favorable PBPs), and emission reductions, would outweigh the negative impacts on some consumers and the potential reduction in INPV for manufacturers.

Under the authority provided by 42 U.S.C. 6295(p)(4), DOE is issuing this direct final rule that establishes amended energy conservation standards for central air conditioners and heat pumps at the Recommended TSL. The amended energy conservation standards for central air conditioners and heat pumps as determined by the DOE test procedure at the time of the 2015–2016 ASRAC negotiations are presented in Table V–29.

TABLE V–29—AMENDED ENERGY CONSERVATION STANDARDS FOR CENTRAL AIR CONDITIONERS AND HEAT PUMPS AS DETERMINED BY THE DOE TEST PROCEDURE AT THE TIME OF THE 2015–2016 ASRAC NEGOTIATIONS

Product class	National		Southeast *	Southwest **	
	SEER	HSPF	SEER	SEER	EER
Split-System Air Conditioners with a Certified Cooling Capacity <45,000 Btu/h	14	....	15	15	*** 12.2/10.2
Split-System Air Conditioners with a Certified Cooling Capacity ≥45,000 Btu/h	14	....	14.5	14.5	*** 11.7/10.2
Split-System Heat Pumps	15	8.8			
Single-Package Air Conditioners †	14	....	....	....	11.0
Single-Package Heat Pumps †	14	8.0			
Space-Constrained Air Conditioners †	12				
Space-Constrained Heat Pumps †	12	7.4			
Small-Duct High-Velocity Systems †	12	7.2			

* Southeast includes: The states of Alabama, Arkansas, Delaware, Florida, Georgia, Hawaii, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, Puerto Rico, South Carolina, Tennessee, Texas, Virginia, the District of Columbia, and the U.S. territories.
** Southwest includes the states of Arizona, California, Nevada, and New Mexico.
*** The 10.2 EER amended energy conservation standard applies to split-system air conditioners with a seasonal energy efficiency ratio greater than or equal to 16.
† The energy conservation standards for small-duct high velocity and space-constrained product classes remain unchanged from current levels.

Table V–30 shows the amended energy conservation standards for central air conditioners and heat pumps as determined by the November 2016 test procedure final rule.

TABLE V–30—AMENDED ENERGY CONSERVATION STANDARDS FOR CENTRAL AIR CONDITIONERS AND HEAT PUMPS AS DETERMINED BY THE NOVEMBER 2016 TEST PROCEDURE FINAL RULE

Product class	National		Southeast *	Southwest **	
	SEER2	HSPF2	SEER2	SEER2	EER2
Split-System Air Conditioners with a Certified Cooling Capacity <45,000 Btu/h	13.4	....	14.3	14.3	*** 11.7/9.8
Split-System Air Conditioners with a Certified Cooling Capacity ≥45,000 Btu/h	13.4	....	13.8	13.8	*** 11.2/9.8
Split-System Heat Pumps	14.3	7.5			

TABLE V–30—AMENDED ENERGY CONSERVATION STANDARDS FOR CENTRAL AIR CONDITIONERS AND HEAT PUMPS AS DETERMINED BY THE NOVEMBER 2016 TEST PROCEDURE FINAL RULE—Continued

Product class	National		Southeast *	Southwest **	
	SEER2	HSPF2	SEER2	SEER2	EER2
Single-Package Air Conditioners †	13.4				10.6
Single-Package Heat Pumps †	13.4	6.7			
Space-Constrained Air Conditioners †	11.7				
Space-Constrained Heat Pumps †	11.9	6.3			
Small-Duct High-Velocity Systems †	12	6.1			

* Southeast includes: The states of Alabama, Arkansas, Delaware, Florida, Georgia, Hawaii, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, Puerto Rico, South Carolina, Tennessee, Texas, Virginia, the District of Columbia, and the U.S. territories.
** Southwest includes the states of Arizona, California, Nevada, and New Mexico.
*** The 9.8 EER amended energy conservation standard applies to split-system air conditioners with a seasonal energy efficiency ratio greater than or equal to 15.2.
† The energy conservation standards for small-duct high velocity and space-constrained product classes remain unchanged from current levels.

The following paragraph describes how DOE translated the energy conservation standards in Table V–29—which are in terms of SEER, HSPF, and EER as determined by the DOE test procedure at the time of the 2015–2016 ASRAC Negotiations—to the energy conservation standard levels in Table V–30—which are in terms of SEER2, HSPF2, and EER2 as determined by the November 2016 test procedure final rule. DOE used a methodology consistent with the recommendations of the CAC/HP Working Group to translate the SEER standard levels to SEER2 standard levels for the split-system and single-package product classes. Note that the heating load line slope factor established by the November 2016 test procedure final rule is different than the heating load line slope factors used by the CAC/HP Working Group in their Term Sheet recommendation #9. DOE translated the HSPF standard levels to HSPF2 standard levels for split-system and single-package heat pumps by adjusting for the intermediate heating load line slope factor established by the November 2016 test procedure final rule using interpolation. (November 2016 Test Procedure Final Rule, pp. 127–130)

Comments in response to the provisional translations for HSPF2 for split system and single-package heat pumps are summarized in the November 2016 test procedure final rule. (November 2016 Test Procedure Final Rule, pp. 127–130) Commenters agreed with the translation for split-system heat pumps, but industry commenters felt that the 6.8 value was too high for single-package heat pumps. Alternative HSPF2 values that were suggested in comments ranged from 6.5 (Docket No. EERE–2016–BT–TP–0029, Lennox, No. 25 at p. 10) to 6.7 (Docket No. EERE–2016–BT–TP–0029, Goodman, No. 39 at p. 10) Data provided under confidentiality supports the range suggested in comments. DOE combined that data with the data it used to validate its interpolated value of 6.8. DOE found that the combined data shows that 6.7 HSPF2 is an appropriate translation. For this reason, DOE is adopting 6.7 HSPF2 for single-package heat pumps in this direct final rule.

The August 2016 test procedure SNOPR and November 2016 test procedure final rule did not include translated levels for small-duct high velocity (SDHV) and space-constrained products. Neither did Recommendation #9 of the Term Sheet. Recommendation #9 did, however, state that the energy conservation standards for those product classes should remain unchanged from current levels (*i.e.,* that there would be no change in stringency). (ASRAC Term Sheet, No. 76 at pp. 4–5) On October 27, 2016, DOE published a notice of data availability (NODA) that provided provisional translations of the CAC/HP Working Group's recommended energy conservation standard levels for small-duct high velocity and space constrained products (which are in terms of the test procedure at the time of the 2015–2016 Negotiations) into levels consistent with the test procedure proposed in the August 2016 test procedure SNOPR. 81 FR 74727 (October 27, 2016). Table V–31 presents the provisional translations included in the October 2016 NODA. Note that multiple provisional translations from SEER to SEER2 are included for space-constrained air conditioners and heat pumps because, at the time of the NODA publication, DOE had not finalized the test procedure which would establish the minimum external static pressure requirements.

TABLE V–31—PROVISIONAL TRANSLATIONS OF CAC/HP WORKING GROUP-RECOMMENDED ENERGY CONSERVATION STANDARD LEVELS INCLUDED IN OCTOBER 2016 NODA

Product class	CAC/HP working group recommendation		August 2016 test procedure SNOPR translation	
	SEER	HSPF	SEER2	HSPF2
Small-Duct High-Velocity Systems	12	7.2	12	6.1
Space-Constrained Air Conditioners			* 11.6/** 11.8	
Space-Constrained Heat Pumps	12		* 11.5/** 11.9	6.3

* Estimated SEER2 at 0.50 in. wc.
** Estimated SEER2 at 0.30 in. wc.

In developing its provisional translations for space-constrained air conditioners published in the NODA, DOE reviewed existing test data, adjusted relevant measurements based on blower performance data, and translated the levels based on the average impact. For the space-constrained and SDHV heat pump translations published in the NODA, DOE also reviewed test data and confirmed that the 15% reduction from HSPF to HSPF2 that DOE observed for split-system and single-package heat pumps was appropriate also for space-constrained and SDHV heat pumps.

In written comments, manufacturers and AHRI expressed support for DOE's provisional translations for SDHV products. Unico stated that it reviewed all of its test reports from the previous two years and found its range of results validated DOE's translations for SDHV products. (Unico, No. 95 at p. 2). AHRI and Lennox also expressed support for DOE's SEER and HPSF to SEER2 and HSPF2 levels for SDHV products. (AHRI, No. 94 at p. 1; Lennox, No. 97 at p. 1) EEI commented that it did not agree with DOE's translation because the HSPF appears to drop by approximately 15.3%, even though there has been no change to the product. (EEI, No. 96 at p. 2).

Regarding the concern expressed by EEI, DOE's translations do not assume nor reflect any change to product design. EPCA requires DOE to consider changes in energy conservation standards if a test procedure change alters the measurement, but does not prohibit a test procedure change that alters the measurement. (42 U.S.C. 6293(e)) In the November 2016 test procedure final rule, DOE adopted provisions that amend the test procedure required to determine representations for CAC/HP, including SDHV products. These provisions impact the value of the test procedure results. For instance, the November 2016 test procedure final rule assumes higher heating loads for heat pumps in colder outdoor conditions, which will typically result in lower HSPF2 ratings. (November 2016 Test Procedure Final Rule, pp. 110–127) Simply stated, an SDHV product tested in accordance with the test procedure at the time of the 2015–2016 ASRAC Negotiations will get a different rating than the same SDHV product (without design changes) tested in accordance with the test procedure adopted in the November 2016 test procedure final rule. DOE's translations are intended to reflect these differences. DOE is using ''SEER2'', ''HSPF2'', and ''EER2'' to distinguish ratings determined by the November 2016 test procedure from the SEER, HSPF and EER ratings determined by past test procedures to mitigate confusion that may result from the possibility that products available before and after the November 2016 test procedure final rule may have a different SEER2/HSPF2/EER2 than SEER/HSPF/EER rating despite no changes to design.

Unico's SDHV data validate DOE's translations, which are also supported by AHRI and Lennox. DOE did not receive any other comments or data suggesting that its translations for SDHV products are inappropriate. For these reasons, DOE is adopting the SDHV translations presented in the October 2016 NODA in this final rule.

AHRI is concerned that the SEER2 translation DOE presented for space-constrained air conditioners is too high by 0.1. AHRI calculated SEER2 to be 11.7 at 0.30 in. wc. rather than 11.8. AHRI provided data for 4 space-constrained products to illustrate its results. (AHRI, No. 94 at p. 2). Lennox also commented that DOE's SEER2 translation for space-constrained air conditioners is too high by 0.1. (Lennox, No. 97 at p. 2) AHRI and Lennox also commented that DOE should adopt the same SEER2 standard for space-constrained air conditioners and heat pumps (AHRI, No. 94 at p.2; Lennox, No. 97 at p. 2) First Co. strongly disagrees with DOE's proposed translation of SEER to SEER2 values for space-constrained air conditioners because DOE's methodology for determining SEER2 fails to account for the significant SEER reduction resulting from what they claim to be ''new'' coil-only testing requirements for space-constrained air conditioners. First Co. is referring to amendments to the certification requirements of 10 CFR 429 adopted for CAC/HP in the June 2016 test procedure final rule, which became effective in July 2016 and are required for representations starting December 5, 2016. (10 CFR 429.16(a)(1)) First Co. stated that prior to the June 2016 test procedure final rule, space constrained units, which are manufactured and sold only for installation with blower coil indoor units, have been tested with blower coil units with high-efficiency motors (ECMs). The high-efficiency motors average 200W/1000 scfm or less for indoor power compared with the default fan power value of 365W/1000 scfm applied under the ''coil- only'' test. First Co. claims that the impact of the ''coil-only'' test alone is approximately a 10% reduction in SEER of these products from 12 SEER to 10.8 SEER, and that DOE's methodology is flawed because it uses a starting point of 365W/1000 (*i.e.,* the ''coil-only'' default fan power value of the current test procedure) and only considers the change in energy usage from 365W/1000 scfm to 441 W/1000 scfm. They claim that this ignores the increase in energy usage from 200W/1000 scfm to 365W/1000 scfm, and the resulting SEER reduction, caused by the imposition of the ''coil-only'' test. First Co. submits that SEER2 should be calculated by applying the following methodology, which takes into account the new ''coil-only'' test and the changes in the August 2016 test procedure SNOPR: replace 200W/1000 scfm (test data using ECM) with 411 W/1000 scfm and recalculate the SEER. First Co. indicates that applying this methodology, SEER will be reduced by approximately 10% for the coil only test and by an additional 4% to account for the suggested 411 W/1000 scfm number, resulting in a 10.4 SEER2 rating for space constrained air conditioners. (First Co., No. 93 at pp. 1,2)

DOE appreciates the space-constrained air conditioner translation data provided by AHRI. DOE combined AHRI's data with the data DOE used to develop DOE's provisional translations. Note that after the October 2016 NODA, DOE issued the November 2016 test procedure final rule in which it adopted a minimum external static pressure requirement of 0.3 in. wc. for space-constrained air conditioners and heat pumps. (November 2016 Test Procedure Final Rule, pp. 97–99) Consequently, DOE combined AHRI's data with DOE's data reflective of performance at that operating condition. Once combined, the data validates AHRI's assertion that 11.7 is the appropriate SEER2 level for space-constrained air conditioners at 0.3 in. wc. Thus, DOE is adopting 11.7 SEER2 as the standard level for space-constrained air conditioners in this final rule. DOE disagrees with AHRI and Lennox that 11.7 SEER2 should also be used for space-constrained heat pumps. While space-constrained air conditioners are required to certify at least one coil-only combination that is representative of the least efficient coil-only combination distributed in commerce, space-constrained heat pumps have no coil-only requirement. (10 CFR 429.16(a)(1)) AHRI derived 11.7 SEER2 using 406 W/1000 scfm (the default fan power at 0.3 in. wc.) for indoor fan power consumption. As discussed in the November 2015 test procedure SNOPR and subsequently referenced in the November 2016 test procedure final rule, this default fan power value is reflective of the weighted-average performance of indoor fan by motor type distribution projected for the effective date of this standard, which includes a significant majority of lower-efficiency PSC motors. 80 FR 69319–20 and (November 2016 Test Procedure Final Rule, pp. 104–110) First

Co. states that most space-constrained blower-coil systems currently sold include a high-efficiency ECM motor. (First Co., No. 93 at pp. 1–2) Brushless permanent magnet motors (often referred to as ''ECM'') are more efficient than PSC motors. Thus, 406 W/1000 scfm is not representative of the field operation of space-constrained blower-coil systems being sold. DOE's provisional analysis presented in the October 2016 NODA is consistent with First Co.'s claims, showing that higher-efficiency motors typically used in space-constrained blower-coil systems sold today consume less than 406 W/1000 scfm, resulting in a higher SEER2 level for space-constrained blower-coil systems compared to space-constrained coil-only systems. DOE did not receive any additional comments or data regarding the SEER2 level for space-constrained heat pumps. For these reasons, DOE finds that a higher SEER2 level for space-constrained heat pumps—which is based on blower-coil performance—compared to space-constrained air-conditioners—which is based on coil-only performance—is appropriate. DOE adopts its provisional translation of 11.9 SEER2 for space-constrained heat pumps for these reasons.

DOE provided a response to First Co.'s comment regarding the required coil-only test for testing of space constrained products in the November 30, 2016 test procedure final rule. (November 2016 Test Procedure Final Rule, pp. 146–148)

2. Summary of Benefits and Costs (Annualized) of the Amended Standards

The benefits and costs of the amended standards can also be expressed in terms of annualized values. The annualized monetary values are the sum of: (1) The annualized national economic value (expressed in 2015$) of the benefits from operation of products that meet the proposed standards (consisting primarily of operating cost savings from using less energy, minus increases in product purchase costs, which is another way of representing consumer NPV), and (2) the annualized monetary value of the benefits of emission reductions, including CO_2 emission reductions.[102]

Estimates of annualized benefits and costs of the amended standards for central air conditioners and heat pumps, expressed in 2015$, are shown in Table V–32. The results under the primary estimate are as follows.

Using a 7-percent discount rate for benefits and costs other than CO_2 reduction, (for which DOE used a 3-percent discount rate along with the average SCC series that uses a 3-percent discount rate ($40.6/t in 2015)), the estimated cost of the adopted standards is $741 million per year in increased product costs, while the estimated benefits are $1,041 million per year in reduced product operating costs, $337 million per year in CO_2 reductions, and $22 million per year in reduced NO_X emissions. In this case, the net benefit would amount to $659 million per year.

Using a 3-percent discount rate for all benefits and costs and the average SCC series that uses a 3-percent discount rate ($40.6/t in 2015), the estimated cost of the standards adopted in this rule is $747 million per year in increased product costs, while the estimated benefits are $1,488 million per year in reduced product operating costs, $337 million per year in CO_2 reductions, and $32 million per year in reduced NO_X emissions. In this case, the net benefit would amount to $1,110 million per year.

DOE also notes that, using a 7-percent discount rate for only the increased product costs and the reduced product operating costs, the net benefit would amount to $300 million per year. Using a 3-percent discount rate for only the increased product costs and the reduced product operating costs, the net benefit would amount to $741 million per year.

TABLE V–32—ANNUALIZED BENEFITS AND COSTS OF AMENDED STANDARDS (RECOMMENDED TSL) FOR CENTRAL AIR CONDITIONERS AND HEAT PUMPS *

	Discount rate (%)	Primary estimate *	Low net benefits estimate *	High net benefits estimate *
	million 2015$/year			
Benefits				
Consumer Operating Cost Savings	7	1,041	1,005	1,147
	3	1,488	1,425.	1,653.
CO_2 Reduction (using mean SCC at 5% discount rate) **	5	100	100	100.
CO_2 Reduction (using mean SCC at 3% discount rate) **	3	337	337	337.
CO_2 Reduction (using mean SCC at 2.5% discount rate) **	2.5	494	494	494.
CO_2 Reduction (using 95th percentile SCC at 3% discount rate) **.	3	1,027	1,027	1,027.
NO_X Reduction †	7	22	22	49.
	3	32	32	73.
Total Benefits ††	7 plus CO_2 range	1,163 to 2,090	1,127 to 2,054	1,296 to 2,223
	7	1,400	1,364	1,533
	3 plus CO_2 range	1,620 to 2,547	1,557 to 2,484	1,826 to 2,753
	3	1,857	1,794	2,063
Costs				
Consumer Incremental Installed Costs	7	741	784	723
	3	747	799	725

[102] To convert the time-series of costs and benefits into annualized values, DOE calculated a present value in 2016, the year used for discounting the NPV of total consumer costs and savings. For the benefits, DOE calculated a present value associated with each year's shipments in the year in which the shipments occur (*e.g.,* 2020 or 2030), and then discounted the present value from each year to 2016. The calculation uses discount rates of 3 and 7 percent for all costs and benefits except for the value of CO_2 reductions, for which DOE used case-specific discount rates. 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.

TABLE V–32—ANNUALIZED BENEFITS AND COSTS OF AMENDED STANDARDS (RECOMMENDED TSL) FOR CENTRAL AIR CONDITIONERS AND HEAT PUMPS *—Continued

	Discount rate (%)	Primary estimate *	Low net benefits estimate *	High net benefits estimate *
	million 2015$/year			
Net Benefits				
Total ††	7 plus CO_2 range	422 to 1,349	342 to 1,269	573 to 1,500
	7	659	580	810
	3 plus CO_2 range	873 to 1,800	757 to 1,684	1,100 to 2,028
	3	1,110	994	1,338

* This table presents the annualized costs and benefits associated with central air conditioners and heat pumps shipped in 2023–2052. These results include benefits to consumers which accrue after 2050 from the products purchased in 2023–2052. The incremental installed costs include incremental equipment cost as well as installation costs. The CO_2 reduction benefits are global benefits due to actions that occur nationally. The Primary, Low Net Benefits, and High Net Benefits Estimates utilize projections of energy prices from the *AEO 2015* Reference case, Low Estimate, and High Estimate, respectively. In addition, incremental product costs reflect a modest decline rate for projected product prices in the Primary Estimate, a constant rate in the Low Net Benefits Estimate, and a higher decline rate in the High Net Benefits Estimate. The methods used to derive projected price trends are explained in section IV.F.1. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

** The CO_2 reduction benefits are calculated using 4 different sets of SCC values. The first three use the average SCC calculated using 5%, 3%, and 2.5% discount rates, respectively. The fourth represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The SCC values are emission year specific. See section IV.L.1 for more details

† DOE estimated the monetized value of NOx emissions reductions using benefit per ton estimates from the *Regulatory Impact Analysis for the Clean Power Plan Final Rule,* published in August 2015 by EPA's Office of Air Quality Planning and Standards. (Available at: *http://www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-regulatory-impact-analysis.*) See section IV.L.2 for further discussion. For the Primary Estimate and Low Net Benefits Estimate, DOE used a national benefit-per-ton estimate for NO_X emitted from the Electric Generating Unit sector based on an estimate of premature mortality derived from the ACS study (Krewski et al., 2009). For the High Net Benefits Estimate, the benefit-per-ton estimates were based on the Six Cities study (Lepuele et al., 2011); these are nearly two-and-a-half times larger than those from the ACS study.

†† Total Benefits for both the 3% and 7% cases are presented using only the average SCC with 3-percent discount rate. In the rows labeled "7% plus CO_2 range" and "3% plus CO_2 range," the operating cost and NO_X benefits are calculated using the labeled discount rate, and those values are added to the full range of CO_2 values.

VI. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866 and 13563

Section 1(b)(1) of Executive Order 12866, ''Regulatory Planning and Review,'' 58 FR 51735 (October 4, 1993), requires each agency to identify the problem that it intends to address, including, where applicable, the failures of private markets or public institutions that warrant new agency action, as well as to assess the significance of that problem. The problems that the standards set forth in this direct final rule are intended to address are as follows:

(1) Insufficient information and the high costs of gathering and analyzing relevant information leads some consumers to miss opportunities to make cost-effective investments in energy efficiency.

(2) In some cases, the benefits of more-efficient equipment are not realized due to misaligned incentives between purchasers and users. An example of such a case is when the equipment purchase decision is made by a building contractor or building owner who does not pay the energy costs.

(3) There are external benefits resulting from improved energy efficiency of appliances and equipment that are not captured by the users of such products. These benefits include externalities related to public health, environmental protection, and national energy security that are not reflected in energy prices, such as reduced emissions of air pollutants and greenhouse gases that impact human health and global warming. DOE attempts to quantify some of the external benefits through use of social cost of carbon values.

The Administrator of the Office of Information and Regulatory Affairs (OIRA) in the OMB has determined that this regulatory action is a significant regulatory action under section (3)(f) of Executive Order 12866. Accordingly, pursuant to section 6(a)(3)(B) of the Order, DOE has provided to OIRA: (i) The text of the draft regulatory action, together with a reasonably detailed description of the need for the regulatory action and an explanation of how the regulatory action will meet that need; and (ii) An assessment of the potential costs and benefits of the regulatory action, including an explanation of the manner in which the regulatory action is consistent with a statutory mandate. DOE has included these documents in the rulemaking record.

In addition, the Administrator of OIRA has determined that the regulatory action is an ''economically'' significant regulatory action under section (3)(f)(1) of Executive Order 12866. Accordingly, pursuant to section 6(a)(3)(C) of the Order, DOE has provided to OIRA an assessment, including the underlying analysis, of benefits and costs anticipated from the 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 can be found in the technical support document for this rulemaking.

DOE has also reviewed this regulation pursuant to Executive Order 13563, issued on January 18, 2011. 76 FR 3281 (January 21, 2011). Executive Order 13563 is supplemental to and explicitly reaffirms the principles, structures, and definitions governing regulatory review established in Executive Order 12866. To the extent permitted by law, agencies are required by Executive Order 13563 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 Executive Order 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, OIRA has emphasized that such techniques may include identifying changing future compliance costs that might result from technological innovation or anticipated behavioral changes. For the reasons stated in the preamble, DOE believes that this direct final rule is consistent with these principles, including the requirement that, to the extent permitted by law, benefits justify costs and that net benefits are maximized.

B. Review Under the Regulatory Flexibility Act

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

1. Description of Reasons Why Action is Being Considered

DOE has undertaken this rulemaking pursuant to 42 U.S.C. 6295(d)(3), which requires DOE to conduct a second round of amended standards rulemaking for residential central air conditioners and heat pumps. The Energy Policy and Conservation Act of 1975 (EPCA), as amended by the Energy Independence and Security Act of 2007 (EISA 2007), requires that not later than six years after issuance of any final rule establishing or amending a standard, DOE must publish either a notice of the determination that standards for the product do not need to be amended, or a notice of proposed rulemaking including new proposed energy conservation standards. (42 U.S.C. 6295(m)(1)) DOE's last final rule for residential central air conditioners and heat pumps was issued on June 27, 2011, so as a result, DOE must act by June 27, 2017.

2. Objectives of, and Legal Basis for, the Rule

As described in section II.A above, Title III, Part B of the Energy Policy and Conservation Act of 1975 (EPCA or the Act), Public Law 94–163 (42 U.S.C. 6291–6309, as codified) established the Energy Conservation Program for Consumer Products Other Than Automobiles, a program covering most major household appliances (collectively referred to as ''covered products''), which includes the residential central air conditioners and heat pumps that are the subject of this rulemaking. (42 U.S.C. 6292(a)(3))

The National Appliance Energy Conservation Act of 1987 (NAECA; Pub. L. 100–12) included amendments to EPCA that established the original energy conservation standards for central air conditioners and heat pumps. (42 U.S.C. 6295(d)(1)–(2)) EPCA, as amended, also requires DOE to conduct two cycles of rulemakings to determine whether to amend the energy conservation standards for central air conditioners and heat pumps. (42 U.S.C. 6295(d)(3)) The first cycle culminated in a final rule published in the **Federal Register** on August 17, 2004 (the August 2004 Rule), which prescribed energy conservation standards for central air conditioners and heat pumps manufactured or imported on and after January 23, 2006. 69 FR 50997. DOE completed the second of the two rulemaking cycles by publishing a direct final rule on June 27, 2011 (2011 Direct Final Rule). 76 FR 37414. The 2011 Direct Final Rule (2011 DFR) amended standards for central air conditioners and heat pumps manufactured on or after January 1, 2015.

EPCA requires DOE to periodically review its already established energy conservation standards for a covered product. Not later than six years after issuance of any final rule establishing or amending a standard, DOE must publish a notice of determination that standards for the product do not need to be amended, or a notice of proposed rulemaking including new proposed standards. (42 U.S.C. 6295(m)(1)) Pursuant to this requirement, the next review that DOE would need to conduct must occur no later than six years from the issuance of the 2011 direct final rule. This direct final rule fulfills that requirement.

3. Description and Estimated Number of Small Entities Regulated

a. Methodology for Estimating the Number of Small Entities

For manufacturers of residential central air conditioners and heat pumps, the Small Business Administration (SBA) has set a size threshold, which defines those entities classified as ''small businesses'' for the purposes of the statute. DOE used the SBA's small business size standards to determine whether any small entities would be subject to the requirements of this rule. The size standards are codified at 13 CFR part 121. The standards are listed by North American Industry Classification System (NAICS) code and industry description and are available at: *http://www.sba.gov/sites/default/files/files/Size_Standards_Table.pdf.*

Residential central air conditioner and heat pump manufacturing is classified under NAICS 333415, ''Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing.'' The SBA sets a threshold of 1,250 employees or fewer for an entity to be considered a small business for this category.

DOE reviewed the potential standard levels considered in today's direct final rule under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. During its market survey, DOE used publicly available information to identify small manufacturers. DOE's research involved industry trade association membership directories (*e.g.,* AHRI), information from previous rulemakings, individual company Web sites, and market research tools (*e.g.,* Hoover's reports) to create a list of companies that manufacture or sell central air conditioner and heat pump products covered by this rulemaking. DOE also asked stakeholders and industry representatives if they were aware of any additional small manufacturers during manufacturer interviews. DOE reviewed publicly available data and contacted various companies on its complete list of manufacturers to determine whether they met the SBA's definition of a small business manufacturer. DOE screened out companies that do not offer products impacted by this rulemaking, do not meet the definition of a ''small business,'' exclusively rebrand and distribute products manufactured by others, or are foreign owned and operated.

DOE identified 30 manufacturers of central air conditioner and heat pump products affected by this direct final rule. Of these, DOE identified three as domestic small businesses.

b. Manufacturer Participation

DOE contacted the identified small businesses to invite them to take part in a manufacturer impact analysis interview. DOE was able to reach and discuss potential standards with one small business. DOE also obtained information about small businesses and potential impacts on small businesses while interviewing large manufacturers.

c. Residential Central Air Conditioner and Heat Pump Industry Structure and Nature of Competition

Seven large manufacturers supply over 95 percent of the market for central air conditioners and heat pumps. Of the three domestic small businesses identified, DOE's research indicates that all three are independent coil manufacturers (ICMs). DOE defines an ICM as a manufacturer of indoor units that does not manufacture single-package units or outdoor units. ICMs match their indoor evaporators or air handlers with condensing units from original equipment manufacturers (OEMs). For the purpose of this rulemaking, DOE did not identify any domestic small businesses that are OEMs of central air conditioner and heat pump products impacted by this direct final rule.

4. Description and Estimate of Compliance Requirements

As discussed in section 2.a, manufacturers of central air conditioners and heat pumps may incur conversion costs to bring their manufacturing facilities and product designs into compliance with amended standards. Because DOE did not identify any small business OEMs of products impacted by this direct final rule, the following discussion of small business impacts focuses on the potential impacts facing small business ICMs. Like OEMs, ICMs operate factories and equipment and, accordingly, would be responsible for updating manufacturing practices to ensure products comply with amended energy conservation standards.

To evaluate impacts facing small ICMs, DOE used data from its engineering analysis and product teardown analysis to estimate investments in equipment and tooling that ICMs may incur as a result of this direct final rule. Indoor coils do not have SEER ratings on their own because they are a component of split-systems. Consequently, their rated efficiency depends on their interaction with the outdoor units with which they are paired. Generally, all else being equal, split-systems with larger indoor coils will be more efficient because the indoor coil has a larger heat transfer surface area. Accordingly, DOE estimated investments in equipment and tooling ICMs may make in response to this direct final rule to increase the heat transfer surface area of their indoor coils and, in turn, increase the overall efficiency of split-systems. DOE used the least-cost coil-only units from its engineering analysis to determine the typical size of indoor coil used by manufacturers at each efficiency level analyzed. DOE then estimated potential capital conversion costs (*i.e.,* investments in equipment and tooling) small ICMs would make to meet the recommended level. Focusing on equipment and tooling used to manufacture heat exchangers and outdoor cases, DOE estimated capital conversion costs of $2.3 million per small ICM. Using assumptions outlined in section 2.a and in chapter 12 of the direct final rule TSD, DOE calculated product conversion costs (*i.e.,* R&D expenditures) as 40 percent of total conversion costs, or $1.5 million per small ICM. This equates to total estimated conversion costs of $3.8 million per small ICM.

Using publicly available data, DOE estimated the average annual revenue of the three small ICMs to be $29.7 million. As negotiated by the CAC/HP Working Group, this direct final rule will not take effect until 2023. DOE therefore expects ICMs will be able to spread their conversion costs over the six-year period between publication of this direct final rule and the compliance year. Given these assumptions, DOE estimates total conversion costs resulting from this direct final rule to be 2.2 percent of small ICMs' six-year revenues.

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

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

6. Significant Alternatives to the Rule

The discussion in the previous section analyzes impacts on small businesses that would result from the recommended standards, represented by TSL 2. In reviewing alternatives to the adopted standards, DOE examined energy conservation standards set at both lower and higher efficiency levels than those recommended in this direct final rule. TSL 1 would establish less stringent efficiency levels, potentially reducing impacts on small business manufacturers. However, it would come at the expense of a reduction in energy savings. Where TSL 2 is projected to save 3.2 quads of energy, TSL 1 would save only 1.3 quads of energy, or 41% of the savings achieved at TSL 2. In addition to TSL 1, DOE examined more stringent efficiency levels at TSLs 3 and 4. These levels would achieve significantly higher energy savings of 8.6 and 14.2 quads respectively; however, the financial burden facing manufacturers, including small businesses, would also be more severe at these levels. (See section V.B.2.a for a more detailed discussion of financial impacts facing manufacturers at each TSL.) DOE believes that establishing standards at the recommended level, TSL 2, balances the benefits of energy savings with the potential burdens placed on manufacturers of covered products, including small business manufacturers. Accordingly, DOE is not adopting one of the other TSLs considered in the analysis, or the other policy alternatives examined as part of the regulatory impact analysis and included in chapter 17 of the direct final rule TSD.

Additional compliance flexibilities for small business manufacturers may be available through other means. For example, individual manufacturers may petition for a waiver of the applicable test procedure. (See 10 CFR 431.401) Further, EPCA provides that a manufacturer whose annual gross revenue from all of its operations does not exceed $8 million may apply for an exemption from all or part of an energy conservation standard for a period not longer than 24 months after the effective date of a final rule establishing the standard. Additionally, Section 504 of the Department of Energy Organization Act, 42 U.S.C. 7194, provides authority for the Secretary to adjust a rule issued under EPCA in order to prevent ''special hardship, inequity, or unfair distribution of burdens'' that may be imposed on that manufacturer as a result of such rule. Manufacturers should refer to 10 CFR part 430, subpart E, and Part 1003 for additional details.

C. Review Under the Paperwork Reduction Act

Manufacturers of central air conditioners and heat pumps must certify to DOE that their products comply with any applicable energy conservation standards. In certifying compliance, manufacturers must test their products according to the DOE test procedures for central air conditioners and heat pumps, including any amendments adopted for those test procedures. DOE has established regulations for the certification and recordkeeping requirements for all covered consumer products and commercial equipment, including central air conditioners and heat pumps. 76 FR 12422 (March 7, 2011); 80 FR 5099 (January 30, 2015). The collection-of-information requirement for the certification and recordkeeping is subject to review and approval by OMB under the Paperwork Reduction Act (PRA). This requirement has been approved by OMB under OMB control number 1910–1400. Public reporting burden for the certification is estimated to average 30 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

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

D. Review Under the National Environmental Policy Act of 1969

Pursuant to the National Environmental Policy Act (NEPA) of 1969, DOE has determined that this direct final rule fits within the category of actions included in Categorical Exclusion (CX) B5.1 and otherwise meets the requirements for application of a CX. See 10 CFR part 1021, App. B, B5.1(b); 1021.410(b) and Appendix B, B(1)–(5). The proposed rule fits within the category of actions because it is a rulemaking that establishes energy conservation standards for consumer products or industrial equipment, and for which none of the exceptions identified in CX B5.1(b) apply. Therefore, DOE has made a CX determination for this rulemaking, and DOE does not need to prepare an Environmental Assessment or Environmental Impact Statement for this proposed rule. DOE's CX determination for this rule is available at *http://cxnepa.energy.gov/.*

E. Review Under Executive Order 13132

Executive Order 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 products that are the subject of this rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297) Therefore, no further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of Executive Order 12988, ''Civil Justice Reform,'' imposes on Federal agencies the general duty to adhere to the following requirements: (1) Eliminate drafting errors and ambiguity; (2) write regulations to minimize litigation; (3) provide a clear legal standard for affected conduct rather than a general standard; and (4) promote simplification and burden reduction. 61 FR 4729 (February 7, 1996). Regarding the review required by section 3(a), section 3(b) of Executive Order 12988 specifically requires that Executive agencies make every reasonable effort to ensure that the regulation: (1) Clearly specifies the preemptive effect, if any; (2) clearly specifies any effect on existing Federal law or regulation; (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction; (4) specifies the retroactive effect, if any; (5) adequately defines key terms; and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of Executive Order 12988 requires Executive agencies to review regulations in light of applicable standards in section 3(a) and section 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, this rule meets the relevant standards of Executive Order 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 *http://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 by the private sector. Such expenditures may include: (1) Investment in research and development and in capital expenditures by central air conditioner and heat pump manufacturers in the years between the final rule and the compliance date for the new standards, and (2) incremental additional expenditures by consumers to purchase higher-efficiency central air conditioners and heat pumps, 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 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 chapter 17 of the TSD for this rule respond to those requirements.

Under section 205 of UMRA, the Department is obligated to identify and consider a reasonable number of regulatory alternatives before promulgating a rule for which a written statement under section 202 is required. (2 U.S.C. 1535(a)) DOE is required to select from those alternatives the most cost-effective and least burdensome alternative that achieves the objectives of the rule unless DOE publishes an explanation for doing otherwise, or the selection of such an alternative is inconsistent with law. In accordance with the statutory provisions discussed in this document, this rule would establish amended energy conservation standards for central air conditioners and heat pumps that are designed to achieve the maximum improvement in energy efficiency that DOE has determined to be both technologically feasible and economically justified. A full discussion of the alternatives considered by DOE is presented in chapter 17 of the TSD for this 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 Executive Order 12630, ''Governmental Actions and Interference with Constitutionally Protected Property Rights,'' 53 FR 8859 (March 15, 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 (February 22, 2002), and DOE's guidelines were published at 67 FR 62446 (October 7, 2002). 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

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

DOE has concluded that this regulatory action, which adopts amended energy conservation standards for central air conditioners and heat pumps, 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 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 (January 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.'' *Id.* at FR 2667.

In response to OMB's Bulletin, DOE conducted formal in-progress peer reviews of the energy conservation standards development process and analyses and has prepared a Peer Review Report pertaining to the energy conservation standards rulemaking analyses. 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. The ''Energy Conservation Standards Rulemaking Peer Review Report'' dated February 2007 has been disseminated and is available at the following Web site: *www1.eere.energy.gov/buildings/appliance_standards/peer_review.html.*

M. Congressional Notification

As required by 5 U.S.C. 801, DOE will report to Congress on the promulgation of this direct final rule prior to its effective date. The report will state that it has been determined that the rule is a ''major rule'' as defined by 5 U.S.C. 804(2). DOE also will submit the supporting analyses to the Comptroller General in the U.S. Government Accountability Office (''GAO'') and make them available to each House of Congress.

VII. Approval of the Office of the Secretary

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

List of Subjects in 10 CFR Part 430

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

Issued in Washington, DC, on December 5, 2016.

David J. Friedman,

Acting Assistant Secretary, Energy Efficiency and Renewable Energy.

For the reasons set forth in the preamble, DOE is amending part 430 of chapter II, subchapter D, of title 10 of the Code of Federal Regulations, as set forth below:

PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

■ 1. The authority citation for part 430 continues to read as follows:

Authority: 42 U.S.C. 6291–6309; 28 U.S.C. 2461 note.

■ 2. Section 430.32 is amended by revising paragraphs (c)(1) through (3) and adding paragraphs (c)(5) and (6) to read as follows:

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

* * * * *

(c) *Central air conditioners and heat pumps.* The energy conservation standards defined in terms of the heating seasonal performance factor are based on Region IV, the minimum standardized design heating requirement, and the provisions of 10 CFR 429.16. (1) Central air conditioners and central air conditioning heat pumps manufactured on or after January 1, 2015, and before January 1, 2023, must have Seasonal Energy Efficiency Ratio and Heating Seasonal Performance Factor not less than:

Product class	Seasonal energy efficiency ratio (SEER)	Heating seasonal performance factor (HSPF)
(i) Split systems—air conditioners	13	
(ii) Split systems—heat pumps	14	8.2
(iii) Single package units—air conditioners	14	
(iv) Single package units—heat pumps	14	8.0
(v) Small-duct, high-velocity systems	12	7.2
(vi)(A) Space-constrained products—air conditioners	12	
(vi)(B) Space-constrained products—heat pumps	12	7.4

(2) In addition to meeting the applicable requirements in paragraph (c)(1) of this section, products in product class (i) of paragraph (c)(1) of this section (*i.e.,* split-systems—air conditioners) that are installed on or after January 1, 2015, and before January 1, 2023, in the States of Alabama, Arkansas, Delaware, Florida, Georgia, Hawaii, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, or Virginia, or in the District of Columbia, must have a Seasonal Energy Efficiency Ratio (SEER) of 14 or higher. Any outdoor unit model that has a certified combination with a rating below 14 SEER cannot be installed in these States. The least efficient combination of each basic model must comply with this standard.

(3)(i) In addition to meeting the applicable requirements in paragraph (c)(1) of this section, products in product classes (i) and (iii) of paragraph (c)(1) of this section (*i.e.,* split systems—air conditioners and single-package units—air conditioners) that are installed on or after January 1, 2015, and before January 1, 2023, in the States of Arizona, California, Nevada, or New Mexico must have a Seasonal Energy Efficiency Ratio (SEER) of 14 or higher and have an Energy Efficiency Ratio (EER) (at a standard rating of 95 °F dry bulb outdoor temperature) not less than the following:

Product class	Energy efficiency ratio (EER)
(i) Split systems—air conditioners with rated cooling capacity less than 45,000 Btu/hr	12.2
(ii) Split systems—air conditioners with rated cooling capacity equal to or greater than 45,000 Btu/hr	11.7
(iii) Single-package units—air conditioners	11.0

(ii) Any outdoor unit model that has a certified combination with a rating below 14 SEER or the applicable EER cannot be installed in this region. The least-efficient combination of each basic model must comply with this standard.

* * * * *

(5) Central air conditioners and central air conditioning heat pumps manufactured on or after January 1, 2023, must have a Seasonal Energy Efficiency Ratio 2 and a Heating Seasonal Performance Factor 2 not less than:

Product class	Seasonal energy efficiency ratio 2 (SEER2)	Heating seasonal performance factor 2 (HSPF2)
(i)(A) Split systems—air conditioners with a certified cooling capacity less than 45,000 Btu/hr	13.4	
(i)(B) Split systems—air conditioners with a certified cooling capacity equal to or greater than 45,000 Btu/hr	13.4	
(ii) Split systems—heat pumps	14.3	7.5
(iii) Single-package units—air conditioners	13.4	

Product class	Seasonal energy efficiency ratio 2 (SEER2)	Heating seasonal performance factor 2 (HSPF2)
(iv) Single-package units—heat pumps	13.4	6.7
(v) Small-duct, high-velocity systems	12	6.1
(vi)(A) Space-constrained products—air conditioners	11.7	
(vi)(B) Space-constrained products—heat pumps	11.9	6.3

(6)(i) In addition to meeting the applicable requirements in paragraph (c)(5) of this section, products in product classes (i) and (iii) of paragraph (c)(5) of this section (*i.e.,* split systems—air conditioners and single-package units—air conditioners) that are installed on or after January 1, 2023, in the southeast or southwest must have a Seasonal Energy Efficiency Ratio 2 and a Energy Efficiency Ratio 2 not less than:

Product class	Southeast *	Southwest **	
	SEER2	SEER2	EER2 ***
(i)(A) Split-systems—air conditioners with a certified cooling capacity less than 45,000 Btu/hr	14.3	14.3	11.7/9.8 †
(i)(B) Split-systems—air conditioners with a certified cooling capacity equal to or greater than 45,000 Btu/hr	13.8	13.8	11.2/9.8 ††
(iii) Single-package units—air conditioners			10.6

* "Southeast" includes the States of Alabama, Arkansas, Delaware, Florida, Georgia, Hawaii, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, Puerto Rico, South Carolina, Tennessee, Texas, Virginia, the District of Columbia, and the U.S. Territories.

** "Southwest" includes the States of Arizona, California, Nevada, and New Mexico.

*** EER refers to the energy efficiency ratio at a standard rating of 95 °F dry bulb outdoor temperature.

† The 11.7 EER2 standard applies to products with a certified SEER2 less than 15.2. The 9.8 EER2 standard applies to products with a certified SEER2 greater than or equal to 15.2.

†† The 11.2 EER2 standard applies to products with a certified SEER2 less than 15.2. The 9.8 EER2 standard applies to products with a certified SEER2 greater than or equal to 15.2.

(ii) Any outdoor unit model that has a certified combination with a rating below the applicable standard level(s) for a region cannot be installed in that region. The least-efficient combination of each basic model must comply with this standard.

* * * * *

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