UNITED STATES COURT OF APPEALS
FOR THE DISTRICT OF COLUMBIA CIRCUIT

American Public Gas Association,	)	
	)	
Petitioner,	)	
	)	
v.	)	**No.** 20-1068
	)	
U.S. Department of Energy,	)	
	)	
Respondent.	)	

PETITION FOR REVIEW

Pursuant to Section 336 of the Energy Policy and Conservation Act of 1975, 42 U.S.C. § 6306(b)(1), and Rule 15(a) of the Federal Rules of Appellate Procedure, the American Public Gas Association hereby respectfully petitions this Court to review a final rule which was promulgated by the United States Department of Energy in a proceeding entitled "Energy Conservation Program: Energy Conservation Standards for Commercial Packaged Boilers" and published in the Federal Register at 85 Fed. Reg. 1592 (Jan. 10, 2020). A copy of the final rule is attached as Exhibit A.

Respectfully submitted,

/s/ John P. Gregg

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Attorneys for Petitioner, American Public Gas Association

Dated: March 9, 2020

UNITED STATES COURT OF APPEALS
FOR THE DISTRICT OF COLUMBIA CIRCUIT

American Public Gas Association,	)	
	)	
Petitioner,	)	
	)	
v.	)	**No. __________**
	)	
U.S. Department of Energy,	)	
	)	
Respondent.	)	

DISCLOSURE STATEMENT OF
AMERICAN PUBLIC GAS ASSOCIATION, LLC

Pursuant to Rule 26.1 of the Federal Rules of Appellate Procedure and Circuit Rule 26.1 of the United States Court of Appeals for the District of Columbia Circuit, the American Public Gas Association ("APGA") hereby files its disclosure statement in the above-captioned proceeding.

APGA is a non-profit, non-stock corporation organized and existing under the laws of the District of Columbia, and has its principal place of business at 201 Massachusetts Avenue, NE, Suite C-4, Washington, D.C. 20002. APGA is the national, non-profit association of publicly-owned natural gas distribution systems, with over 700 members in 36 states. APGA promotes and advances the interests of publicly-owned gas systems, including municipal gas distribution systems, public utility districts, county districts, and other public agencies that have natural gas distribution facilities.

APGA is a trade association within the meaning of Local Rule 26.1(b) and thus is exempt from the requirement to list the names of its members that have issued shares or debt securities to the public.

Respectfully submitted,

/s/ John P. Gregg

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Attorneys for Petitioner, American Public Gas Association

Dated: March 9, 2020

CERTIFICATE OF SERVICE

I certify that I caused a copy of the foregoing Petition for Review and Disclosure Statement pursuant to Circuit Rule 15 to be mailed today, March 9, 2020, by certified mail, return receipt requested, to:

Hon. Dan Brouillette
Secretary
U.S. Department of Energy
1000 Independence Ave., SW
Washington, D.C. 20585

Office of the General Counsel
U.S. Department of Energy
1000 Independence Ave., SW
Washington, D.C. 20585

William P. Barr
Attorney General
U.S. Department of Justice
950 Pennsylvania Ave., NW
Washington, D.C. 20530

/s/ William C. Simmerson
William C. Simmerson

Dated: March 9, 2020

Exhibit A

Petroleum Institute standard 619, ''Rotary-Type Positive-Displacement Compressors for Petroleum, Petrochemical, and Natural Gas Industries,''

(8) Has full-load actual volume flow rate greater than or equal to 35 cubic feet per minute (cfm), or is distributed in commerce with a compressor motor nominal horsepower greater than or equal to 10 horsepower (hp),

(9) Has a full-load actual volume flow rate less than or equal to 1,250 cfm, or is distributed in commerce with a compressor motor nominal horsepower less than or equal to 200 hp,

(10) Is driven by a three-phase electric motor,

(11) Is manufactured alone or as a component of another piece of equipment; and

(12) Is in one of the equipment classes listed in the Table 1, must have a full-load package isentropic efficiency or part-load package isentropic efficiency that is not less than the appropriate ''Minimum Package Isentropic Efficiency'' value listed in Table 1 of this section.

TABLE 1—ENERGY CONSERVATION STANDARDS FOR CERTAIN COMPRESSORS

Equipment class	Minimum package isentropic efficiency	η_{Regr} (package isentropic efficiency reference curve)	d (percentage loss reduction)
Rotary, lubricated, air-cooled, fixed-speed compressor.	$\eta_{Regr} + (1 - \eta_{Regr})$ * (d/100)	$-0.00928 * \ln^2(.4719 * V_1) + 0.13911 * \ln(.4719 * V_1) + 0.27110$.	−15
Rotary, lubricated, air-cooled, variable-speed compressor.	$\eta_{Regr} + (1 - \eta_{Regr})$ * (d/100)	$-0.01549 * \ln^2(.4719 * V_1) + 0.21573 * \ln(.4719 * V_1) + 0.00905$.	−10
Rotary, lubricated, liquid-cooled, fixed-speed compressor.	$.02349 + \eta_{Regr} + (1 - \eta_{Regr})$ * (d/100)	$-0.00928 * \ln^2(.4719 * V_1) + 0.13911 * \ln(.4719 * V_1) + 0.27110$.	−15
Rotary, lubricated, liquid-cooled, variable-speed compressor.	$.02349 + \eta_{Regr} + (1 - \eta_{Regr})$ * (d/100)	$-0.01549 * \ln^2(.4719 * V_1) + 0.21573 * \ln(.4719 * V_1) + 0.00905$.	−15

(b) Instructions for the use of Table 1 of this section:

(1) To determine the standard level a compressor must meet, the correct equipment class must be identified. The descriptions are in the first column (''Equipment Class''); definitions for these descriptions are found in § 431.342.

(2) The second column (''Minimum Package Isentropic Efficiency'') contains the applicable energy conservation standard level, provided in terms of package isentropic efficiency.

(3) For ''Fixed-speed compressor'' equipment classes, the relevant Package Isentropic Efficiency is Full-load Package Isentropic Efficiency. For ''Variable-speed compressor'' equipment classes, the relevant Package Isentropic Efficiency is Part-load Package Isentropic Efficiency. Both Full- and Part-load Package Isentropic Efficiency are determined in accordance with the test procedure in § 431.344.

(4) The second column (''Minimum Package Isentropic Efficiency'') references the third column (''η_{Regr}''), also a function of full-load actual volume flow rate, and the fourth column (''d''). The equations are provided separately to maintain consistency with the language of the preamble and analysis.

(5) The second and third columns contain the term V_1, which denotes compressor full-load actual volume flow rate, given in terms of cubic feet per minute (''cfm'') and determined in accordance with the test procedure in § 431.344.

Note: The following letter will not appear in the Code of Federal Regulations.

U.S. Department of Justice, Antitrust Division.

Renata B. Hesse,

Acting Assistant Attorney General.

Main Justice Building, 950 Pennsylvania Avenue NW, Washington, DC 20530–0001, (202) 514–2401/(202) 616–2645 (Fax)

July 18, 2016

Anne Harkavy,
Deputy General Counsel for Litigation, Regulation and Enforcement, U.S. Department of Energy, Washington, DC 20585

Re: Energy Conservation Standards for Compressors; Doc. No. EERE–2013–BT–STD–0040

Dear Deputy General Counsel Harkavy:

I am responding to your May 19, 2016, letter seeking the views of the Attorney General about the potential impact on competition of proposed energy conservation standards for compressors. Your request was submitted under Section 325(o)(2)(B)(i)(V) of the Energy Policy and Conservation Act, as amended (ECPA), 42 U.S.C. 6295(o)(2)(B)(i)(V), which requires the Attorney General to make a determination of the impact of any lessening of competition that is likely to result from the imposition of proposed energy conservation standards. The Attorney General's responsibility for responding to requests from other departments about the effect of a program on competition has been delegated to the head of the Antitrust Division in 28 CFR 0.40(g).

In conducting its analysis, the Antitrust Division examines whether a proposed standard may lessen competition, for example, by substantially limiting consumer choice or increasing industry concentration. A lessening of competition could result in higher prices to manufacturers and consumers.

We have reviewed the proposed standards contained in the Notice of Proposed Rulemaking (81 FR 31680, May 19, 2016) and the related technical support documents. We have also reviewed supplementary information submitted to the Attorney General by the Department of Energy, as well as materials presented at the public meeting held on the proposed standards on June 20, 2016, and conducted interviews with industry members.

Based on the information currently available, we do not believe that the proposed energy conservation standards for compressors are likely to have a significant adverse impact on competition.

Sincerely,

Renata B. Hesse

[FR Doc. 2019–26355 Filed 1–9–20; 8:45 am]

BILLING CODE 6450–01–P

DEPARTMENT OF ENERGY

10 CFR Part 431

[Docket Number EERE–2013–BT–STD–0030]

RIN 1904–AD01

Energy Conservation Program: Energy Conservation Standards for Commercial Packaged Boilers

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

ACTION: Final rule.

SUMMARY: The Energy Policy and Conservation Act of 1975 (EPCA), as amended, prescribes energy

conservation standards for various consumer equipment and certain commercial and industrial equipment, including commercial packaged boilers (CPBs). EPCA also requires the U.S. Department of Energy (DOE) to periodically review standards. In this final rule, DOE is adopting more-stringent energy conservation standards for certain commercial packaged boilers.

DATES: The effective date of this rule is March 10, 2020. Compliance with the amended standards established for commercial packaged boilers in this final rule is required on and after January 10, 2023.

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

The docket web page can be found at *www.regulations.gov/docket?D=EERE-2013-BT-STD-0030.* The docket web page contains simple instructions on how to access all documents, including public comments, in the docket.

For further information on how to review the docket, contact the Appliance and Equipment Standards Program staff at (202) 586–6636 or by email: *ApplianceStandardsQuestions@ee.doe.gov.*

FOR FURTHER INFORMATION CONTACT:

Mr. James Raba, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, EE–5B, 1000 Independence Avenue SW, Washington, DC 20585–0121. Telephone: (202) 586–8654. Email: *ApplianceStandardsQuestions@ee.doe.gov.*

Mr. Peter Cochran, U.S. Department of Energy, Office of the General Counsel, GC–33, 1000 Independence Avenue SW, Washington, DC 20585–0121. Telephone: (202) 586–9496. Email: *Peter.Cochran@hq.doe.gov.*

SUPPLEMENTARY INFORMATION:

Table of Contents

I. Synopsis of the Final Rule

Title III of the Energy Policy and Conservation Act of 1975 (42 U.S.C. 6291, *et seq;* ''EPCA''), Public Law 94–163, sets forth a variety of provisions designed to improve energy efficiency. Part C of Title III, which for editorial reasons was re-designated as Part A–1 upon incorporation into the U.S. Code (42 U.S.C. 6311–6317, as codified), establishes the ''Energy Conservation Program for Certain Industrial Equipment,'' which includes commercial packaged boilers (CPBs), the subject of this rulemaking.[1] (42 U.S.C. 6311(1)(J))

EPCA requires DOE to conduct an evaluation of its standards for CPB equipment every 6 years and to publish either a notice of determination that such standards do not need to be amended or a notice of proposed rulemaking (NOPR) including new proposed standards. (42 U.S.C. 6313(a)(6)(C)(i)) This final rule satisfies DOE's statutory obligation under 42 U.S.C. 6313(a)(6)(C).

In accordance with these and other statutory requirements discussed in this document, DOE is adopting amended energy conservation standards for commercial packaged boilers. DOE has examined the existing CPB standards and concludes that modifying and expanding the existing 10 CPB equipment classes to 12 equipment classes is warranted. As discussed in detail in section IV.A.3 of this document, DOE opted to: (1) Discontinue the use of draft type as a criterion for equipment classes; and (2) establish separate equipment classes for ''very large'' commercial packaged boilers. Eliminating the use of draft type as a distinguishing feature for equipment classes consolidated the 4 existing draft-specific equipment classes into 2 non-draft-specific equipment classes, while adding very large commercial packaged boilers as separate equipment classes resulted in an additional 4 equipment classes. As a result, the total number of equipment classes has increased from 10 to 12. DOE is adopting more stringent standards for 8 of the 12 equipment classes in this final rule, which includes all classes except for the newly adopted very large CPB classes. The amended standards, which prescribe minimum thermal efficiencies (E_T) or combustion efficiencies (E_C), as applicable, are shown in Table I.1. These amended standards apply to all equipment listed in Table I.1 and manufactured in, or imported into, the United States on and after the compliance dates in Table I.1.

TABLE I.1—ENERGY CONSERVATION STANDARDS FOR COMMERCIAL PACKAGED BOILERS

Equipment	Size category (input)	Energy conservation standard *	Compliance date †
Small Gas-Fired Hot Water Commercial Packaged Boilers	≥300,000 Btu/h and ≤2,500,000 Btu/h	84.0% E_T	January 10, 2023.
Large Gas-Fired Hot Water Commercial Packaged Boilers	>2,500,000 Btu/h and ≤10,000,000 Btu/h	85.0% E_C	January 10, 2023.
Very Large Gas-Fired Hot Water Commercial Packaged Boilers	>10,000,000 Btu/h	82.0% E_C	March 2, 2012.
Small Oil-Fired Hot Water Commercial Packaged Boilers	≥300,000 Btu/h and ≤2,500,000 Btu/h	87.0% E_T	January 10, 2023.
Large Oil-Fired Hot Water Commercial Packaged Boilers	>2,500,000 Btu/h and ≤10,000,000 Btu/h	88.0% E_C	January 10, 2023.
Very Large Oil-Fired Hot Water Commercial Packaged Boilers	>10,000,000 Btu/h	84.0% E_C	March 2, 2012.
Small Gas-Fired Steam Commercial Packaged Boilers	≥300,000 Btu/h and ≤2,500,000 Btu/h	81.0% E_T	January 10, 2023.
Large Gas-Fired Steam Commercial Packaged Boilers	>2,500,000 Btu/h and ≤10,000,000 Btu/h	82.0% E_T	January 10, 2023.
Very Large Gas-Fired Steam Commercial Packaged Boilers **	>10,000,000 Btu/h	79.0% E_T	March 2, 2012.
Small Oil-Fired Steam Commercial Packaged Boilers	≥300,000 Btu/h and ≤2,500,000 Btu/h	84.0% E_T	January 10, 2023.
Large Oil-Fired Steam Commercial Packaged Boilers	>2,500,000 Btu/h and ≤10,000,000 Btu/h	85.0% E_T	January 10, 2023.
Very Large Oil-Fired Steam Commercial Packaged Boilers	>10,000,000 Btu/h	81.0% E_T	March 2, 2012.

* E_T means ''thermal efficiency.'' E_C means ''combustion efficiency.''
** Prior to March 2, 2022, for natural draft very large gas-fired steam commercial packaged boilers, a minimum thermal efficiency level of 77% is permitted and meets Federal commercial packaged boiler energy conservation standards.
† For very large CPB equipment classes DOE is not amending the existing standards, which had a compliance date of March 2, 2012, as shown.

A. Benefits and Costs to Consumers

Table I.2 summarizes DOE's evaluation of the economic impacts of the adopted energy conservation standards on consumers of commercial packaged boilers, as measured by the average life-cycle cost (LCC) savings and the simple payback period (PBP).[2] The average LCC savings are positive for all equipment classes, and the PBP is less than the average lifetime of the equipment, which is estimated to be 24.8 years for all equipment classes evaluated in this final rule.

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

[2] The average LCC savings refer to consumers that are affected by a standard and are measured relative to the no-new-standards case efficiency distribution, which depicts the CPB market in the compliance year in the absence of amended standard levels (see section IV.F.9 of this document and chapter 8 of the final rule technical support document (TSD)). The simple PBP, which is designed to compare specific efficiency levels for commercial packaged boilers, is measured relative to the baseline CPB equipment (see section IV.F.10 of this document and chapter 8 of the TSD).

TABLE I.2—IMPACTS OF ADOPTED ENERGY CONSERVATION STANDARDS ON CONSUMERS OF COMMERCIAL PACKAGED BOILERS

Equipment class	Average LCC savings (2015$)	Simple payback period (years)
Small Gas-Fired Hot Water	$212	10.1
Large Gas-Fired Hot Water	2,037	7.0
Small Oil-Fired Hot Water	14,421	4.1
Large Oil-Fired Hot Water	31,379	4.8
Small Gas-Fired Steam	1,002	10.1
Large Gas-fired Steam	11,188	4.2
Small Oil-fired Steam	5,839	4.0
Large Oil-Fired Steam	36,832	2.7

DOE's analysis of the impacts of the amended standards on consumers is described in section IV.F of this document and in chapter 8 of the final rule technical support document (TSD).

B. Impact on Manufacturers

The industry net present value (INPV) is the sum of the discounted cash flows to the industry from the reference year through the end of the analysis period (2016 to 2049). Using a real discount rate of 9.5 percent,[3] DOE estimates that the INPV for manufacturers of commercial packaged boilers in the case without amended standards is $277.6 million in 2015$. Under amended standards, DOE expects the change in INPV to range from approximately −6.7 to −3.7 percent, which corresponds to approximately −$18.5 to −$10.3 million (in 2015$). In order to bring equipment into compliance with amended standards, DOE expects the industry to incur $21.2 million in conversion costs.

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

C. National Benefits and Costs[4]

DOE's analyses indicate that the adopted standards would save a significant amount of energy. The lifetime energy savings for commercial packaged boilers purchased in the 30-year period that begins in the anticipated first full year of compliance with amended standards (2020–2049), relative to the case without amended standards (referred to as the ''no-new-standards case''), amount to 0.27 quadrillion Btu (quad).[5] This represents a savings of 0.6 percent relative to the energy use of this equipment in the no-new-standards case.[6]

The cumulative net present value (NPV) of total consumer benefits of the amended standards for commercial packaged boilers ranges from $0.558 billion (at a 7-percent discount rate) to $1.977 billion (at a 3-percent discount rate). This NPV expresses the estimated total value of future operating-cost savings minus the estimated increased equipment and installation costs for commercial packaged boilers purchased in 2020–2049.

In addition, the adopted CPB standards are projected to yield significant environmental benefits. The energy savings described in this section are estimated to result in cumulative emission reductions (over the same period as for energy savings) of 16 million metric tons (Mt)[7] of carbon dioxide (CO_2), 139 thousand tons of methane (CH_4), 3.1 thousand tons of sulfur dioxide (SO_2), 41 thousand tons of nitrogen oxides (NO_X), 0.1 thousand tons of nitrous oxide (N_2O), and 0.0003 tons of mercury (Hg).[8] The estimated cumulative reduction in CO_2 emissions through 2030 amounts to 1.58 Mt, which is equivalent to the emissions resulting from the annual electricity use of 0.233 million homes.

[3] DOE estimated draft financial metrics, including the industry discount rate, based on data from Securities and Exchange Commission (SEC) filings. DOE presented the draft financial metrics to manufacturers in MIA interviews and adjusted those values based on feedback from industry. The complete set of financial metrics and more detail about the methodology can be found in section 12.4.3 of chapter 12 of the TSD.

[4] All monetary values in this section are expressed in 2015 dollars and, where appropriate, are discounted to 2016.

[5] A quad is equal to 10^{15} British thermal units (Btu). The quantity refers to full-fuel-cycle (FFC) energy savings. FFC energy savings include the energy consumed in extracting, processing, and transporting primary fuels (*i.e.,* coal, natural gas, petroleum fuels), and thus present a more complete picture of the impacts of energy efficiency standards. For more information on the FFC metric, see section IV.H.2 of this document.

[6] The no-new-standards case assumptions are described in section IV.F.9 of this document.

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

[8] DOE calculated emissions reductions relative to the no-new-standards-case, which reflects key assumptions in the *Annual Energy Outlook 2016* (*AEO2016*). *AEO2016* represents current federal and state legislation and final implementation of regulations as of the end of February 2016.

The value of the CO_2 reductions is calculated using a range of values per metric ton (t) of CO_2 (otherwise known as the ''social cost of CO_2,'' or SCC) developed by a Federal interagency working group.[9] The derivation of the SCC values is discussed in section IV.L.1 of this document. Using discount rates appropriate for each set of SCC values (see Table I.3), DOE estimates the present value of the CO_2 emissions reduction is between $0.1 billion and $1.5 billion, with a value of $0.48 billion using the central SCC case represented by $40.6 per metric ton in 2015.[10] DOE also estimates the present monetary value of the NO_X emissions reduction is $0.35 billion at a 7-percent discount rate and $0.99 billion at a 3-percent discount rate.[11] DOE is investigating appropriate valuation of the reduction in other emissions and did not include any such values in this rulemaking. More detailed results can be found in chapter 14 of the final rule TSD.

Table I.3 summarizes the national economic benefits and costs expected to result from the adopted standards for commercial packaged boilers.

TABLE I.3—SELECTED CATEGORIES OF NATIONAL ECONOMIC BENEFITS AND COSTS OF ENERGY CONSERVATION STANDARDS FOR COMMERCIAL PACKAGED BOILERS

[TSL 2 *]

Category	Present value (million 2015$)	Discount rate (%)
Benefits		
Operating Cost Savings	907	7
	2,585	3
CO_2 Reduction Monetized Value (using mean SCC at 5% discount rate) **	100	5
CO_2 Reduction Monetized Value (using mean SCC at 3% discount rate) **	482	3
CO_2 Reduction Monetized Value (using mean SCC at 2.5% discount rate) **	777	2.5
CO_2 Reduction Monetized Value (using 95th percentile SCC at 3% discount rate) **	1,468	3
NO_X Reduction †	35	7
	99	3
Total Benefits ‡	1,425	7
	3,166	3
Costs		
Incremental Installed Costs	350	7
	609	3
Total Net Benefits		
Including CO_2 and NO_X Reduction Monetized Value ‡	1,075	7
	2,558	3

* This table presents the costs and benefits associated with commercial packaged boilers shipped in 2020–2049. These results include benefits to consumers that accrue after 2049 from the equipment purchased in 2020–2049. 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 percent, 3 percent, and 2.5 percent. 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-percent 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 for more details.

† DOE estimated the monetized value of NO_X emissions reductions associated with electricity savings 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 *www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-regulatory-impact-analysis.*) See section IV.L.2 for further discussion. To be conservative, 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-percent and 7-percent cases are presented using only the average SCC with 3-percent discount rate.

The benefits and costs of the adopted energy conservation standards, for covered commercial packaged boilers sold in 2020–2049, can also be expressed in terms of annualized values. The monetary values for the total annualized net benefits are the sum of (1) the annualized national economic value of the benefits from consumer operation of the equipment that meets the amended standards (consisting primarily of reduced operating costs minus increases in equipment purchase price and installation costs) and (2) the

[9] 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.* (Revised July 2015). *https://www.whitehouse.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf.*

[10] The values only include CO_2 emissions; CO_2 equivalent emissions from other greenhouse gases are not included.

[11] DOE estimated the monetized value of NO_X emissions reductions associated with electricity savings 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 *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. To be conservative, 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.

annualized value of the benefits of CO_2 and NO_X emission reductions.[12]

The national operating cost savings are domestic private U.S. consumer monetary savings that occur as a result of purchasing the covered equipment. The national operating cost savings is measured for the lifetime of commercial packaged boilers shipped in 2020–2049. 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,[13] the SCC values in future years reflect future CO_2-emissions impacts that continue 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 reductions (for which DOE used a 3-percent discount rate along with the average SCC series corresponding to a value of $40.6/t in 2015 (2015$)),[14] the estimated cost of the adopted standards for CPB equipment is $35 million per year in increased equipment costs, while the estimated benefits are $90 million per year in reduced equipment operating costs, $27 million per year in CO_2 reductions, and $3.5 million per year in reduced NO_X emissions. In this case, the net benefit amounts to $85 million per year.

Using a 3-percent discount rate for all benefits and costs and the average SCC series corresponding to a value of $40.6/t in 2015 (in 2015$), the estimated cost of the adopted standards for commercial packaged boilers is $34 million per year in increased equipment costs, while the estimated annual benefits are $144 million in reduced operating costs, $27 million in CO_2 reductions, and $5.5 million in reduced NO_X emissions. In this case, the net benefit would amount to $143 million per year.

TABLE I.4—SELECTED CATEGORIES OF ANNUALIZED BENEFITS AND COSTS OF ADOPTED ENERGY CONSERVATION STANDARDS FOR COMMERCIAL PACKAGED BOILERS

	Discount rate	Primary estimate *	Low net benefits estimate *	High net benefits estimate *
		(million 2015$/year)		
Benefits				
Consumer Operating Cost Savings *	7%	90	80	98.
	3%	144	128	160.
CO_2 Reduction Monetized Value (using mean SCC at 5% discount rate) ***.	5%	8	7	8.
CO_2 Reduction Monetized Value (using mean SCC at 3% discount rate) ***.	3%	27	24	29.
CO_2 Reduction Monetized Value (using mean SCC at 2.5% discount rate) ***.	2.5%	40	36	43.
CO_2 Reduction Monetized Value (using 95th percentile SCC at 3% discount rate) ***.	3%	82	74	89.
NO_X Reduction †	7%	3	3	9.
	3%	5	5	12.
Total Benefits ‡	7% plus CO_2 range	101 to 175	90 to 158	115 to 196.
	7%	120	108	136.
	3% plus CO_2 range	157 to 231	140 to 208	180 to 261.
	3%	177	158	201.
Costs				
Consumer Incremental Equipment Costs	7%	35	31	37.
	3%	34	31	37.
Net Benefits				
Total ‡	7% plus CO_2 range	66 to 140	59 to 127	78 to 158.
	7%	85	77	99.
	3% plus CO_2 range	123 to 198	109 to 177	144 to 224.

[12] 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.

[13] The atmospheric lifetime of CO_2 is estimated to be on the order of 30–95 years. Jacobson, MZ, ''Correction to 'Control of fossil-fuel particulate black carbon and organic matter, possibly the most effective method of slowing global warming,' '' *J. Geophys. Res.* 110. pp. D14105 (2005).

[14] 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—SELECTED CATEGORIES OF ANNUALIZED BENEFITS AND COSTS OF ADOPTED ENERGY CONSERVATION STANDARDS FOR COMMERCIAL PACKAGED BOILERS—Continued

	Discount rate	Primary estimate *	Low net benefits estimate *	High net benefits estimate *
		(million 2015$/year)		
	3%	143	127	165.

* This table presents the annualized costs and benefits associated with commercial packaged boilers shipped in 2020–2049. These results include benefits to consumers that accrue after 2049 from the equipment purchased in 2020–2049. 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 Benefits, and High Benefits Estimates utilize projections of building stock and energy prices from the *AEO2016* No-CPP case, a Low Economic Growth case, and a High Economic Growth case, respectively. In addition, DOE used a constant equipment price assumption as the default price projection; the cost to manufacture a given unit of higher efficiency neither increases nor decreases over time. Compared to a case where a reduction in equipment price over time is applied (*e.g.,* due to an observed price learning), a constant price assumption results in a more conservative estimate of economic benefits. The equipment price projection is described in section IV.F.1 of this document and chapter 8 of the final rule technical support document (TSD). In addition, DOE used estimates for equipment efficiency distribution in its analysis based on national data supplied by industry. Purchases of higher efficiency equipment are a result of many different factors unique to each consumer including boiler heating loads, installation costs, site environmental consideration, and others. For each consumer, all other factors being the same, it would be anticipated that higher efficiency purchases in the baseline would correlate positively with higher energy prices. To the extent that this occurs, it would be expected to result in some lowering of the consumer operating cost savings from those calculated in this rule.

** The CO_2 reduction benefits are calculated using 4 different sets of SCC values. The first three use the average SCC calculated using 5-percent, 3-percent, and 2.5-percent discount rates, respectively. The fourth represents the 95th percentile of the SCC distribution calculated using a 3-percent 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 associated with electricity savings 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 *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 national benefit-per-ton estimates 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-percent and 7-percent cases are presented using 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.

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

D. Conclusion

Based on the analysis culminating in this final rule, DOE finds the benefits of the amended standards to the Nation (energy savings, positive NPV of consumer benefits, consumer LCC savings, and emission reductions) outweigh the burdens (loss of INPV for manufacturers and LCC increases for some consumers). DOE also concludes that the amended standards represent significant additional energy conservation and are technologically feasible and economically justified. DOE further notes that equipment achieving these standard levels is already commercially available for all equipment classes covered by this final rule.[15]

II. Introduction

The following section briefly discusses the statutory authority underlying this final rule, as well as some of the relevant historical background related to the establishment of standards for commercial packaged boilers.

A. Authority

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 90.1 (ASHRAE Standard 90.1), "Energy Standard for Buildings Except Low-Rise Residential Buildings," sets industry energy efficiency levels for small, large, and very large commercial package air-conditioning and heating equipment, packaged terminal air conditioners, packaged terminal heat pumps, warm air furnaces, packaged boilers, storage water heaters, instantaneous water heaters, and unfired hot water storage tanks (collectively "ASHRAE equipment"). For each type of listed equipment, EPCA directs that if ASHRAE amends Standard 90.1, DOE must adopt amended standards at the new ASHRAE efficiency level, unless DOE determines, supported by clear and convincing evidence, that adoption of a more stringent level would produce significant additional conservation of energy and would be technologically feasible and economically justified. (42 U.S.C. 6313(a)(6)(A)(ii)

Under EPCA, DOE must also review energy efficiency standards for commercial packaged boilers every six years and either: (1) Issue a notice of determination that the standards do not need to be amended as adoption of a more stringent level is not supported by clear and convincing evidence; or (2) issue a notice of proposed rulemaking including new proposed standards based on certain criteria and procedures in subparagraph (B).[16] (42 U.S.C. 6313(a)(6)(C))

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

(1) The economic impact of the standard on manufacturers and

[15] See chapter 3 of the final rule TSD for information about the efficiency ratings of equipment currently available on the market.

[16] In relevant part, subparagraph (B) specifies that: (1) In making a determination of economic justification, DOE must consider, to the maximum extent practicable, the benefits and burdens of an amended standard based on the seven criteria described in EPCA; (2) DOE may not prescribe any standard that increases the energy use or decreases the energy efficiency of a covered product; and (3) DOE may not prescribe any standard that interested persons have established by a preponderance of evidence is likely to result in the unavailability in the United States of any product type (or class) of performance characteristics (including reliability, features, sizes, capacities, and volumes) that are substantially the same as those generally available in the United States. (42 U.S.C. 6313(a)(6)(B)(ii)–(iii))

consumers of 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 equipment that are likely to result from the standard;

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

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

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

(6) The need for national energy conservation; and

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

42 U.S.C. 6313(a)(6)(B)(ii)(I)–(VII))

Because ASHRAE did not update its efficiency levels for commercial packaged boilers in any of its most recent updates to ASHRAE Standard 90.1 (*i.e.,* ASHRAE Standard 90.1–2010, ASHRAE Standard 90.1–2013, and ASHRAE Standard 90.1–2016), DOE is analyzing amended standards consistent with the procedures defined under 42 U.S.C. 6313(a)(6)(C).

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

Further, EPCA, as codified, establishes a rebuttable presumption that an energy conservation standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product that complies with the standard 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 applicable test procedure. (42 U.S.C. 6295(o)(2)(B)(iii)) However, while this rebuttable presumption analysis applies to most commercial and industrial equipment (42 U.S.C. 6316(a)), it is not a required analysis for ASHRAE equipment, including commercial packaged boilers (42 U.S.C. 6316(b)(1)). Nonetheless, DOE considered the criteria for rebuttable presumption as part of its economic justification analysis.

After carefully reviewing all CPB equipment classes, DOE has concluded that amended energy conservation standards for 8 of the 12 CPB equipment classes adopted in this final rule (*i.e.,* all commercial packaged boilers with rated inputs ≤10,000 kBtu/h) will result in significant additional conservation of energy and are technologically feasible and economically justified, as mandated by 42 U.S.C. 6313(a)(6).

For the remaining 4 equipment classes, (*i.e.,* all commercial packaged boilers with rated inputs >10,000 kBtu/h), DOE tentatively decided in the March 2016 NOPR not to amend energy conservation standards because of a lack of sufficient data to justify amended standards. 81 FR 15836, 15851–15853 (March 24, 2016). DOE did not receive any additional information or data that would support the rulemaking analysis for such commercial packaged boilers. Therefore, DOE maintains the existing standards because there is not sufficient data to support, by clear and convincing evidence, more stringent standards for commercial packaged boilers with rated inputs >10,000 kBtu/h. (42 U.S.C. 6313(a)(6)(C)(i)(I) For more discussion on commercial packaged boilers with rated input greater than 10,000 kBtu/h, see section IV.A.3 of this final rule.

B. Background

1. Current Standards

Prior to this final rule, DOE last amended its energy conservation standards for commercial packaged boilers through a final rule published in the **Federal Register** on July 22, 2009 (July 2009 final rule). 74 FR 36312. More specifically, the July 2009 final rule updated the energy conservation standards for commercial packaged boilers to correspond to the levels in the 2007 revision of ASHRAE Standard 90.1 (*i.e.,* ASHRAE Standard 90.1–2007). The July 2009 final rule established thermal efficiency as the energy efficiency metric for all equipment classes other than commercial packaged boilers with fuel rated input greater than 2,500,000 Btu/h and that are designed to deliver hot water. For such equipment classes (*i.e.,* gas-fired and oil-fired hot water commercial packaged boilers with rated input greater than 2,500,000 Btu/h), DOE established combustion efficiency as the energy efficiency metric. Compliance with the standards adopted in the July 2009 final rule was required beginning on March 2, 2012. These levels are shown in Table II.1. Also in the July 2009 final rule, DOE again followed ASHRAE's approach in Standard 90.1–2007 and adopted a second tier of energy conservation standards for two classes of commercial packaged boilers, which are shown in Table II.2. Compliance with the latter standards is required beginning on March 2, 2022.

TABLE II.1—FEDERAL ENERGY EFFICIENCY STANDARDS FOR COMMERCIAL PACKAGED BOILERS MANUFACTURED ON OR AFTER MARCH 2, 2012

Equipment type	Subcategory	Size category (input)	Efficiency level—effective date: March 2, 2012 *
Hot Water Commercial Packaged Boilers.	Gas-fired	≥300,000 Btu/h and ≤2,500,000 Btu/h	80.0% E_T.
Hot Water Commercial Packaged Boilers.	Gas-fired	>2,500,000 Btu/h	82.0% E_C.
Hot Water Commercial Packaged Boilers.	Oil-fired	≥300,000 Btu/h and ≤2,500,000 Btu/h	82.0% E_T.
Hot Water Commercial Packaged Boilers.	Oil-fired	>2,500,000 Btu/h	84.0% E_C.
Steam Commercial Packaged Boilers	Gas-fired—All, Except Natural Draft	≥300,000 Btu/h and ≤2,500,000 Btu/h	79.0% E_T.
Steam Commercial Packaged Boilers	Gas-fired—All, Except Natural Draft	>2,500,000 Btu/h	79.0% E_T.
Steam Commercial Packaged Boilers	Gas-fired—Natural Draft	≥300,000 Btu/h and ≤2,500,000 Btu/h	77.0% E_T.

TABLE II.1—FEDERAL ENERGY EFFICIENCY STANDARDS FOR COMMERCIAL PACKAGED BOILERS MANUFACTURED ON OR AFTER MARCH 2, 2012—Continued

Equipment type	Subcategory	Size category (input)	Efficiency level—effective date: March 2, 2012 *
Steam Commercial Packaged Boilers	Gas-fired—Natural Draft	>2,500,000 Btu/h	77.0% E_T.
Steam Commercial Packaged Boilers	Oil-fired	≥300,000 Btu/h and ≤2,500,000 Btu/h	81.0% E_T.
Steam Commercial Packaged Boilers	Oil-fired	>2,500,000 Btu/h	81.0% E_T.

* E_T means "thermal efficiency." E_C means "combustion efficiency."

TABLE II.2—FEDERAL ENERGY EFFICIENCY STANDARDS FOR COMMERCIAL PACKAGED BOILERS MANUFACTURED ON OR AFTER MARCH 2, 2022

Equipment type	Subcategory	Size category (input)	Efficiency level—effective date: March 2, 2022
Steam Commercial Packaged Boilers	Gas-fired—Natural Draft	≥300,000 Btu/h and ≤2,500,000 Btu/h	79.0% E_T.
Steam Commercial Packaged Boilers	Gas-fired—Natural Draft	>2,500,000 Btu/h	79.0% E_T.

2. History of Standards Rulemaking for Commercial Packaged Boilers

DOE is conducting this rulemaking pursuant to 42 U.S.C. 6313(a)(6)(C), which requires that every 6 years, DOE must publish either: (1) A notice of the determination that standards for the equipment do not need to be amended, or (2) a NOPR including proposed energy conservation standards. As noted above, DOE's last final rule for commercial packaged boilers was published on July 22, 2009. DOE is issuing this final rule pursuant to its statutory obligation under 42 U.S.C. 6313(a)(6)(C).

In initiating this rulemaking, DOE prepared a Framework document, "Energy Conservation Standards Rulemaking Framework Document for Commercial Packaged Boilers," which describes the procedural and analytical approaches DOE anticipated using to evaluate energy conservation standards for commercial packaged boilers. DOE published a notice that announced both the availability of the Framework document and a public meeting to discuss the proposed analytical framework for the rulemaking. That notice also invited written comments from the public. 78 FR 54197 (Sept. 3, 2013). The Framework document is available at: *https://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx/ruleid/79.*

DOE held a public meeting on October 1, 2013, at which it described the various analyses DOE would conduct as part of the rulemaking, such as the engineering analysis, the life-cycle cost (LCC) and payback period (PBP) analyses, and the national impact analysis (NIA). Representatives of manufacturers, trade associations, environmental and energy efficiency advocates, and other interested parties attended the meeting. The participants discussed the following major topics, among others: (1) The rulemaking scope (2) test procedures for commercial packaged boilers; and (3) various issues related to the planned analyses of amended energy conservation standards. Interested parties also provided comments on the Framework document, which DOE considered and responded to in chapter 2 of the preliminary analysis TSD.

On November 20, 2014, DOE published a second notice, "Energy Conservation Standards for Commercial Packaged Boilers: Public Meeting and Availability of the Preliminary Technical Support Document" in the **Federal Register** to announce the availability of the preliminary analysis technical support document (TSD). 79 FR 69066. The preliminary analysis TSD provided preliminary results of the analyses that DOE conducted in support of the energy conservation standards rulemaking. DOE invited interested parties to comment on the preliminary analysis, and requested public comments on specific issues related to the TSD. These issues are listed in the Executive Summary chapter of the preliminary analysis TSD. The preliminary analysis TSD is available at: *https://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx/ruleid/79.*

On December 9, 2014, DOE held a public meeting, at which it described the methodology and preliminary results of the various analyses it conducted as part of the rulemaking, such as the engineering analysis, the LCC and PBP analyses, and the NIA. Representatives of manufacturers, trade associations, environmental and energy efficiency advocates, and other interested parties attended the meeting. The public meeting provided an opportunity for the attendees to provide feedback and comments that would help improve DOE's analysis and results for the NOPR stage. In addition, DOE also received several written comments from interested parties and stakeholders, in response to the preliminary analysis TSD.

On March 24, 2016, DOE subsequently published a notice of proposed rulemaking (NOPR) and notice of public meeting in the **Federal Register** (March 2016 NOPR) that addressed all of the comments received in response to the preliminary analysis TSD and proposed amended energy conservation standards for commercial packaged boilers. 81 FR 15836. In addition to amended energy conservation standards, DOE also proposed to reorganize the equipment class structure for commercial packaged boilers. The March 2016 NOPR also updated the rulemaking analysis based on comments received in response to the preliminary analysis and the most recent data sources available, and sought comments from interested parties on specific issues listed in the March 2016 NOPR. The March 2016 NOPR and the NOPR TSD are available at: *https://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx/ruleid/79.*

On April 21, 2016, DOE held a public meeting where it presented and discussed the analyses conducted as part of this rulemaking (*e.g.,* engineering analysis, LCC and PBP analysis, national impact analysis). In the public meeting, DOE presented the results of these analyses and requested comments from stakeholders on various issues related to the rulemaking. In response to the March 2016 NOPR, DOE received both verbal comments (during the public meeting) and written comments from interested parties that were considered while updating its analysis for this final rule. The interested parties that commented on the March 2016 NOPR are shown in Table II.3 of this final rule.

TABLE II.3—PARTIES THAT PROVIDED COMMENTS ON THE MARCH 2016 NOPR

Name of party	Abbreviation	Source of comments	Type *
Air-Conditioning, Heating and Refrigeration Institute	AHRI	Public Meeting, Written	TA
American Boiler Manufacturers Association	ABMA	Public Meeting, Written	TA
American Council for Energy Efficient Economy, Appliance Standards Awareness Project, Natural Resource Defense Council, Northwest Energy Efficiency Alliance.	Joint Advocates	Written	EA
American Gas Association, American Public Gas Association	Gas Associations	Public Meeting, Written	UA
Appliance Standards Awareness Project	ASAP	Public Meeting	EA
Bradford White Corporation	Bradford White	Written	M
Burnham Holdings	BHI	Written	M
Cato Institute	Cato	Written	O
The U.S. Chamber of Commerce, the American Chemistry Council, the American Coke and Coal Chemicals Institute, the American Forest & Paper Association, the American Fuel & Petrochemical Manufacturers, the American Petroleum Institute, the Brick Industry Association, the Council of Industrial Boiler Owners, the National Association of Manufacturers, the National Mining Association, the National Oilseed Processors Association, and the Portland Cement Association.	The Associations	Written	TA
Crown Boiler	Crown	Public Meeting, Written	M
Industrial Energy Consumers of America	IECA	Written	TA
Lochinvar, LLC	Lochinvar	Public Meeting, Written	M
Sidel Systems	Sidel	Written	M
Pacific Gas & Electric, San Diego Gas & Electric	Joint Utilities	Written, Public Meeting	U
Phoenix Energy Management	PEM	Public Meeting	C
Raypak, Inc	Raypak	Public Meeting, Written	M
Southern California Gas	SoCalGas	Public Meeting, Written	U
Spire (formerly The LaClede Group, Inc.)	Spire/LaClede Spire	Public Meeting Written	U
Tom Nussbaum	Tom Nussbaum	Written	I
Weil-McLain	Weil-McLain	Written	M

* TA: Trade Association; EA: Efficiency/Environmental Advocate; M: Manufacturer; C: Contractor; U: Utility; UA: Utility Association; I: Individual; O: Other.

In parallel to the energy conservation standards rulemaking, DOE published a notice of proposed determination on August 13, 2013 (August 2013 NOPD), which initiated a coverage determination to explicitly clarify DOE's statutory authority under EPCA to cover natural draft commercial packaged boilers. DOE initiated this coverage determination because the existing definition of ''packaged boiler'' could have allowed for differing interpretations as to whether natural draft commercial packaged boilers are covered equipment. 78 FR 49202. In the August 2013 NOPD, DOE proposed a definition for natural draft commercial packaged boilers that would clarify its statutory authority to cover such equipment. DOE sought public comments in response to its proposed determination and definition for natural draft commercial packaged boilers, and received several written comments from interested parties. In addition, DOE also received several comments in response to the preliminary analysis TSD that are relevant to the issue of coverage determination of natural draft commercial packaged boilers. After carefully reviewing all of the comments received on the issue of coverage determination of natural draft commercial packaged boilers and determining that the comments indicated a common and long-standing understanding from interested parties that natural draft commercial packaged boilers are and have been covered equipment under part A–1 of Title III of EPCA, DOE decided to withdraw the August 2013 NOPD on August 25, 2015 (August 2015 withdrawal notice). 80 FR 51487.

DOE also recently completed a separate test procedure rulemaking to consider an amended test procedure for commercial packaged boilers. On February 20, 2014, DOE initiated the test procedure rulemaking by publishing a request for information (RFI) in the **Federal Register** that sought comments and information from stakeholders on several issues pertaining to the CPB test procedure. 79 FR 9643. On March 17, 2016, DOE published a NOPR in the **Federal Register**, which proposed to update the test procedure for determining the efficiency of commercial packaged boilers (2016 CPB TP NOPR). 81 FR 14642. Subsequently, on December 9, 2016, DOE published a final rule in the **Federal Register**, which updated the test procedure for commercial packaged boilers. 81 FR 89276. Section III.B of this document briefly discusses the amendments made to the test procedure.[17] The analyses conducted for this final rule reflect the changes adopted in the December 2016 test procedure final rule. (2016 CPB TP final rule)

III. General Discussion

A. Compliance Dates

In 42 U.S.C. 6313(a), EPCA prescribes a number of compliance dates for amended standards for commercial packaged boilers. These compliance dates vary depending on the specific statutory authority under which DOE is conducting its review (*i.e.,* whether DOE is triggered by a revision to ASHRAE Standard 90.1 or whether DOE is undertaking a 6-year review), and the action taken (*i.e.,* whether DOE is adopting ASHRAE Standard 90.1 levels or more stringent levels). The discussion

[17] For detailed discussion on the test procedure including the comments and DOE's response please see the docket #EERE–2014–BT–TP–0006.

that follows explains the compliance dates as they pertain to this rulemaking.

As discussed in section II.A of this document, EPCA requires that at least once every 6 years, DOE must review standards for commercial packaged boilers and publish either a notice of determination that standards for this type of equipment do not need to be amended or a NOPR containing amended standards. (42 U.S.C. 6313(a)(6)(C)(i)) EPCA requires that an amended standard prescribed under 42 U.S.C. 6313(a)(6)(C) must apply to products manufactured after the date that is the later of: (1) The date 3 years after publication of the final rule establishing a new standard or (2) the date 6 years after the effective date of the current standard for a covered product. (42 U.S.C. 6313(a)(6)(C)(iv)) The current standards for commercial packaged boilers went into effect in 2012. Thus, the date 3 years after publication of this final rule is later than the date 6 years after 2012, the effective date of the current standard. As a result, compliance with any amended energy conservation standards promulgated in this final rule is required starting from the dates specified in paragraph (b) of 10 CFR 431.87.

B. Test Procedure

1. Summary of Recent Updates

DOE's current test procedure for commercial packaged boilers is found at 10 CFR 431.86.

As stated previously, on December 9, 2016, DOE published a final rule amending the CPB test procedure. 81 FR 89276. The 2016 CPB TP final rule adopted specific sections of American National Standards Institute (ANSI)/AHRI Standard 1500, ''Standard for Performance Rating of Commercial Space Heating Boilers,'' (ANSI/AHRI Standard 1500–2015) as the basis of the test procedure for commercial packaged boilers, replacing the previous industry test standard BTS–2000. In addition, the 2016 CPB TP final rule incorporates the following amendments to the DOE test procedure: (1) Clarifies the coverage for field-constructed commercial packaged boilers and the applicability of DOE's test procedure and standards for this category of commercial packaged boilers, (2) provides an optional field test for commercial packaged boilers with rated input greater than 5,000,000 Btu/h, (3) provides a conversion method to calculate thermal efficiency based on combustion efficiency testing for steam commercial packaged boilers with rated input greater than 5,000,000 Btu/h, (4) modifies the inlet water temperature requirements during tests of hot water commercial packaged boilers, (5) establishes limits on the ambient temperature and relative humidity conditions during testing, (6) modifies setup and instrumentation requirements to remove ambiguity, and (7) standardizes terminology and provisions for ''fuel input rate'' and ''rated input.''

In response to the March 2016 NOPR, DOE received several comments that are specifically related to the CPB test procedure. Comments related to the technical aspects of the test procedure development were considered and addressed in the test procedure final rule.

2. Timing of the Test Procedure and Energy Conservation Standards Rulemakings

Several stakeholders expressed legal, procedural, and practical concerns regarding the timing of the test procedure and energy conservation standards revisions for commercial packaged boilers, and requested that DOE delay any further work on the rulemakings to amend efficiency standards until after the finalization of the test procedure. (Bradford White, No. 68 at p. 1; Gas Associations, No. 69 at p. 2; BHI, No. 71 at p. 5; Lochinvar, No. 70 at p. 7; AHRI, No. 76 at pp. 2–3; ABMA, No. 64 at p. 1, Crown, Public Meeting Transcript, No. 61 at p. 13; AHRI, Public Meeting Transcript, No. 61, at p. 14);[18] AHRI highlighted that DOE has two years from the publication of the NOPR for energy conservation standards before it must publish a final rule for CPB standards under 42 U.S.C. 6313(a)(6)(C)(iii), and asserted that DOE has sufficient time to finalize the test procedure and subsequently reopen comments on the proposed standard. (AHRI, No. 76 at p. 5)

AHRI argued that the non-final status of the test procedure inhibits stakeholders' fair evaluation of the proposed standards and stressed the importance of having a known efficiency test procedure. AHRI pointed out that DOE is required to provide stakeholders the opportunity to submit meaningful comments (42 U.S.C. 6306(a), 42 U.S.C. 6314(b)), and opined that the joint proposal of test procedures and standards eliminates that opportunity. (AHRI, No. 76 at pp. 2–3)

AHRI further commented that having simultaneous rulemakings creates an unfair burden on stakeholders. (AHRI, Public Meeting Transcript, No. 61 at p. 80) Similarly, Raypak, Bradford White, and Crown commented that the ongoing changes to the test procedure do not allow manufacturers the opportunity to properly evaluate the effects of the proposed standards. Bradford White noted that their resources are focused on proposed test procedure changes. (Raypak, No. 72 at p. 1; Bradford White, No. 68 at p. 1; Crown, Public Meeting Transcript, No. 61 at p. 13; Bradford White, No. 68 at p. 12) Several stakeholders also contended that the timing of the test procedure and standards rulemaking violated DOE's own procedural policies or ''the process rule.'' (Gas Associations, No. 69 at p. 2; Bradford White, No. 68 at p. 12; Weil-McLain, No. 67 at p. 4; Spire, No. 73 at pp. 5–7; AHRI, No. 76 at p. 3; Lochinvar, No. 71 at p. 7) AHRI highlighted that the process rule is not merely a guideline, noting it was codified in the Code of Federal Regulations. AHRI contended that DOE must abide by its own regulations. (AHRI, No. 76 at p. 3)

DOE provided a detailed response on this issue in the 2016 CPB TP final rule. DOE re-iterates in this final rule that the amendments to the Federal test procedure includes updates to the referenced industry test standard (ANSI/AHRI Standard 1500–2015) which was developed by a consensus-based AHRI process. In May 2015, AHRI petitioned DOE to replace its references to BTS–2000 with ANSI/AHRI Standard 1500–2015. In addition, DOE received insightful and detailed comments on the proposed amendments to the test procedure in response to the 2016 CPB TP NOPR. Considering these developments leading up to the 2016 CPB TP final rule, the industry was involved at all stages of the test procedure rulemaking, and DOE's amendments are largely in keeping with the test methodology found in consensus-based industry standard ANSI/AHRI Standard 1500–2015. Any deviations in the 2016 CPB TP final rule from ANSI/AHRI 1500–2015 are a result of DOE's efforts to make the test procedure better reflect the energy efficiency during a representative average use cycle, as required by EPCA. (42 U.S.C. 6314(a)(2)). In the 2016 CPB TP final rule, as discussed in section III.B.3, DOE concluded that the amendments to the test procedure that were ultimately adopted would mitigate

[18] DOE will identify comments received in response to the March 2016 CPB ECS NOPR and placed in Docket No. EERE–2013–BT–STD–0030 by the commenter, the number of the comment document as listed in the docket maintained at *www.regulations.gov,* and the page number of that document where the comment appears (for example: Bradford White, No. 68 at p. 1). If a comment was made during the CPB ECS NOPR public meeting, DOE will also specifically identify those as being located in the NOPR public meeting transcript (for example: Crown, Public Meeting Transcript, No. 61 at p. 13).

concerns regarding the impact on ratings. 81 FR 89276, 89281–89282 (December 9, 2016).

Furthermore, in the energy conservation standards rulemaking, DOE granted a 30-day extension of the comment period following the publication of the March 2016 NOPR to ensure that stakeholders had sufficient time to comment on the analyses and results. Therefore, DOE believes that stakeholders have had adequate time to gauge the effect of the standards rulemaking to enable them to provide meaningful comments on its analysis and results.

Regarding the commenters' assertions that DOE has violated the process rule, DOE notes that the codified procedures at 10 CFR part 430, subpart C, appendix A (7)(c), Appendix A establish 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 part 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. In the case of commercial packaged boilers, DOE was petitioned by the industry to adopt the industry test standard AHRI Standard 1500–2015, while the energy conservation standards rulemaking was in process. The energy conservation standards rulemaking was initiated in August 2013 with the publication of the Framework document, as discussed in section II.B.2 of this final rule, and AHRI petitioned DOE to amend the test procedure in May 2015, as noted above. Therefore, per AHRI's request, DOE initiated a test procedure rulemaking concurrent with the standards rulemaking. As noted above and discussed in section III.B.3, the changes to the test procedure that were ultimately adopted in the 2016 CPB TP final rule mitigated stakeholders' concerns about impacts to efficiency ratings. Accordingly, DOE has concluded that there is no basis to delay the final rule adopting standards for commercial packaged boilers.

3. Impact on Efficiency Ratings

Several commenters indicated that they expected that the proposed changes to the test procedure would result in changes to the rated efficiency. Lochinvar, BHI, and AHRI questioned DOE's tentative determination that the test procedure changes would not impact efficiency ratings. (Lochinvar, No. 70 at p. 7; BHI, No. 71 at p. 3; AHRI No. 76 at p. 4)

Lochinvar noted that DOE's own test summary shows that the TP changes would reduce the rated efficiency of some boilers. Lochinvar also stated that anti-backsliding provisions would prevent DOE from making any changes to the standard after the fact if TP changes negatively impact ratings. (Lochinvar, No. 70 at p. 7) AHRI noted that DOE's conclusion that the efficiency ratings would not be impacted by the proposed test procedure changes is based on limited testing data, and stakeholders did not have sufficient time to provide meaningful comments. (AHRI No. 76 at p. 4) BHI added that that the rating of some equipment could be significantly impacted, given that the test procedure is significantly different. (BHI, No. 71 at pp. 3, 4–5) They suggested that the efficiency of 85-percent E_T "Category I" boilers in the directory will change due to the proposed water temperature changes in the 2016 CPB TP NOPR. (BHI, No. 71 at p. 10) Raypak provided similar comments. (Raypak, No. 72 at p. 3)

Weil-McLain and SoCalGas commented that the efficiency ratings of non-condensing boilers will drop due to the new test procedure and that the proposed increases in the minimum standard would combine to significantly reduce the types of feasible non-condensing equipment. (Weil-McLain, No. 67 at p. 2; SoCalGas, No. 77 at p. 2) AHRI commented that the analysis must be based on finalized test procedures in order to realistically represent the impacts of amended standards (including energy savings, cost to consumers and manufacturers). (AHRI, No. 76 at pp. 2–3) SoCal suggested that the benefits of TSL 1 may actually be closer to those calculated for TSL 2, given the proposed water temperature changes in the test procedure. (SoCalGas, No. 77 at p. 2)

In the 2016 CPB TP NOPR, DOE tentatively determined that the proposed test procedure amendments would not result in an overall measureable impact on equipment's measured efficiency. 81 FR 14642, 12878 (March 17, 2016). However, as discussed above, DOE received comments from stakeholders in response to both the March 2016 NOPR and the 2016 CPB TP NOPR suggesting that several proposals included in the 2016 CPB TP NOPR would impact efficiency ratings. In the 2016 CPB TP final rule, DOE addressed stakeholders' concerns and ultimately revised the proposals that could have resulted in changes to the efficiency ratings in order to mitigate impacts on the efficiency ratings.[19] 81 FR 89276, 89289–89290 (December 9, 2016).

C. Technological Feasibility

1. General

In each energy conservation standards rulemaking, DOE conducts a screening analysis based on information gathered on all current technology options and prototype designs that could improve the efficiency of the equipment that is the subject of the rulemaking. As the first step in such an analysis, DOE conducts a market and technology assessment that develops a list of technology options for consideration in consultation with manufacturers, design engineers, and other interested parties. DOE then determines which of those means for improving efficiency are technologically feasible. DOE considers technologies incorporated in commercially available equipment or in working prototypes to be technologically feasible. 10 CFR part 430, subpart C, appendix A, section 4(a)(4)(i)

After DOE has determined that particular technology options are technologically feasible, it further evaluates each technology option in light of the following additional screening criteria: (1) Practicability to manufacture, install, and service; (2) adverse impacts on equipment 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, DOE notes that these screening criteria do not directly address the proprietary status of design options. DOE only considers efficiency levels achieved through 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 concludes that the amended standards for the equipment covered in this final rule do not mandate the use of any proprietary technologies, and that all manufacturers are able to achieve the amended standard levels through the use of non-proprietary designs. Section IV.B and IV.C of this final rule discuss the results of the screening analysis and engineering analysis for commercial packaged boilers. For further details on the screening analysis and engineering

[19] For additional discussion and DOE's detailed response to the comments please refer to the 2016 CPB TP final rule docketed at ID #EERE–2014–BT–TP–0006. *https://www.regulations.gov/docket?D=EERE-2014-BT-TP-0006.*

analysis for this final rule, see chapter 4 and chapter 5 of the final rule TSD.

2. Maximum Technologically Feasible Levels

When DOE proposes to adopt an amended standard for a type or class of covered equipment, it determines the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible for such equipment. Accordingly, in the engineering analysis of this final rule, DOE determined the maximum technologically feasible (''max-tech'') improvements in energy efficiency for commercial packaged boilers, using the design parameters for the most efficient equipment currently available on the market. The max-tech levels that DOE determined for this rulemaking are described in section IV.C.4 of this document and in chapter 5 of the final rule TSD.

D. Energy Savings

1. Determination of Savings

For each trial standard level (TSL), DOE projected energy savings from the application of the TSL to commercial packaged boilers purchased in the 30-year period that begins in the year of compliance with amended standards (2020–2049).[20] The savings are measured over the entire lifetime of commercial packaged boilers purchased in the 30-year analysis period. DOE quantified the energy savings attributable to each TSL as the difference in energy consumption between each standards case and the no-new-standards-case. The no-new-standards case represents a projection of energy consumption that reflects how the market for equipment would likely evolve in the absence of amended efficiency standards.

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

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

2. Significance of Savings

To amend standards for commercial packaged boilers, DOE must determine that the standards would result in ''significant'' additional energy savings. (42 U.S.C. 6313(a)(6)(A)(ii)(II) and (C)(i)) 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), indicated that Congress intended ''significant'' energy savings in the context of EPCA to be savings that were not ''genuinely trivial.'' DOE concludes the energy savings for the amended standards (presented in section V.B.3 of this document) are ''significant'' as required by 42 U.S.C. 6313(a)(6)(A)(ii)(II) and (C)(i).

E. Economic Justification

1. Specific Criteria

EPCA provides seven factors to be evaluated in determining whether a potential energy conservation standard is economically justified. (42 U.S.C. 6313(a)(6)(B)(ii)(I)–(VII)) The following sections discuss how DOE has addressed each of those seven factors in this rulemaking.

a. Economic Impact on Manufacturers and Consumers

EPCA requires DOE to consider the economic impact of a standard on manufacturers and the consumers of the products subject to the standard. (42 U.S.C. 6313(a)(6)(B)(ii)(I)) In determining the impacts of a potential amended standard on manufacturers, DOE conducts a manufacturer impact analysis (MIA), as discussed in section IV.J of this document. DOE first uses an annual cash-flow approach to determine the quantitative impacts. This step includes both a short-term assessment—based on the cost and capital requirements during the period between when a regulation is issued and when entities must comply with the regulation—and a long-term assessment over a 30-year period. The industry-wide impacts analyzed include: (1) INPV, which values the industry based on expected future cash flows; (2) cash flows by year; (3) changes in revenue and income; and (4) other measures of impact, as appropriate. Second, DOE analyzes and reports the impacts on different types of manufacturers, including impacts on small manufacturers. Third, DOE considers the impact of standards on domestic manufacturer employment and manufacturing capacity, as well as the potential for standards to result in plant closures and loss of capital investment. Finally, DOE takes into account cumulative impacts of various DOE regulations and other regulatory requirements on manufacturers.

For individual consumers, measures of economic impact include the changes in LCC and PBP associated with new or amended standards. These measures are discussed further in the following section. For consumers in the aggregate, DOE also calculates the national NPV of the economic impacts applicable to a particular rulemaking. 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

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

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

The LCC savings for the considered efficiency levels are calculated relative to a no-new-standards-case that reflects projected market trends in the absence of amended standards. DOE identifies the percentage of consumers estimated to receive LCC savings or experience an LCC increase, in addition to the average LCC savings associated with a particular standard level. DOE's LCC and PBP analysis is discussed in further detail in section IV.F of this document.

c. Energy Savings

EPCA requires DOE, in determining the economic justification of a standard, to consider the total projected energy savings that are expected to result directly from the standard. (42 U.S.C. 6313(a)(6)(B)(ii)(III)) As discussed in section III.D.1 and section IV.E of this document and chapter 10 of the final rule TSD, DOE uses spreadsheet models to project national energy savings.

d. Lessening of Utility or Performance of Equipment

In determining whether amending a standard is economically justified, DOE evaluates any lessening of the utilities or performance of the considered equipment. (42 U.S.C. 6313(a)(6)(B)(ii)(IV)) Based on data available to DOE, the standards adopted in this document do not reduce the utility or performance of the equipment under consideration in this rulemaking. See section IV.A.3 and section IV.B for DOE's detailed determinations that adopted standards in this final rule do not reduce utility or performance of CBP equipment covered under this rulemaking.

e. Impact of Any Lessening of Competition

EPCA directs DOE to consider the impact of any lessening of competition, as determined in writing by the Attorney General of the United States that is likely to result from a standard. (42 U.S.C. 6313(a)(6)(B)(ii)(V)) DOE transmitted a copy of its proposed rule to the Attorney General with a request that the Department of Justice (DOJ) provide its determination on this issue. On October 19, 2015, DOJ provided its determination to DOE that the amended standards for commercial packaged boilers are unlikely to have a significant adverse impact on competition. DOE has included this determination from DOJ at the end of this rule.

f. Need for National Energy Conservation

In considering new or amended energy conservation standards, EPCA also directs DOE to consider the need for the national energy conservation. (42 U.S.C. 6313(a)(6)(B)(ii)(VI)) The adopted standards are likely to improve the security and reliability of the Nation's energy system. Reductions in the demand for electricity also may result in reduced costs for maintaining the reliability of the Nation's electricity system. DOE conducts a utility impact analysis to estimate how standards may affect the Nation's needed power generation capacity, as discussed in section IV.M of this document.

The adopted 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 standards may affect these emissions, as discussed in section IV.K of this document. DOE reports the emissions impacts from each TSL it considered in section V.B.6 of this document. DOE also estimates the economic value of emissions reductions resulting from the considered TSLs, as discussed in section IV.L of this document.

g. Other Factors

In determining whether an energy conservation standard is economically justified, DOE may consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6313(a)(6)(B)(ii)(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.''

2. Rebuttable Presumption

EPCA creates a rebuttable presumption that an energy conservation standard is economically justified if the additional cost to the consumer of the equipment that meets the standard is less than three times the value of the first year's energy savings resulting from the standard, as calculated under the applicable DOE test procedure. DOE's LCC and PBP analyses generate values used to calculate the effects that amended energy conservation standards would have on the PBP for consumers. These analyses include, but are not limited to, the 3-year PBP 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. 6313(a)(6)(B)(ii) and (C)(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 V.B.1.c of this document.

F. General Comments

1. Proposed Standard Levels

In response to the efficiency levels proposed in the March 2016 NOPR (NOPR TSL 2), DOE received numerous comments on the appropriate levels for selection as the Federal standards.

a. Comments on Proposed TSL 2

The Joint Utilities expressed their support for the proposed standard levels (*i.e.,* NOPR TSL 2). (Joint Utilities, No. 66 at p. 1)

BHI, Weil-McLain, and Lochinvar opposed the proposed standard levels at NOPR TSL 2, and Lochinvar encouraged DOE to make no change to the minimum efficiency standard. (BHI, No. 71 at p. 1; Weil-McLain, No. 67 at pp. 4–5; Lochinvar, No. 70 at p. 8)

BHI expressed concern that commercial packaged boilers meeting the efficiency levels proposed in the March 2016 NOPR for small gas-fired hot water (SGHW) and large gas-fired hot water (LGHW) equipment classes (85-percent E_T and 85-percent E_C, respectively) cannot be safely vented using a conventional ''category I'' chimney. (BHI, No. 71 at p. 2) Raypak added that the category I venting commercial packaged boilers must be retained to allow replacement of boilers from old installations. (Raypak, No. 72 at p. 3) Raypak also expressed concern that the proposed TSL 2 is too close to condensing and could lead to failure of B-vent pipes and leaking combustion equipment.

Raypak suggested that DOE selected the proposed efficiency levels because higher efficiency standards exist in Europe. Raypak noted that the regulations governing boiler maintenance in Europe are substantially different, and that some countries require annual boiler inspections and service, which are not required in the United States. Raypak argued that DOE should not set standards at the levels proposed in the March 2016 NOPR until maintenance practices in the United States are comparable to those in other countries. Raypak further stated that the complexity of newer technology requires installers who are skilled and experienced to install higher efficiency commercial packaged boilers. (Raypak, No. 72 at p. 3)

Weil-McLain expressed concern that the proposed levels included in the NOPR TSL 2 would significantly reduce the non-condensing options available to consumers. Weil-McLain also added that DOE would erase a future increase in efficiency that was to take effect in 2022 pursuant to 10 CFR 431.87(c), noting that manufacturers' ability to make long-term development plans are impacted when efficiency requirements are obsoleted before they have even gone into effect. (Weil-McLain, No. 67 at pp. 2–3) Both Weil-McLain and BHI suggested that the proposed levels could reduce their ability to sell non-condensing commercial packaged boilers, and therefore would create a significant burden on manufacturers. (Weil-McLain, No. 67 at pp. 4–5; BHI, No. 71 at p. 1) BHI further commented that adopting NOPR TSL 2 would potentially reduce employment at their facilities. (BHI, No. 71 at p. 1) The Gas Associations urged DOE to revise the technical analysis and economic justification for the 85-percent level proposed in the March 2016 NOPR. The Gas Associations expressed concern about issues with possible condensation in the venting system and interior heat exchanger leading to premature failure and believe that the current standards are sufficient and justified. (Gas Associations, No. 69 at p. 2)

SoCalGas and AHRI recommended that DOE adopt NOPR TSL 1. (SoCalGas, No. 77 at p. 4; AHRI, No. 76 at pp. 27, 44) SoCalGas argued that the changes to test procedure may impact efficiency ratings, and noted that if a 1 percent decrease in ratings were to occur as a result of the test procedure changes, the result would be effectively requiring an 86-percent E_T for SGHW commercial packaged boilers. SoCalGas cited DOE's own analysis demonstrating that there are very few commercial packaged boilers on the market meeting the 86-percent E_T level. (SoCalGas, No. 77 at p. 3) AHRI also stated that, based on DOE's analysis, it should not adopt a standard more stringent than the proposed TSL 2 in all equipment classes, because the increase in incorrect venting and other installation decisions should prohibit consideration of near-condensing efficiency levels. (AHRI, No. 76 at p. 27) AHRI and Raypak stated that forcing consumers to buy near-condensing and condensing boilers in circumstances where they are not warranted for installation is a perversion of the regulatory process. (AHRI, No. 76 at p. 27; Raypak, No. 72 at p. 2)

ABMA commented that the proposed levels included in NOPR TSL 2 for the LGHW and LOHW equipment classes (*i.e.,* 85-percent E_C and 88-percent E_C) would be unattainable for certain sizes of commercial packaged boilers in its members' equipment lines and recommended that DOE adopt standards at 83 percent and 86 percent, respectively. (ABMA, No. 64 at p. 2)

Bradford White and Raypak recommended that DOE adopt a minimum standard of 82-percent E_T for the SGHW equipment class. For the LGHW equipment class, Bradford White recommended DOE select 84-percent E_C, while, Raypak recommended 82-percent E_C. (Bradford White, No. 68 at p. 4; Raypak, No. 72 at p. 4)

Bradford White stated that the proposed level of 85-percent E_C for LGHW commercial packaged boilers forces the use of such equipment in applications where it may not make sense. Bradford White added that equipment with a combustion efficiency of approximately 85 to 88 percent in use today is a result of contractors consciously determining such equipment is appropriate for each respective installation. Bradford White stated that the proposed level of 85-percent E_C for LGHW commercial packaged boilers forces the use of such equipment in inappropriate applications and noted that changing out the vent system may not be possible in these installations. (Bradford White, No. 68 at p. 3)

In view of the preceding stakeholder comments about TSLs, DOE notes that DOE is required to set a standard that achieves significant additional energy savings that is determined to be technologically feasible and economically justified. In making such a determination, DOE must consider, to the maximum extent practicable, the benefits and burdens based on the seven criteria described in EPCA (see 42 U.S.C. 6313(a)(6)(B)(ii)(I)–(VII)). DOE's weighing of the benefits and burdens based on the final rule analysis and rationale for the TSL selection is discussed in section V and in detail in appendix 10C of the final rule TSD. DOE notes that much of the commentary regarding the selection of TSL levels for the standards is based on more detailed comments regarding specific portions of the final rule analysis. These comments related to specific analyses are addressed within the specific analysis section to which they pertain.

DOE also disagrees with Raypak's comments that the proposed standards were based on the standards applicable in Europe. Although DOE researches international energy efficiency regulations in the context of its market assessment, the standard levels that were proposed in the March 2016 NOPR, and those that are adopted in this final rule are not determined based on international regulations. Rather, DOE selects standard levels by weighing the benefits and burdens of each TSL to ensure that the standards save a significant additional amount of energy and are technologically feasible and economically justified, as required by EPCA. (42 U.S.C. 6313(a)(6)(A)(ii)(II) and (C)(i))

In addition, Bradford White questioned the selection of TSL 2 due the fact that it does not meet the rebuttable presumption payback of three years, and therefore would place a significant burden on consumers. (Bradford White, No. 68 at p. 4)

DOE notes that the 3-year payback period is contemplated under the rebuttable presumption test. However, DOE routinely conducts a full economic analysis that considers the full range of impacts, including those to the consumer, manufacturer, Nation and environment, and the results of this economic analysis are what serve as the basis for DOE to definitively evaluate the economic justification for a standard level. As detailed in section IV and section V of DOE's full economic analysis for this final rule document, DOE concludes based on clear and convincing evidence that the benefits of amended standards at TSL 2 outweigh the burdens, and the standards at TSL 2 are economically justified.

b. Comments on TSL 3

The Joint Advocates urged DOE to adopt NOPR TSL 3, noting that TSL 3 was found to be cost effective for purchasers and would more than double the national energy savings achieved by NOPR TSL 2. (Joint Advocates, No. 74 at p. 1) ASAP also suggested DOE should consider adopting NOPR TSL 3. (ASAP, Public Meeting Transcript, No. 61 at pp. 14–15) Weil-McLain, ABMA, and AHRI opposed the adoption of NOPR TSL 3. (Weil-McLain, No. 67 at p. 9; ABMA, No. 64 at p. 3; AHRI, No. 76 at pp. 1, 27, 44) Bradford White expressed the belief that the estimated gains of the SGHW equipment class at NOPR TSL 3 (*i.e.,* at 95-percent E_T) were overstated in DOE's analysis, and noted that the market is voluntarily moving towards products with efficiencies in excess of 90-percent E_T. (Bradford White, No. 68 at p. 3)

DOE considered the comments received in response to the consideration for TSL 3 as proposed in the March 2016 NOPR. However, based on DOE's updated analyses and the results presented in this final rule (see section V), TSL 3 is no longer economically feasible. Therefore, for the reasons discussed in section V.C.1, DOE has rejected TSL 3.

c. Other Comments

SoCalGas expressed concerns that the results of a SoCalGas modified LCC analysis shows a potentially significant burden to California and SoCalGas consumers, in particular regarding the LGHW equipment class, but acknowledged limitations to their analysis and filtering of the CBECS dataset. (SoCalGas, No. 77 at p. 4)

Nussbaum requests clarity on whether DOE's regulations are intended to remove enforcement from existing authorities, stating that California Energy Commission's interpretation is that DOE has taken over all enforcement related to efficiency. He further states that without state and local enforcement of efficiency, it will be sacrificed in order to achieve low NO_X requirements since in California emissions requirements are enforced. (Nussbaum, No. 60 at p. 1)

In response, DOE notes that while the SoCalGas analysis shows a small decline in the cost effectiveness (*i.e.,* LCC savings) of small gas-fired hot water equipment at certain efficiency levels, it showed an increase in the LCC savings at other levels relative to DOE's analysis. While the analysis did show negative LCC savings for the large gas-fired hot water equipment class at all efficiency levels, the approach taken in modifying the model to only look at a relatively small sample of buildings in the combined San Francisco and Los Angeles climate regions, may allow for a substantial uncertainty in the LCC results obtained for those regions. DOE's analysis focuses on the national costs and benefits obtained, as befitting development of National standards. Regarding the comment submitted by Nussbaum, under EPCA DOE has authority to establish and regulate minimum efficiency for commercial packaged boilers as measured under a standardized test procedure, but DOE recognizes that performance in the field can vary based on installation conditions, set-up, and maintenance.

2. Statutory Requirements

AHRI pointed out that EPCA's requirements in 42 U.S.C. 6295(o)(2) for DOE to achieve the maximum improvement in energy efficiency in its energy conservation standards rulemakings do not apply to commercial packaged boilers. Therefore, AHRI suggested that DOE's entire analysis is predicated on a fundamental flaw because it reflects an analysis that blatantly disregards the crucial flexibility that DOE has to more fully consider negative impacts on industry, particularly on small business and job loss. (AHRI, No. 76 at p. 6)

DOE agrees that EPCA does not require DOE to select the standard level that provides the maximum improvement in energy savings for commercial packaged boilers. However, as discussed in section II.A, an amended CPB standard must be designed to achieve significant additional energy conservation and be technologically feasible and economically justified. (42 U.S.C. 6313(a)(6)(A)(ii)(II) and (C)(i)) It is in DOE's discretion to adopt amended standards at any level that meet these legal criteria. DOE does not base its rulemaking solely on achieving maximum energy efficiency improvements as claimed by the stakeholders. In making the determination of economic justification of an amended standard, DOE considers, to the maximum extent practicable, the benefits and burdens of an amended standard based on the seven criteria described in EPCA, which include the economic impact of the standard on manufacturers. (See 42 U.S.C. 6313(a)(6)(B)(ii)(I)–(VII).) In considering both the standards proposed in the March 2016 NOPR and those being adopted in this final rule, DOE fully addressed EPCA's requirements in 42 U.S.C. 6313(a)(6)(B)(ii)(I)–(VII), including economic impact of the amended standards on manufacturers and small businesses. A discussion of DOE's weighting of the benefits and burdens based on these factors is contained in section V of this final rule. With regard to the specific comments on impact on manufacturers and employment impacts, DOE has considered these impacts, and they are discussed in V.B of this final rule. The differential impacts for small business manufacturers are discussed in section VI.B.

AHRI and Spire commented that DOE's CPB ECS rulemaking does not meet EPCA's requirement for clear and convincing evidence prescribed in 42 U.S.C. 6313 (a)(6)(A)(ii)(II), because DOE failed to provide reasonable basis for its analyses, such as its unsupported assumptions for venting costs and the fundamental energy use of commercial packaged boilers. AHRI further stated that this burden of proof is met only if evidence ''instantly tilted the evidentiary scales'' when viewed in light of alternative information. *Colorado* v. *New Mexico,* 467 U.S. 310, 316 (1984). By asking the stakeholders to substantiate its assumptions and by initiating a rulemaking amending ASHRAE standards without meeting the burden of proof requirements, AHRI argues that DOE impermissibly shifted the agency's burden of production onto the stakeholders. (AHRI, No. 76 at p. 7; Spire, No. 73 at pp. 6–8, 10)

DOE notes that it is adopting these standards pursuant to 42 U.S.C. 6313(a)(6)(C)(i)(II), which requires DOE to issue new standards based on ''the criteria and procedures established under subparagraph (B).'' In relevant part, subparagraph (B) specifies that: (1) In making a determination of economic justification, DOE must consider, to the maximum extent practicable, the benefits and burdens of an amended standard based on the seven criteria described in EPCA; (2) DOE may not prescribe any standard that increases the energy use or decreases the energy efficiency of a covered product; and (3) DOE may not prescribe any standard that interested persons have established by a preponderance of evidence is likely to result in the unavailability in the United States of any product type (or class) of performance characteristics (including reliability, features, sizes, capacities, and volumes) that are substantially the same as those generally available in the United States. (42 U.S.C. 6313(a)(6)(B)(ii)–(iii))

Importantly, subparagraph (B) does not mention clear and convincing evidence. What is more, multiple features of the statutory text indicate that a rule establishing standards under subparagraph (C)(i)(II) need not be based on clear and convincing evidence.[21] But

[21] To explain, the reference to ''criteria and procedures established under subparagraph (B)'' is not best read as encompassing a ''clear and convincing evidence'' threshold. For that phrase appears in subparagraph (A), not subparagraph (B), and therefore it is not a criterion or procedure ''established under subparagraph (B).'' Subparagraph (B) does mention subparagraph (A), but not in a manner that incorporates subparagraph (A) by reference; rather, subparagraph (B) says the criteria and procedures it establishes are to be used *in* subparagraph (A)(ii)(II). Subparagraph (C)(i)(II) says the subparagraph (B) criteria and procedures are also to be used in a subparagraph (C)(i)(II) decision. It does not follow—logistically or linguistically—that such a decision must also incorporate an evidentiary threshold that is used in a different type of decision to which subparagraph (B) also applies.

In addition, subsection (a) includes multiple cross-references to various paragraphs, subparagraphs, clauses, and subclauses. See, *e.g.,* 42 U.S.C. 6313(a)(5)(A); 6313(a)(5)(G);

Continued

assuming that clear and convincing evidence is required here, DOE believes its findings fully satisfy that threshold. To explain that conclusion, DOE articulates how it understands the ''clear and convincing evidence'' concept to operate in the context of DOE's setting energy conservation standards. Commenters referred to the context of litigation, where ''clear and convincing'' means that the evidence must ''place in the ultimate factfinder an abiding conviction that the truth'' of its conclusions is ''highly probable.'' [22] At the same time, to satisfy the ''clear and convincing'' standard of proof, a litigant need not eliminate all possible doubt, or even all reasonable doubt; ''clear and convincing'' is an intermediate standard that is less stringent than the ''beyond all reasonable doubt'' threshold required for a criminal conviction.

DOE fully recognizes that whenever it must have ''clear and convincing evidence'' pursuant to subclause (A)(i)(II), it needs a higher degree of confidence in its conclusions than would be required under the ''preponderance'' standard that ordinarily applies in an agency rulemaking. In such matters, the administrative record, taken as a whole, must justify DOE in a strong conviction that its conclusions are highly likely to be correct.

However, some commenters appear to think that the ''clear and convincing'' threshold would preclude DOE from using its expert judgment to make predictions. That would not be the case in litigation; a ''clear and convincing evidence'' standard of proof does not restrict the type, quality, or nature of evidence, including expert opinions that can be used. Moreover, a standards-setting rulemaking is not a litigation, and the differences warrant some differences in how the ''clear and convincing evidence'' threshold operates. DOE both develops the record and reviews it to make findings. Also, as an agency tasked with setting policy, DOE is ordinarily expected to use its predictive judgment. The text of paragraph (6) is consistent with that notion. Subparagraph (B), which describes various factors that DOE is to consider in making a subclause (A)(i)(II) decision for which it would need clear and convincing evidence, repeatedly calls for predictive judgments. DOE is to forecast the likely energy savings of a standard, the economic costs and benefits of the standard, and other future effects. By their nature, these assessments cannot be instantly determined to be correct. Rather, DOE believes ''clear and convincing evidence'' would mean that DOE must be strongly convinced that its forecasts are highly likely to be reasonable forecasts given current conditions and information.

In sum, for purposes of setting standards under paragraph (a)(6), ''clear and convincing evidence'' can include the same sorts of evidence and analysis that DOE would use in any other standards rulemaking. But DOE will conclude it has ''clear and convincing evidence'' only when it is strongly convinced that it is highly likely to have reached appropriate findings. With respect to the findings discussed in this rulemaking, DOE does have that strong conviction, well placed given the record as a whole.

Spire further commented that the NOPR was issued without remotely sufficient information and analysis to justify adoption of the standards proposed and that key information and analysis underlying it has yet to be disclosed so that it can be exposed to potential refutation through comment, and as such the NOPR is inadequate to satisfy notice and comment requirements, and should therefore be withdrawn.

Under the notice-and-comment or informal rulemaking provisions of the Administrative Procedure Act, DOE must publish in the **Federal Register** a notice of proposed rulemaking that includes: (1) A statement of the time, place, and nature of the public rulemaking proceedings; (2) a reference to the legal authority under which the rule is proposed; and (3) either the terms or substance of the proposed rule or a description of the subjects and issues involved. (5 U.S.C. 553(b)) DOE must then allow interested parties an opportunity to participate in the rulemaking through submission of written data, views, or arguments with or without opportunity for oral presentation. (5 U.S.C. 553(c)) On March 24, 2016, DOE published a NOPR and notice of public meeting in the **Federal Register** that met the requirements under 5 U.S.C. 553(b). DOE also provided the public an opportunity to present oral and written data, views, and arguments on the March 2016 CPB ECS NOPR.

IV. Methodology and Discussion of Related Comments

This section addresses the analyses DOE has performed for this rulemaking with regard to commercial packaged boilers. Separate subsections address each component of DOE's analyses.

DOE used three analytical tools to estimate the impact of the standards. The first tool is a spreadsheet that calculates the LCC savings and PBP of potential amended energy conservation standards. See section IV.F and chapter 8 of final rule TSD for details of the LCC and PBP spreadsheet tool. The second tool is a Microsoft Excel spreadsheet that calculates national energy savings and net present value resulting from potential amended energy conservation standards. More details of this spreadsheet tool can be found in section IV.H and chapter 10 of the final rule TSD. The third spreadsheet tool, the Government Regulatory Impact Model (GRIM), helps DOE to assess manufacturer impacts of potential standards. See section IV.J and chapter

6313(a)(6)(A)(ii)(I). Consistent with the ordinary scheme of cross-references, see House Legislative Counsel's Manual on Drafting Style, HLC No. 104–1, p. 24 (1995); Senate Office of the Legislative Counsel, Legislative Drafting Manual 10 (1997), in each of these cross-references a ''subparagraph'' reference is to an item labeled with a capital letter (such as ''subparagraph (B)''). Given the careful construction of the network of cross-references in subsection (a), it would be unusual for ''established under subparagraph (B)'' to sweep in an evidentiary standard stated in text other than subparagraph (B).

DOE also notes that clause (C)(i) contains two cross-references. Subclause (I), addressing one decision DOE might make, mandates that it be based on ''the criteria established under subparagraph (A).'' Subclause (II), addressing the decision DOE is making in this rulemaking, refers to ''the criteria and procedures established under subparagraph (B).'' By interpreting the latter phrase not to encompass ''clear and convincing evidence,'' DOE appropriately gives significance to this difference in language. Evidently ''the criteria established under subparagraph (A)'' are different from the ''the criteria established under subparagraph (B)''; were they the same criteria, there would have been no need to use different cross-references. ''Clear and convincing evidence'' is in (A), not (B).To the extent there is ambiguity in paragraph (a)(6) about whether DOE must have clear and convincing evidence to establish an amended standard under subparagraph (C), DOE believes its approach is consistent with the purposes of subparagraph (C). That is to say, the intent of paragraph (6) is to include ASHRAE in the standards-developing process. ASHRAE maintains standards that achieve energy conservation with respect to the products to which paragraph (6) applies, and ASHRAE is expected to update those standards as technology and markets evolve over time. When ASHRAE has acted in a timely fashion, DOE is to reflect ASHRAE's standards in its own standards, unless it has clear and convincing evidence justifying more stringent standards (on the terms of subclause (A)(i)(II)). However, the statute directs DOE to review its standards every six years—in case ASHRAE has not acted. This six-year review encourages ASHRAE to keep its standards up to date, because if it has recently amended its standards (and triggered DOE to follow), DOE will not need to engage in its independent standards revision. But, if ASHRAE has not revisited its standards for some while, DOE's six-year review provides an occasion on which DOE might adopt more stringent standards, without being tied to the ASHRAE standards. By not imposing the ''clear and convincing'' threshold for such a rulemaking, the statute encourages ASHRAE to continually update its standards. In short, a common-sense approach to the purposes of subparagraph (C) aligns with the above careful textual reading.

[22] *Colorado* v. *New Mexico,* 467 U.S. 310, 316 (1984).

12 of the final rule TSD. In addition, these tools are available on the DOE website for this rulemaking: *http://www.regulations.gov/docket?D=EERE-2013-BT-STD-0030.*

Additionally, DOE used output from the 2016 version of the Energy Information Administration's (EIA's) *Annual Energy Outlook* (*AEO*) for the emissions and utility impact analyses.

A. Market and Technology Assessment

1. General

For the market and technology assessment, DOE develops information that provides an overall snapshot of the market for the equipment considered, including the nature of the equipment, market characteristics, industry structure, and technologies that improve energy efficiency. DOE divides the market and technology assessment broadly into two categories: (1) Market assessment and (2) technology assessment. The purpose of the market assessment is to develop a qualitative and quantitative characterization of the CPB industry and market structure, based on information that is publicly available as well as data submitted by manufacturers and other interested parties. Issues addressed include CPB characteristics (gathered from market databases and literature), market share and equipment classes; existing regulatory and non-regulatory efficiency improvement initiatives; models currently available and their distribution with respect to efficiency and rated input in each equipment class. The purpose of the technology assessment is to investigate technologies currently used in commercial packaged boilers, and identify those that will improve the energy efficiency of commercial packaged boilers. The technology assessment results in a preliminary list of technology options that can improve the thermal and/or combustion efficiency of commercial packaged boilers. Chapter 3 of the final rule TSD contains all the information related to the market and technology assessment. The chapter also provides additional details on the methodology used, information gathered, and results. DOE typically uses the information gathered in this chapter in the various downstream analyses such as engineering analysis, shipment analysis, and manufacturer impact analyses.

For this final rule, DOE explored the market to identify manufacturers of commercial packaged boilers. As per the definition set forth in 10 CFR 431.82, a manufacturer of a commercial packaged boiler is any entity that: (1) Manufactures, produces, assembles, or imports a commercial packaged boiler in its entirety; (2) manufactures, produces, assembles, or imports a commercial packaged boiler in part, and specifies or approves the boiler's components, including burners or other components produced by others, as for example by specifying such components in a catalogue by make and model number or parts number; or (3) is any vendor or installer who sells a commercial packaged boiler that consists of a combination of components that is not specified or approved by a person described in the two previous parts of this definition.

Through extensive search of publicly available information, including DOE's Compliance Certification Database[23] and ABMA's and AHRI's websites, DOE identified 46 unique parent companies that manufacture CPB equipment. The complete list of manufacturers can be found in chapter 3 of the final rule TSD.

In the NOPR analysis, DOE relied on equipment listing data from AHRI and other public sources and requested comment on any manufacturers of CPB equipment that were not represented in this analysis. Bradford White recommended that DOE review the paid research reports, included in research from BRG Building Solutions to identify manufacturers that are neither members of AHRI nor ABMA.[24] (Bradford White, No. 68 at p. 4)

For the final rule, DOE's market analysis is primarily based on the Compliance Certification Database. The Compliance Certification Database houses certification reports and compliance statements submitted by manufacturers for covered equipment and equipment subject to Federal conservation standards. Manufacturers of all covered equipment are required to submit a certification report before a basic model is distributed in commerce. The Compliance Certification Database includes only certification records of current basic models that have been submitted to DOE in the past year. Thus, this database should provide the most comprehensive list of manufacturers actively selling commercial packaged boilers in the United States. However, DOE also surveyed the market to identify manufacturers that are not included in the Compliance Certification Database, but that appear to be actively selling CPB models. DOE reviewed AHRI and ABMA member manufacturers, and also searched publicly available information to identify several manufacturers who are neither members of AHRI nor ABMA. Through these information sources, DOE concludes it has generated a complete picture of the CPB market and manufacturers, and, thus, did not require the report suggested by Bradford White. The models offered by all manufacturers that DOE identified in this rulemaking characterize the market for commercial packaged boilers in the market and technology assessment (chapter 3 of the final rule TSD).

2. Scope of Coverage

EPCA lists ''packaged boilers'' as a type of covered equipment. (42 U.S.C. 6311(1)) EPCA defines the term ''packaged boiler'' as ''a boiler that is shipped complete with heating equipment, mechanical draft equipment, and automatic controls; usually shipped in one or more sections.'' (42 U.S.C. 6311(11)(B))

In the 2016 CPB TP final rule, DOE consolidated various definitions related to commercial packaged boilers by revising its definitions for ''packaged boiler'' and ''commercial packaged boiler'' at 10 CFR 431.82, and removing the definitions for ''packaged low pressure boiler'' and ''packaged high pressure boiler.'' The definition for ''packaged boiler'' adopted by DOE in the 2016 CPB TP final rule is essentially the same as EPCA's definition, but clarifies that if the boiler is shipped in more than one section, the sections may be produced by more than one manufacturer, and may be originated or shipped at different times and from more than one location. DOE updated the definition of a ''commercial packaged boiler'' to define the term as a packaged boiler that meets all of the following criteria: (1) Has a rated input of 300,000 Btu/h or greater; (2) is distributed in commerce for space conditioning and/or service water heating in buildings but does not meet the definition of ''hot water supply boiler''; (3) does not meet the definition of ''field-constructed''; and (4) is designed to, or is operated at a steam pressure of at or below 15 psig or a water pressure at or below 160 psig and water temperature of 250 °F. 81 FR 89276, 89279–89280 (December 9, 2016). DOE also adopted a related definition for ''field-constructed.''

As noted above, the definition of ''packaged boiler'' refers to a boiler that is shipped complete with heating

[23] DOE's Compliance Certification Database houses certification reports and compliance statements submitted by manufacturers for covered products and equipment subject to Federal conservation standards. *http://energy.gov/eere/buildings/implementation-certification-and-enforcement.*

[24] BRG Building Solutions is a global consultancy that provides market data for various construction, building products, and utility industries, including heating and ventilation products. *www.brgbuildingsolutions.com/.*

equipment, mechanical draft equipment, and automatic controls. Although, the definition does not explicitly include natural draft equipment, DOE concluded in the August 2015 withdrawal notice that natural draft commercial packaged boilers are and have been covered equipment subject to DOE's energy conservation standards for commercial packaged boilers. 80 FR 51487. Accordingly, DOE proposed amended energy conservation standards in the March 2016 NOPR that are applicable to natural draft commercial packaged boilers, and has likewise included natural draft commercial packaged boilers in the analysis for this final rule and adopts standards that are applicable to this equipment.

3. Equipment Classes

When evaluating and establishing energy conservation standards, DOE typically divides covered equipment into equipment classes based on the type of energy used, capacity, or performance-related features that justify a different standard. In making a determination whether a performance-related feature justifies a different standard, DOE considers such factors as the utility to the consumer of the feature and other factors DOE determines are appropriate. The current regulations for commercial packaged boilers list 10 equipment classes with corresponding energy efficiency standards for each.[25] 10 CFR 431.87. These equipment classes are based on (1) size (rated input), (2) heating media (hot water or steam), and (3) type of fuel used (oil or gas).[26] The gas-fired steam commercial packaged boilers are further classified according to draft type. In the March 2016 NOPR, DOE proposed to consolidate CPB equipment classes that are currently divided by draft type.[27] Specifically, DOE proposed to combine the small (≥300,000 Btu/h and ≤2,500,000 Btu/h), gas fired—all except natural draft, steam and small (≥300,000 Btu/h and ≤2,500,000 Btu/h), gas fired—natural draft, steam classes; and the large (>2,500,000 Btu/h and ≤10,000,000 Btu/h), gas fired—all except natural draft, steam and large (≥2,500,000 Btu/h and ≤10,000,000 Btu/h), gas fired—natural draft, steam classes from four equipment classes to two equipment classes: (1) Small (≥300,000 Btu/h and ≤2,500,000 Btu/h), gas-fired steam; and (2) large (>2,500,000 Btu/h and ≤10,000,000 Btu/h), gas-fired steam. 81 FR 15852.

The Joint Advocates and Bradford White supported DOE's reconfiguration of the equipment classes to eliminate draft type as a distinguishing feature. (Joint Advocates, No. 74 at p. 2; Bradford White, No. 68 at p. 4) The Joint Advocates added that natural draft boilers provide no distinct performance-related utility. (Joint Advocates, No. 74 at p. 2)

Weil-McLain, Spire, the Gas Associations, and BHI requested that DOE establish separate equipment classes for natural draft and mechanical draft commercial packaged boilers, noting that the ability to utilize natural draft in installations provides consumers with utility. (Weil-McLain, No. 67 at p. 6; BHI, No. 71 at pp. 14–15; Spire, No. 73 at p. 11; Gas Associations, No. 69 at p. 4; Crown, Public Meeting Transcript, No. 61 at p. 159) BHI stated that loss of the ability to use Category I venting (suitable for non-condensing boilers) is a loss in utility because the circumstances of many real world installations offer no practical alternatives to Category I venting. BHI argued that providing heat and hot water are not the only utility functions, features, and performance characteristics of boilers, and that designs that allow proper installation in a variety of cases are a critical aspect of utility so that such equipment can be installed and used safely. In addition, BHI stated that there is a point at which increasing installation costs become large enough to effectively create a ''loss of utility,'' and this situation in the real world is as likely to ''result in the unavailability'' of appropriate Category I boilers as a pure design issue. Further, BHI adds that DOE overstated the availability and utility of 85-percent gas-fired hot water boilers, particularly 85-percent atmospheric boilers in its screening analysis. BHI suggests that the adoption of 85-percent gas-fired hot water standard will leave many consumers with no cost effective option for replacement boiler and could lead to safety issues due to problems in venting system. BHI stated that this is a direct violation of the ''safe harbor rule.'' (BHI, No. 71 at pp. 4, 13–15) Spire also suggested that easy installation to existing natural draft venting systems should qualify as a unique utility of natural draft units and therefore should be preserved under 42 U.S.C. 6313(a)(6)(B)(i)(IV). Spire noted that DOE has recognized this fact in its decision to maintain separate equipment classes for ''space-constrained'' heat pumps and air conditions. (Spire, No. 72, at pp. 10–12) Raypak commented that DOE should not assume that all boiler installations will be capable of handling new installations at the amended efficiencies proposed in the March 2016 NOPR. They add that half of the commercial buildings were built before 1980 and when these boilers need to be replaced, it may not be possible to install an 85-percent efficient boiler in its place. Raypak further states that the category I boilers must be retained for such replacement scenarios. (Raypak, No. 72 at p. 3)

DOE maintains its position explained in the March 2016 NOPR and reiterates that the utility derived by consumers from commercial packaged boilers is in the form of the space heating function that a boiler performs, rather than the type of venting the boiler uses. Boilers requiring Category I or Category IV venting are capable of providing the same heating function to the consumer, and, thus, provide the same utility with respect to their primary function. DOE does not consider reduced costs associated with Category I venting in certain installations as a utility to the consumer, and also disagrees with BHI's assertion that there is a point at which the installation costs get so prohibitively expensive that they create a loss of utility to the consumer. Instead, the expenses associated with venting requirements are considered as an economic impact on consumers in the rulemaking's cost-benefit analysis and ultimately the analysis determines if the cost is economically prohibitive. Details regarding installation costs can be located in section IV.F.2. Further, DOE maintains that this final rule is not in violation of ''safe harbor'' rule because it does not result in the unavailability of any covered product class of performance characteristics (including reliability, features, sizes, capacities and volumes) that are substantially the same as those currently available. 42 U.S.C. 6313(a)(B)(iii)(II)(aa) DOE does not consider the type of venting to be a ''feature'' that would provide utility to consumers; instead DOE properly accounts for the economic benefits of the venting type in the economic analysis. Further, with regard to issues of safety in venting and incorrect

[25] These standard levels were adopted in the July 2009 final rule. 74 FR 36312 (July 22, 2009).

[26] Under subpart E of 10 CFR part 431, commercial packaged boilers are divided into equipment classes based on rated input (*i.e.,* size category). Throughout this document, DOE refers to units with a rated input of ≥300,000 Btu/h and ≤2,500,000 Btu/h as ''small'' and units with a rated input of >2,500,000 Btu/h as ''large.'' *See* 10 CFR 431.87.

[27] Because DOE is not adopting amended standards for commercial packaged boilers with rated inputs above 10,000,000 Btu/h, the standards for equipment in this class will remain unchanged. Thus, although DOE is consolidating this equipment into a single class, an allowance will still be made for natural draft units to have a lower minimum efficiency until March 2, 2022, as is allowed under the current standards.

installation, DOE notes that there is equipment that is currently installed in commercial buildings that meets or exceeds the amended standards established in this final rule. Manufacturers will also have sufficient time after the publication of this final rule and before the compliance date to revise their installation and operation manuals of their compliant equipment or to train contractors on installation of equipment that requires a change of the venting system.

In the March 2016 NOPR, DOE tentatively decided to classify commercial packaged boilers with rated input greater than 10,000 kBtu/h into separate equipment classes and not amend energy conservation standards for those classes because of regulatory complexities and lack of sufficient data to justify amended standards. 81 FR 15851–15853. Specifically, DOE noted that commercial packaged boilers with rated input greater than 10,000 kBtu/h are generally engineered-to-order, have very low shipment volumes as compared to other equipment classes with lower rated input, and have limited potential for significant additional energy savings. These factors, combined with a lack of information on pricing, shipments, and rated efficiency, led DOE to not propose amended energy conservation standards for very large commercial packaged boilers; however, the current efficiency standards applicable for the large CPB equipment classes remain applicable to the very large CPB equipment classes.

In response to these proposed amendments, Bradford White and ABMA expressed support for the introduction of the ''Very Large'' equipment classes. (Bradford White, No. 68 at p. 4; ABMA, No. 64 at p. 1) However, ABMA requested DOE to place a capacity limit on this rulemaking. (ABMA, No. 64 at p. 1) Raypak expressed support for not increasing the efficiency standard for very large commercial packaged boilers. (Raypak, No. 72 at p. 4) ABMA also noted that very large commercial packaged boilers are generally custom-built, and obtaining realistic prices for such equipment will not be possible. (ABMA, No. 64 at p. 2)

Based on the foregoing, DOE adopts equipment classes for ''very large'' commercial packaged boilers in this final rule. However, as discussed in the March 2016 NOPR, an upper limit for the rated input for commercial packaged boilers regulated by DOE's standards would violate EPCA's anti-backsliding provisions set forth in 42 U.S.C. 6313(a)(6)(B)(iii)(I), as the existing standards apply to all equipment meeting the definition of commercial packaged boiler regardless of the rated input. Providing an upper limit for rated input above which standards do not apply would essentially be repealing the existing standards for that equipment, which is prohibited by the anti-backsliding clause. As such, DOE maintains the existing standards for very large commercial packaged boilers at the levels currently applicable to all commercial packaged boilers with rated input greater than or equal to 2,500 kBtu/h.

In summary, today's final rule adopts the following changes proposed in the March 2016 NOPR: (1) Separating the equipment classes for commercial packaged boilers that have rated input above 10,000 kBtu/h, and (2) consolidating the equipment classes for small and large gas-fired steam boilers that are currently divided based on draft type into equipment classes that are not divided based on draft type, thereby reducing the four draft-specific classes into two classes that are not draft specific. In addition, DOE has decided not to amend energy conservation standards for very large commercial packaged boilers. The current standards for large CPB equipment classes will remain applicable to the corresponding very large CPB equipment classes.

Thus, in total, DOE is adopting 12 equipment classes [28] for commercial packaged boilers. The equipment classes are categorized based on: (1) Rated input (small (≥300,000 Btu/h to ≤2,500,000 Btu/h), large (>2,500,000 Btu/h and ≤10,000,000 Btu/h) and very large (>10,000,000 Btu/h)); (2) heating medium (hot water or steam); and (3) fuel type (gas-fired or oil-fired). Table IV.1 shows all of the CPB equipment classes, including the eight equipment classes for which DOE is amending standards and four equipment classes for which DOE did not amend standards.

TABLE IV.1—EQUIPMENT CLASSES FOR COMMERCIAL PACKAGED BOILERS

Equipment class	Size	Fuel	Heating medium	Acronym	Amended standards adopted in this final rule
Small Gas-fired Hot Water	≥300kBtu/h to ≤2,500kBtu/h	Gas	Hot Water	SGHW	Yes.
Large Gas-fired Hot Water	>2,500kBtu/h to ≤10,000kBtu/h	Gas	Hot Water	LGHW	Yes.
Very Large Gas-fired Hot Water **	>10,000kBtu/h	Gas	Hot Water	VLGHW	No.
Small Oil-fired Hot Water	≥300kBtu/h to ≤2,500kBtu/h	Oil	Hot Water	SOHW	Yes.
Large Oil-fired Hot Water	>2,500kBtu/h to ≤10,000kBtu/h	Oil	Hot Water	LOHW	Yes.
Very Large Oil-fired Hot Water **	>10,000kBtu/h	Oil	Hot Water	VLOHW	No.
Small Gas-fired Steam *	≥300kBtu/h to ≤2,500kBtu/h	Gas	Steam	SGST	Yes.
Large Gas-fired Steam *	>2,500kBtu/h to ≤10,000kBtu/h	Gas	Steam	LGST	Yes.
Very Large Gas-fired Steam **	>10,000kBtu/h	Gas	Steam	VLGST	No.
Small Oil-fired Steam	≥300kBtu/h to ≤2,500kBtu/h	Oil	Steam	SOST	Yes.
Large Oil-fired Steam	>2,500kBtu/h to ≤10,000kBtu/h	Oil	Steam	LOST	Yes.
Very Large Oil-fired Steam **	>10,000kBtu/h	Oil	Steam	VLOST	No.

* The small, gas-fired, steam, natural draft equipment classes and small, gas-fired steam, all except natural draft equipment classes prior to this final rule are consolidated into a single small gas-fired, steam equipment class. Similarly, the large, gas-fired, steam, natural draft equipment classes and large, gas-fired steam, all except natural draft equipment classes prior to this final rule are consolidated into a single large, gas-fired, steam equipment class.

** DOE establishes separate equipment classes for commercial packaged boilers with rated input above 10,000kBtu/h.

[28] Consolidating the 4 draft-specific classes into 2 non-draft-specific classes reduces the number of equipment classes from 10 to 8, and creating separate equipment classes for very large CPB equipment adds 4 equipment classes. These changes result in 12 equipment classes.

4. Market Assessment

As discussed previously, in the market assessment DOE uses qualitative and quantitative information to assess the past and present industry structure and market characteristics. In carrying out this assessment, DOE examines literature from a variety of sources, including industry publications, trade journals, government agencies, manufacturers, and trade organizations.

In the March 2016 NOPR, DOE compiled a database of commercial packaged boilers that was sourced from the AHRI's Directory of Certified Product Performance (AHRI database) for commercial packaged boilers and information gathered from manufacturer specifications of ABMA member manufacturers. In chapter 3 of the NOPR TSD, DOE presented histograms showing the distribution of commercial packaged boilers by efficiency and rated input for each equipment class. DOE used these distributions of models as inputs to the engineering analysis to calculate the incremental prices and identify intermediate and max-tech efficiency levels in each equipment class.

In response to using the distribution of models in the engineering analysis, AHRI provided comments requesting DOE to reconsider its approach. AHRI provided histograms of the distribution of the boiler models based on their directory of certified equipment performance and highlighted the differences with the histograms presented in the market and technology assessment (chapter 3 of the NOPR TSD). (AHRI, No. 76 at p. 12) Raypak also provided comments opposing the use of the distribution of CPB models available on the market in each equipment class, to conduct the engineering analysis. Raypak also added that DOE does not have equipment listings for 11 out of 45 manufacturers who are not represented by AHRI or ABMA. (Raypak, Public Meeting Transcript, No. 61 at pp. 57–58; Raypak, No. 72 at pp. 2–3)

In response, DOE notes that it created the equipment database for the March 2016 NOPR using the AHRI database (that was accessed in July 2015) and models of ABMA member manufacturers. The histograms that AHRI provided in their comments only include models from a more recent version of AHRI's directory of equipment performance. Therefore, the difference in the histograms is most likely due to the difference in the versions of the AHRI database considered in the March 2016 NOPR and in AHRI's comments; and due to the additional data from ABMA member manufacturer literature which is not accounted for in the histograms in AHRI's comments.

In this final rule, DOE has created an updated database, that includes commercial packaged boilers from several sources of information, including its own Compliance Certification Database,[29] AHRI's Directory of Certified Product Performance[30] (accessed in July 2016) for commercial packaged boiler, and manufacturer literature. In response to comments provided by Raypak, DOE has also considered boilers that meet the definition of commercial packaged boilers and are produced by manufacturers who are not members of ABMA or AHRI. DOE compiled a database consisting of a total of 4,791 CPB models for the final rule (MTA database). However, in the downstream analysis, DOE did not use information for certain models because they either: (1) Did not list the relevant energy efficiency metric applicable for that commercial packaged boiler; (2) had rated efficiency lower than the corresponding energy conservation standard; or (3) listed an efficiency rating based on a test procedure other than DOE's test procedure for commercial packaged boilers. While such equipment was considered as part of the boiler models available on the market since they meet the definition of commercial packaged boilers, they were not considered in the downstream analysis since the relevant data was missing. Out of the total of 4,791 CPB models in the MTA database, 2,826 models had the necessary data for consideration in the engineering analysis. (Note, the 2,826 model count does not include the models in the ''very large'' equipment classes.) DOE used these remaining boiler models for selecting efficiency levels and to conduct the analysis for evaluating the incremental prices for higher efficiency. DOE has presented the distribution of commercial packaged boilers based on the relevant energy-efficiency metric (*i.e.,* E_T or E_C) and rated input in chapter 3 of the final rule TSD.

In response to the March 2016 NOPR, AHRI provided aggregated shipments data for SGHW and LGHW equipment classes, broken down by efficiencies and rated input for the years 2014 and 2015. In a separate correspondence with DOE, AHRI has also provided aggregated annual shipment information for different non-condensing and condensing; and gas- and oil-fired commercial packaged boilers spanning the years from 2001 to 2015. (AHRI, No. 76 at p. 13)

DOE used the shipment data provided by AHRI in its rulemaking analyses for this final rule.

Chapter 3 of the final rule TSD, the market and technology assessment, contains a detailed discussion of the models in the analysis used and the distribution of CPB models by their efficiency and rated input, and other characteristics (*e.g.,* material, modulating or non-modulating). Chapter 5 of the final rule TSD, the engineering analysis, discusses the models used for the selection of efficiency levels and the engineering analysis.

5. Technology Options

As part of the rulemaking analysis, DOE identifies technology options that are currently used in commercial packaged boilers at different efficiency levels available on the market. This helps DOE to assess the technology changes that would be required to increase the efficiency of a commercial packaged boiler from baseline to other higher efficiency levels. Initially, these technologies encompass all those DOE determines are technologically feasible.

As a starting point, DOE typically uses information from existing and past rulemakings as inputs to determine what technologies manufacturers use to attain higher performance levels. DOE also researches emerging technologies that have been demonstrated in prototype designs. DOE developed its list of design options for the considered equipment classes through consultation with manufacturers, including manufacturers of components and systems, and from trade publications and technical papers.

In the March 2016 NOPR, DOE presented a list of technologies for improving the efficiency of commercial packaged boilers: (1) Jacket insulation; (2) heat exchanger improvements (including condensing heat exchanger); (3) burner derating; (4) improved burner technology; (5) combustion air preheaters; (6) economizers; (7) blowdown waste heat recovery; (8) oxygen trim systems; and (9) integrated, high efficiency steam boiler. DOE also added in the March 2016 NOPR that it is considering ''pulse combustion burners'' as an option to achieve condensing operation and tentatively decided to categorize it under condensing boiler heat exchanger design. 81 FR 15853.

[29] DOE's Compliance Certification Database is located at: *https://www.regulations.doe.gov/certification-data/#q=Product_Group_s%3A*.*

[30] AHRI's Directory of Certified Product Performance can be found at *https://www.ahridirectory.org/ahridirectory/pages/home.aspx.*

In response to the March 2016 NOPR, Lochinvar suggested that the benefits of the oxygen trim technology were overstated in the TSD and requested that DOE provide more details on the 1 to 2 percent efficiency improvement claim. Lochinvar noted that oxygen trim systems require electronically positioned valves and other controls that increase the cost of the boiler which must be factored into the analysis. Lochinvar added that oxygen trim systems incorporate oxygen sensors which require replacement every few years. (Lochinvar, No. 70 at p. 7)

In response, DOE notes that the efficiency increments specified in the NOPR TSD for oxygen trim systems are based on a possible reduction in combustion air and an estimated improvement in efficiency corresponding to that reduction in excess air. These efficiency improvements are sourced from publicly available literature.[31] Based on the literature, every 1-percent decrease in excess oxygen or 15-percent decrease in excess air in the stack, could result in an improvement in efficiency of 0.5 percent and 1 percent, respectively. While DOE considered these technology options as opportunities to improve the efficiency for the technology assessment, it did not use the options directly in the engineering analysis to establish a path for improvement in efficiency and calculate the corresponding incremental cost. Instead, in the engineering analysis, DOE used the price-efficiency approach to determine the increase in manufacturer selling price of the boiler with respect to increase in efficiency (see section IV.C.1). This approach relies on selecting efficiency levels and collecting pricing for commercial packaged boilers at those levels, regardless of the particular technology used to reach the level and using that information to develop aggregate industry price estimates at each efficiency level. Therefore, the technology options identified and specifically the options that passed the screening analysis (discussed in section IV.B of this final rule) do not directly impact the engineering analysis, but rather serve an informational purpose for options that manufacturers, researchers, and other interested parties may consider to improve the efficiency of commercial packaged boilers.

[31] For more information on ''Oxygen trim systems'' see: *http://www1.eere.energy.gov/manufacturing/tech_assistance/pdfs/steam4_boiler_efficiency.pdf* and *http://www.pdhonline.com/courses/m166/m166content.pdf.*

DOE also received comments from Raypak in the NOPR public meeting recommending moving pulse combustion as a completely independent technology option rather than enlisting it under heat exchanger improvements. (Raypak, Public Meeting Transcript, No. 61 at p. 51)

DOE agrees with the comments and has decided to add pulse combustion as a separate technology option different from heat exchanger improvements or improved burner technology.

DOE did not receive any other comments on the technology options it considered in the March 2016 NOPR. Therefore, in this final rule, DOE has retained all the technology options that were identified in the March 2016 NOPR and has included ''pulse combustion'' as a separate technology option. The technology options that are identified for the final rule analysis are described in detail in chapter 3 of the final rule TSD.

B. Screening Analysis

After DOE identified the technologies that might improve the energy efficiency of commercial packaged boilers, DOE conducted a screening analysis. The goal of the screening analysis is to identify technology options that will be considered further, and those that will be eliminated from further consideration, in the rulemaking analyses. DOE applied the following set of screening criteria to each of the technologies identified in the technology assessment to determine which technology options are unsuitable for further consideration in the rulemaking:

- *Technological feasibility:* DOE will consider technologies incorporated in commercial equipment or in working prototypes to be technologically feasible.
- *Practicability to manufacture, install, and service:* If mass production and reliable installation and servicing of a technology in commercial equipment could be achieved on the scale necessary to serve the relevant market at the time the standard comes into effect, then DOE will consider that technology practicable to manufacture, install, and service.
- *Adverse impacts on equipment utility or equipment availability:* If DOE determines a technology would have a significant adverse impact on the utility of the equipment to significant subgroups of consumers, or would result in the unavailability of any covered equipment type with performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as equipment generally available in the United States at the time, it will not consider this technology further.
- *Adverse impacts on health or safety:* If DOE determines that a technology will have significant adverse impacts on health or safety, it will not consider this technology further. 10 CFR part 430, subpart C, appendix A, 4(a)(4) and 5(b)

In sum, 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. 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.

In the March 2016 NOPR, DOE applied the screening criteria to all technologies identified in the technology assessment (see section IV.A.5). Based on the screening criteria described previously, DOE removed ''burner derating'' from further consideration in the rulemaking analysis, noting that the technology option could lower the heating output to the consumer thereby reducing consumer utility. The remaining technology options passed the screening analysis. Out of the options that passed the screening analysis criteria, DOE further identified technology options that would have negligible impact on the efficiency as measured by DOE's test procedure set forth in 10 CFR 431.86. Specifically, DOE identified the following technologies as having a negligible impact on the rated energy efficiency: (1) Jacket insulation; (2) combustion air pre-heaters; (3) economizers; and (4) blowdown waste heat recovery. These technologies were removed from further consideration in the rulemaking analysis. The remaining technology options were found to have an impact on the measured energy efficiency of commercial packaged boilers: (1) Heat exchanger improvements (including condensing heat exchangers); (2) improvements in burner technology; and (3) oxygen trim systems. 81 FR 15853–15855.

As discussed in section IV.A.5 of this final rule, DOE has decided to add pulse combustion as a separate technology option. Previously DOE had included pulse combustion under heat exchanger technology options which passed the screening analysis in the March 2016 NOPR. Therefore, in this final rule, pulse combustion was included as a separate technology option in the list that passed the screening analysis.

DOE did not receive any comments on the technology options that were removed from further consideration or passed the screening criteria. Therefore, DOE continues to screen the technologies as was done for the March 2016 NOPR and summarized immediately above. For more information on the screening analysis see chapter 4 of the final rule TSD.

C. Engineering Analysis

The engineering analysis establishes the relationship between manufacturer selling prices (MSP) and energy-efficiency of commercial packaged boilers. This price-efficiency relationship serves as a basis for subsequent cost-benefit calculations for individual consumers, manufacturers, and the Nation.

To determine this price-efficiency relationship, DOE uses data from the market and technology assessment, publicly available equipment literature and research reports, and information from manufacturers, distributors, and contractors. For this rulemaking, DOE first used information from the market and technology assessment to identify efficiency levels and representative equipment for analysis (see section IV.A). In the engineering analysis, DOE collected CPB prices primarily from manufacturers, mechanical contractors, and equipment distributors. DOE tabulated all of the price data in a separate database, which is referred to as the ''prices database.''

1. Methodology

DOE has identified three basic methods for developing price-efficiency curves: (1) The design-option approach, which provides the incremental manufacturing costs of adding design options to a baseline model that will improve its efficiency; (2) the efficiency-level approach, which provides the incremental price of moving to higher efficiency levels without regard to any particular design option; (3) the reverse-engineering (or cost-assessment) approach, which provides ''bottom-up'' manufacturing cost assessments for achieving various levels of increased efficiency based on teardown analyses (or physical teardowns) providing detailed data on costs for parts and material, labor, shipping/packaging, and investment for models that operate at particular efficiency levels.[32]

For this rulemaking, DOE has decided to use the efficiency-level approach to conduct the engineering analysis. This methodology generally involves calculating prices of commercial packaged boilers for a given rated input (representative capacity) for each manufacturer at different efficiency levels spanning from the minimum allowable standard (*i.e.,* baseline level) to the maximum technologically feasible efficiency level. The primary output of the analysis is a set of price-efficiency relationships that represent the average change in manufacturer selling price for higher efficiency equipment (*i.e.,* ''incremental price''). In the subsequent markups analysis (chapter 6 in the final rule TSD), DOE determines consumer prices by applying additional distribution chain markups and sales tax to the manufacturer selling prices developed in the engineering analysis. After applying these markups, the data serve as inputs to the life-cycle cost and payback period analyses (chapter 8 in the final rule TSD).

As discussed previously, DOE classified commercial packaged boilers into twelve equipment classes based on rated input, heating medium (hot water or steam), and fuel type (gas or oil). For all equipment classes, except the very large CPB equipment classes (for which DOE is not amending energy conservation standards), DOE collected pricing data which it used to directly analyze the price-efficiency relationship of each equipment class. DOE did not analyze very large CPB equipment classes in this engineering analysis.

For each manufacturer selling price obtained, DOE first calculated the ratio of the price of the commercial packaged boiler with respect to its rated input to obtain all prices on a per-unit rated input basis (dollars per kBtu/h). The prices obtained were at various rated inputs, so DOE assigned weights to individual prices (on a per rated input basis) based on the distribution of rated inputs of either CPB shipments (where DOE had this data available) or CPB models available on the market. DOE gave more weight to the prices for equipment at input capacities that have higher representation in CPB shipments or CPB models on the market. For SGHW equipment class, AHRI provided shipment information that includes the distribution of CPB shipments by rated input and by efficiency. Therefore, for the engineering analysis for the SGHW equipment class, DOE used the information provided by AHRI to calculate the weights based on the distribution of shipments by rated input. For all other equipment classes, DOE did not have information on distribution of shipment by rated input. As a result, DOE used the numbers of models available on the market from the equipment database to calculate the weights to corresponding to the rated input of each CPB price. DOE applied these weights to calculate the weighted average price per rated input and the weighted average rated input for each efficiency level.

Next, DOE scaled the weighted average price (on a per rated input basis) at each efficiency level from the weighted average rated input (at which the price was calculated in the previous step) to the representative rated input for the respective equipment class. DOE used 800 kBtu/h and 3,000 kBtu/h as the representative rated input for the small and large equipment classes. To normalize the prices back to the representative capacity, DOE used non-linear regression to determine the equation that best represents the price on a per-unit input basis as a function of rated input. Through the non-linear regression, DOE noticed that for lower input capacities the price on a per input basis is higher, and as the rated input increases, the price per input decreases. In addition, the rate of change of the price on a per-unit input basis with respect to rated input also decreases considerably as the rated input increases. The result of this non-linear regression is a scatter plot that appears to resemble a decreasing exponential curve. This trend is expected, as CPB models will have certain fixed costs that are present regardless of the size, and other costs that will increase as the rated input increases. DOE applied the regression equation to determine the weighted average price per input at the representative rated input for each efficiency level analyzed.

Once DOE had determined the weighted average price per input at the representative capacity for all efficiency levels, DOE performed a regression analysis to deduce the equation that best represents the price-efficiency relationship. Using the regression equation, DOE calculated the predicted weighted average price per input at the representative capacity for all efficiency levels that were analyzed in each equipment class. DOE then multiplied the predicted weighted average price per input at the representative capacity by the representative capacity to get the manufacturer selling price at each efficiency level. As a final step, DOE calculated the incremental prices by subtracting the baseline price from the manufacturer selling price of each efficiency level above the baseline.

DOE used the methodology described above to analyze each equipment class (other than very large equipment classes). For the SGHW equipment classes DOE used the same methodology

[32] The term 'cost' refers to the manufacturing cost, while the term 'price' refers to the manufacturer selling price. In some of the engineering analysis approaches DOE calculates the manufacturing cost which is multiplied with the appropriate markups to get the manufacturer selling price.

to conduct separate analyses for condensing and non-condensing efficiency levels. This was done to account for difference in the slopes of the price efficiency curves between non-condensing and condensing efficiency levels. To carry out the separate assessment for condensing SGHW commercial packaged boilers, DOE separated the condensing SGHW models from the non-condensing SGHW models and used the separate datasets to conduct the analysis as per the methodology described in the previous paragraph. DOE did not have sufficient pricing data to analyze each condensing efficiency level of LGHW, SOHW and LOHW. As a result, DOE did not analyze these condensing levels separately. Instead, DOE used the same incremental manufacturer selling prices that were determined in the preliminary analysis TSD to evaluate the prices for condensing efficiency levels in these equipment classes. DOE did not receive any comments in the previous stages of the rulemaking providing additional pricing data or suggesting that the prices were inaccurate.

For further details on the methodology and results are provided in the chapter 5 of the final rule TSD.

a. Analysis of Large CPB Equipment Classes

As discussed in section IV.C.2, DOE collected 584 CPB prices that covered all CPB equipment classes that are analyzed in this final rule. Out of the eight equipment classes analyzed, DOE received sufficient information to analyze five equipment classes at all efficiency levels without extrapolation of data from other equipment class. For three large equipment classes, *i.e.,* LOHW, LGST and LOST, DOE did not have pricing data at several efficiency levels that are analyzed in this final rule. The lack of data stems from the general low number of models available in the market for such equipment classes. To address these cases, DOE leveraged the pricing collected for the small CPB equipment classes to estimate the price of a large commercial packaged boiler. To extrapolate the prices, DOE first combined the price data of each small and large equipment classes that have the same characteristics (*e.g.,* SHOW and LOHW). DOE then performed a regression analysis of the entire dataset to find an equation that represents the relationship between equipment price and rated input for the given type of equipment. DOE then used the equation to estimate the price of a commercial packaged boiler when its size is scaled up to 3,000 kBtu/h. The detailed methodology for the engineering analysis including, the plots that show the variation of CPB price with rated input are included in chapter 5 of the final rule TSD. In the March 2016 NOPR DOE tentatively used this approach to estimate prices for commercial packaged boilers at certain efficiency levels for the three equipment classes. DOE requested comments and feedback from interested parties on various aspects of the engineering analysis performed for the NOPR analysis, and specifically on the methodology and results.

In response to this approach, DOE received comments from ABMA expressing concern about the extrapolation of prices from small boilers to address the lack of data for large boilers. ABMA stated that large boilers not only have a significantly different applications and features but also carry an exponentially higher cost for transportation, installation and start-up. (ABMA, No. 64 at p. 1) Phoenix Energy Management stated in the NOPR public meeting that there is no connection between a small and a large boiler and that there are multiple variables that come into play in establishing the price. (PEM, Public Meeting Transcript, No. 61 at p. 64) Raypak stated that the price of a 3,000 kBtu/h boiler is substantially different from a 10,000 kBtu/h boiler. (Raypak, Public Meeting Transcript, No. 61 at p. 65)

In response, DOE notes that the extrapolation of prices from the small to large equipment classes (for oil-fired hot water and steam; and gas-fired steam equipment classes) is based on actual pricing data that is available for commercial packaged boilers in each corresponding small and large equipment classes. DOE obtained 163 prices for large CPB models in the LOHW, LGST, and LOST equipment classes that were used in developing the price trend between small and large commercial packaged boilers in these classes. There are only a few efficiency levels in the three large equipment classes where DOE extrapolated data from the corresponding small classes. The trends in prices between the small and large classes show a smooth linear trend and are devoid of sudden changes in pricing structure. The r-squared values for the linear equations that fit the pricing data are 0.923, 0.982 and 0.967 for oil-fired hot water, gas-fired steam and oil-fired steam equipment classes, respectively, indicating a strong fit to the data. Considering the r-squared value of the plots, DOE is highly confident that the extrapolated prices used in the analysis are representative of the prices for larger commercial packaged boilers. Therefore, in this final rule, DOE continues to use this approach to estimate the prices at several efficiency levels for LOHW, LGST and LOST commercial packaged boilers.

The detailed methodology for the engineering analysis including the plots that show the variation of CPB price with rated input are included in chapter 5 of the final rule TSD.

2. Data Collection and Categorization

As part of the engineering analysis, DOE collected 584 CPB prices from manufacturers, wholesalers, distributors and contractors.

A distributor or wholesaler is usually the first consumer in the distribution chain and typically receives a discount on the list price when purchasing equipment from the manufacturer. This discount varies by manufacturer and the equipment being sold, and also depends on the business relationship between the manufacturer and the purchaser (*i.e.,* the discount may vary depending on the volume of units that a distributor or contractor purchases). While collecting price data, DOE also obtained information on typical discounts applicable on the list prices, and applied the discount to list prices to obtain the actual manufacturer selling price. All manufacturer selling prices used in the engineering analysis include the appropriate discount to the list prices. In chapter 5 of the NOPR TSD, DOE specified that the discount rates offered by manufacturers typically lie within a range of 15 to 40 percent.

In response to this, AHRI commented that the equipment costs were wrongly generated using estimated discounts from list prices. AHRI highlighted that the discount factors used in the analysis had a large range (15 to 40 percent) and were based on manufacturers or DOE's estimates rather than actual data. AHRI stated that even small errors in these factors would have a significant effect on the resulting relationships established by DOE for determining actual manufacturer selling prices. AHRI opposed DOE's use of a single price estimate for an assumption with known variability and suggested using distribution of the estimates. (AHRI, No. 76 at pp. 41–42)

DOE disagrees with AHRI's comment suggesting that it used its own estimates rather than actual data to determine the discounts from list pricing that are applicable to the pricing data. The range of discount rates specified in the chapter 5 of the NOPR TSD and mentioned in AHRI's comment, represent the typical rates offered by manufacturers. DOE gathered this information through consultations with manufacturers, distributors, and contractors that provided CPB price data. While collecting pricing data, DOE also requested and received specific information on the discounts from list price offered by specific manufacturers and received by specific distributors. As a result, DOE had actual data on list price discounts for the models for which pricing was obtained, and DOE applied those discounts directly to the corresponding CPB list prices to calculate the manufacturer selling price that was used in the analysis. DOE considered the comments received from AHRI with regard to using a distribution of list price discount estimates instead of a fixed value. DOE concludes that using actual list price discounts that were shared by manufacturers, contractors and distributors is a more accurate approach to estimate the actual manufacturer selling prices than randomly assigning the discount based on a distribution through a Monte Carlo simulation, as suggested by AHRI. As a result, DOE decided to use the actual data for list price discounts received from manufacturers, distributors and contractors and applied it to the list prices received from the respective source before using the pricing data in the engineering analysis.

DOE collected the bulk of its prices for commercial packaged boilers from distributors and contractors. This price data was also supplemented by information gathered through manufacturer interviews. The prices cover a wide variety of commercial packaged boiler models. The models for which DOE obtained pricing include mechanical draft, natural (or atmospheric) draft, condensing boilers and non-condensing boilers, and cover all equipment classes that are analyzed in this rulemaking. The input capacities of boilers for which prices were obtained ranged from 300 kBtu/h to 9,500 kBtu/h.

In the March 2016 NOPR, DOE also described the approach it used in selecting the add-on features applicable to each commercial packaged boiler that is included in the price books. Most of the add-on features are related to control system that do not have an impact on the E_T or E_C as measured using DOE's test procedure. Each additional feature installed on a basic boiler model adds to the price of the model. However, this increase in price is generally not associated with the corresponding increase in efficiency.

In response to the engineering analysis, ABMA stated that very large commercial packaged boilers are extremely difficult to price because these boilers are custom built to a specific set of requirements for a given installation. ABMA noted that the customization is primarily in the area of controls, instrumentation, interfacing with building energy management systems and meeting location specific emission requirements. ABMA noted that these add-ons carry a high price tag. However, ABMA suggested that while these units are custom built, they are built on a standard heat exchanger design and burner capacity and therefore energy efficiency should not be affected by the customizing features. (ABMA, No. 64 at p. 2) Raypak provided comments at the public meeting that DOE should be looking at the local code requirements that vary with jurisdiction, for installing commercial packaged boilers, stating that as the size increases the number of applicable controls and codes also increase. (Raypak, Public Meeting Transcript, No. 61 at pp. 62–63)

DOE agrees with ABMA that the customizing of certain optional features do not impact the efficiency of commercial packaged boilers. To ensure that the cost of added features (that do not improve the efficiency of the equipment) are not included in the prices used for the engineering analysis, DOE normalized the optional features applicable to each boiler model by selecting the same options for all CPB prices collected. For example, DOE noticed that in several CPB series, prices of control and safety features are listed separately which get added to the basic model trade price. For such cases, DOE chose the same type of control feature for all CPB models where a choice is offered. While selecting the prices DOE also encountered scenarios where (1) a feature that DOE has consistently selected for all CPB models is not offered for a particular series; and (2) a particular feature becomes inapplicable for commercial packaged boilers of higher capacity within the same CPB series. In such cases DOE selected a similar feature that would offer similar functionality. This approach helped to minimize the effects of optional auxiliary components.

In response to the engineering analysis presented in the NOPR public meeting, ABMA asked how much data was available and used for large sized boilers. (ABMA, Public Meeting Transcript, No. 61 at pp. 93–94)

In response, Table IV.2 shows the number of CPB prices that DOE used in the engineering analysis in each equipment class. This table was also presented in the March 2016 NOPR. 81 FR 15858. DOE did not collect additional price data for the final rule analysis.

TABLE IV.2—NUMBER OF PRICES COLLECTED FOR ENGINEERING ANALYSIS

Equipment class	Number of prices used in analysis
SGHW	203
LGHW	52
SOHW	70
LOHW	44
SGST	72
LGST	76
SOST	24
LOST	43
Total	584

As discussed previously, in response to DOE's requests for shipment data for conducting the rulemaking analyses, AHRI provided actual shipments data for SGHW and LGHW equipment classes for the years 2014 and 2015. The information received represents shipment data collected by AHRI from AHRI-member manufacturers in an aggregated form. The information includes distributions of shipments by rated input for the SGHW equipment class for the years 2014 and 2015, distribution of shipments by efficiency for SGHW and LGHW equipment classes for the years 2014 and 2015, and shipment weighted efficiency for all equipment classes. DOE used the information for the distribution of shipment by rated input to conduct the analysis for SGHW condensing and non-condensing efficiency levels. Further, this information is also used to conduct LCC and PBP analysis.

3. Baseline Efficiency

DOE selects baseline efficiency levels as reference points for each equipment class, against which DOE calculates potential changes in energy use, cost, and utility that could result from an amended energy conservation standard. Typically, a baseline unit is one that meets, but does not exceed, the required energy conservation standard, as applicable, and provides basic consumer utility. A CPB model that has a rated efficiency equal to its applicable baseline efficiency is referred to as a ''baseline model.'' DOE uses the baseline model for comparison in several phases of the analyses, including the engineering analysis, LCC analysis, PBP analysis and NIA. For the engineering analysis, DOE used the current energy conservation standards that are set forth in 10 CFR 431.87 as baseline efficiency levels.

As discussed previously in section IV.A.3 of this document, DOE has consolidated the equipment classes that are set forth in the current regulations such that the current draft-specific classes (*i.e.,* those identified as being ''natural draft'' and ''all except natural draft'') are merged into non-draft-specific classes. For the four draft-specific classes, DOE used the natural draft equipment class efficiency standard as the baseline efficiency level. For the remaining equipment classes, DOE used the current standards in 10 CFR 431.87 as the baseline efficiency levels in the engineering analysis. The baseline efficiency levels for each equipment class are presented in Table IV.3.

TABLE IV.3—BASELINE EFFICIENCIES CONSIDERED IN THE ENGINEERING ANALYSIS

Equipment class	Baseline efficiency * (%)
Small Gas-fired Hot Water	80
Large Gas-fired Hot Water	82
Small Oil-fired Hot Water	82
Large Oil-fired Hot Water	84
Small Gas-fired Steam	** 77
Large Gas-fired Steam	** 77
Small Oil-fired Steam	81
Large Oil-fired Steam	81

* Efficiency levels represent thermal efficiency for all equipment classes except for Large Gas Hot Water and Large Oil Hot Water, for which the efficiency levels are in terms of combustion efficiency.

** Mechanical draft equipment within this class currently has a minimum standard of 79-percent thermal efficiency. 10 CFR 431.87 All equipment analyzed below 79 percent is natural draft equipment.

4. Intermediate and Max-Tech Efficiency Levels

As part of its engineering analysis, DOE determined the maximum technologically feasible (''max-tech'') improvement in energy efficiency for each equipment class of commercial packaged boilers. DOE surveyed the CPB market and the research literature relevant to commercial packaged boilers to determine the max-tech efficiency levels. Additionally, for each equipment class, DOE generally identifies several intermediate efficiency levels between the baseline efficiency level and max-tech efficiency level. These efficiency levels typically represent the most common efficiencies available on the market or a major design change (*e.g.,* switching to a condensing heat exchanger). In the analysis, DOE uses the intermediate and max-tech efficiency levels as target efficiencies for conducting the cost-benefit analysis of achieving increased efficiency levels.

During the market assessment, DOE conducted an extensive review of publicly available CPB equipment literature. DOE used the distribution of models in the equipment database compiled during the market assessment to identify intermediate and max-tech efficiency levels for analysis. DOE generally selected the efficiency levels with the most models or that represented a significant technology (*e.g.,* condensing) for analysis. The efficiency levels for each equipment class that DOE considered in the final rule TSD are presented in Table IV.4.

TABLE IV.4—BASELINE, INTERMEDIATE AND MAX TECH EFFICIENCY LEVELS ANALYZED IN THE ENGINEERING ANALYSIS

Equipment class	Efficiency * (%)	Efficiency level identifier
Small Gas Hot Water	80	EL—0 Baseline.
	81	EL—1.
	82	EL—2.
	84	EL—3.
	85	EL—4.
	93	EL—5.
	95	EL—6.
	99	EL—7 Max Tech.
Large Gas Hot Water	82	EL—0 Baseline.
	83	EL—1.
	84	EL—2.
	85	EL—3.
	94	EL—4.
	97	EL—5 Max Tech.
Small Oil Hot Water	82	EL—0 Baseline.
	83	EL—1.
	84	EL—2.
	85	EL—3.
	87	EL—4.
	88	EL—5.
	97	EL—6 Max Tech.
Large Oil Hot Water	84	EL—0 Baseline.
	86	EL—1.
	88	EL—2.
	89	EL—3.
	97	EL—4 Max Tech.
Small Gas Steam	77	EL—0 Baseline.
	78	EL—1.
	79	EL—2.
	80	EL—3.
	81	EL—4.
	83	EL—5 Max Tech.
Large Gas Steam	77	EL—0 Baseline.
	78	EL—1.
	79	EL—2.
	80	EL—3.
	81	EL—4.

TABLE IV.4—BASELINE, INTERMEDIATE AND MAX TECH EFFICIENCY LEVELS ANALYZED IN THE ENGINEERING ANALYSIS—Continued

Equipment class	Efficiency * (%)	Efficiency level identifier
	82	EL—5.
	84	EL—6 Max Tech.
Small Oil Steam	81	EL—0 Baseline.
	83	EL—1.
	84	EL—2.
	86	EL—3 Max Tech.
Large Oil Steam	81	EL—0 Baseline.
	83	EL—1.
	85	EL—2.
	87	EL—3 Max Tech.

* Efficiency levels represent thermal efficiency for all equipment classes except for LGHW and LOHW, for which the efficiency levels are in terms of combustion efficiency.

Bradford White commented that the prices of commercial packaged boilers will increase due to the effect of the proposed CPB test procedure changes. Bradford White noted that if DOE establishes an 85-percent E_T standard for SGHW commercial packaged boilers, manufacturers may choose to overdesign their equipment by increasing their efficiency to be 0.5 to 1 percent greater than the minimum to ensure that the equipment passes any random audit test. Bradford White stated that as a result of this increase, commercial packaged boilers will likely be operating at temperatures that will lead to condensation forming in the vent. Manufacturers may incorporate additional sensors and controls, as well as more costly materials to protect the equipment longevity. This will lead to more costly equipment. (Bradford White, No. 63 at p. 3)

In response, DOE conducts its analysis to evaluate the increase in manufacturer selling price or manufacturing cost to achieve the desired efficiency level selected as part of the engineering analysis. Although some manufacturers may choose to overdesign their equipment, DOE cannot assume that the models on the market today and rated at a given efficiency would not be representative of models at that efficiency under an amended standard, as such a decision would be made by individual manufacturers based on their business practices. Further, DOE notes that if tests on a small sample produce a mean sample efficiency that is lower than what a manufacturer believes to be the true mean across manufactured units, DOE's regulations for commercial packaged boilers at 10 CFR 429.60 would permit the manufacturer to enlarge the sample rather than overdesign the equipment. The mean of a larger sample would tend to have smaller departures from the population mean. Therefore, DOE has determined it would be inappropriate to assume that at a given standard level under consideration costs would be incurred to achieve an efficiency greater than that being analyzed.

5. Incremental Price and Price-Efficiency Curves

The final results of the engineering analysis are a set of price-efficiency curves that represent the manufacturer selling price for higher efficiency models. DOE uses these results as inputs to the downstream analyses such as the life cycle cost analysis.

DOE received several comments on the incremental price results and the price-efficiency curves published in the NOPR analysis TSD.

Weil-McLain suggested that DOE's analysis did not adequately account for the additional costs related to additional components, venting materials, system engineering and design, manufacturing costs, installation costs and operating costs of higher efficiency mechanical draft equipment. (Weil-McLain, No. 67 at p. 2)

DOE does not agree with Weil-McLain, in that the engineering analysis conducted in this final rule is based on list prices that manufacturers and their representatives use to sell their equipment. These prices include the manufacturing cost and the relevant manufacturer markups (Markups analysis is discussed in section IV.D of this final rule). Other costs related to installation and venting are discussed in section IV.F of this final rule.

Table IV.5 shows the incremental manufacturer selling price results based on prices in 2015$ for all eight equipment classes along with the baseline prices.

TABLE IV.5—MANUFACTURER SELLING PRICE-EFFICIENCY RESULTS

[2015$]

Equipment class	Efficiency level*	Incremental prices	Baseline manufacturer selling price
Small Gas Hot Water	Baseline—80%	$0	$7,043
	81%	510	
	82%	961	
	84%	3,112	
	85%	4,048	
	93%	11,076	
	95%	11,719	
	Max Tech—99%	13,910	
Large Gas Hot Water	Baseline—82%	0	22,123
	83%	1,983	
	84%	4,144	

TABLE IV.5—MANUFACTURER SELLING PRICE-EFFICIENCY RESULTS—Continued

[2015$]

Equipment class	Efficiency level*	Incremental prices	Baseline manufacturer selling price
	85%	6,498	
	94%	31,917	
	Max Tech—97%	36,025	
Small Oil Hot Water	Baseline—82%	0	8,626
	83%	689	
	84%	1,433	
	85%	2,236	
	87%	4,040	
	88%	5,051	
	Max Tech—97%	17,465	
Large Oil Hot Water	Baseline—84%	0	19,128
	86%	4,870	
	88%	10,980	
	89%	14,595	
	Max Tech—97%	49,710	
Small Gas Steam	Baseline—77%	0	6,630
	78%	568	
	79%	1,184	
	80%	1,853	
	81%	2,580	
	Max Tech—83%	4,225	
Large Gas Steam	Baseline—77%	0	19,365
	78%	1,132	
	79%	2,329	
	80%	3,597	
	81%	4,939	
	82%	6,359	
	Max Tech—84%	9,453	
Small Oil Steam	Baseline—81%	0	7,617
	83%	1,651	
	84%	2,607	
	Max Tech—86%	4,823	
Large Oil Steam	Baseline—81%	0	18,781
	83%	3,236	
	85%	7,029	
	Max Tech—87%	11,476	

* Efficiency levels represent thermal efficiency for all equipment classes except for LGHW and LOHW, for which the efficiency levels are in terms of combustion efficiency.

D. Markups Analysis

The markups analysis develops appropriate markups in the distribution chain (*e.g.,* retailer markups, distributer markups, contractor markups, and sales taxes) to convert the estimates of manufacturer selling price derived in the engineering analysis to consumer prices (''consumer'' refers to purchasers of the equipment being regulated), which are then used in the LCC and PBP analysis and in the manufacturer impact analysis. DOE develops baseline and incremental markups based on the equipment markups at each step in the distribution chain. For this rulemaking, DOE developed distribution chain markups in the form of multipliers that represent increases above equipment purchase costs for key market participants, including CPB wholesalers/distributors, and mechanical contractors and general contractors working on behalf of CPB consumers. 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.

Four different markets exist for commercial packaged boilers: (1) New construction in the residential buildings sector, (2) new construction in the commercial buildings sector, (3) replacements in the residential buildings sector, and (4) replacements in the commercial buildings sector. In this rulemaking, DOE characterized eight distribution channels to address these four markets.

For both the residential and commercial buildings sectors, DOE characterizes the replacement distribution channels as follows:

- Manufacturer → Wholesaler → Mechanical Contractor → Consumer
- Manufacturer → Manufacturer Representative → Mechanical Contractor → Consumer

DOE characterizes the new construction distribution channels for both the residential and commercial buildings sectors as follows:

- Manufacturer → Wholesaler → Mechanical Contractor → General Contractor → Consumer
- Manufacturer → Manufacturer Representative → Mechanical Contractor → General Contractor → Consumer

In addition to these distribution channels, there are scenarios in which manufacturers sell commercial packaged boilers directly to a consumer through a national account via a manufacturer representative, and its associated markup (assumed as 12.5 percent of sales; other distribution channels previously discussed make up the remaining 87.5 percent of sales).

These scenarios occur in both new construction and replacements markets and in both the residential and commercial sectors. The relative shares for these are dependent on equipment class and details may be found in chapter 6 of the final rule TSD. In these instances, installation is typically accomplished by site personnel. These distribution channels are depicted as follows:

- Manufacturer → Manufacturer Representative → Consumer (National Account)

To develop markups for the parties involved in the distribution of the commercial packaged boilers, DOE utilized several sources, including (1) the Heating, Air-Conditioning & Refrigeration Distributors International (HARDI) 2013 Profit Report [33] to develop wholesaler markups; (2) the 2005 Air Conditioning Contractors of America's (ACCA) financial analysis for the heating, ventilation, air-conditioning, and refrigeration (HVACR) contracting industry [34] to develop mechanical contractor markups; and (3) U.S. Census Bureau's 2012 Economic Census data [35] for the commercial and institutional building construction industry to develop general contractor markups. In addition to the markups, DOE derived State and local taxes from data provided by the Sales Tax Clearinghouse.[36] 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.

In the March 2016 NOPR, DOE requested information or insight that would better inform its markups analysis. Bradford White commented that for the CPB market most units are sold from the manufacturer to a buy/sell representative, also known as a specialty wholesaler, before being sold to the contractor and eventually the consumer. It is also Bradford White's experience that sales to national accounts still go through a wholesaler. (Bradford White, No. 68 at p. 4) Lochinvar stated that a distributor/wholesaler as the first consumer in the distribution chain does not adequately represent the primary commercial boiler market, noting 80 percent of small and large commercial packaged boilers typically follow the path of Manufacturer → Manufacturer Representative → Mechanical Contractor → General Contractor → Owner. (Lochinvar, No. 70 at p. 2) Raypak somewhat agreed with the distribution model used by DOE for commercial packaged boilers, noting that it uses manufacturer representatives almost exclusively, but also noting that DOE's model shows wholesalers and manufacturer representatives in the same category and that these should be handled separately, as their functions differ. Further, Raypak commented that DOE is underestimating the markups associated with manufacturer representatives in the distribution formula and other downstream analyses, and that it believes the estimated market segment and sector weights by CPB equipment class breakouts are not appropriate and that the assumption of 17.5 percent of commercial packaged boilers sold via national accounts is a considerable overstatement, noting it believes it should be closer to 5 percent. (Raypak, No. 72 at p. 4)

DOE appreciates the stakeholder inputs regarding distribution channels for commercial packaged boilers. DOE believes that there is a misunderstanding around the national account distribution channel. DOE wishes to clarify that the national account considered for commercial packaged boilers already includes a manufacturer representative tier whose markup is the same as a wholesale distributor in the regular channel and the equipment does not get sold to the consumers directly from the manufacturer but through the manufacturer representative. With respect to the estimated market segment and sector weights, while Raypak commented that 17.5 percent is an overestimation, Lochinvar's comment suggests that 20 percent of the market segment is handled through the national distribution channel. DOE considered these comments and adjusted the fraction of commercial packaged boilers sold via the national account distribution channel to 12.5 percent.

DOE also received comments regarding its use of incremental markups. BHI commented that DOE should eliminate the use of incremental markups, noting the varying supply chains and tremendous number of options, and recommends that DOE survey building owners to find out what they are actually paying for various classes of equipment, acknowledging that this has drawbacks but should result in more accurate costs. (BHI, No. 71 at pp. 17–18) AHRI continues to object to DOE's use of incremental markups, and reiterates that it has provided ample evidence that contractors do not use incremental markups. However, it understands that the markups in DOE's analysis are approximately accurate as average markups, also noting manufacturer's representatives have markups in the 10- to 15-percent range. (AHRI, No. 76 at pp. 41–42) NEEA commented that when they do similar analyses, the focus is on the costs that change based on the efficiency of the boiler, noting that in their experience it is when you change technology (*e.g.,* non-condensing to condensing) that things will change, and that DOE's approach is similar in that it is looking for incremental differences, not specific differences in any given building. (NEEA, Public Meeting Transcript, No. 61 at pp. 99–101) AHRI also commented that the markups for large and small boilers were not different enough. Crown commented that the markup methodology being used is probably inappropriate and that DOE should take the time to survey the engineers who are actually installing units. AHRI commented that they had little confidence in the incremental markups process, despite acknowledging in written comments that the markups in DOE's analysis are approximately accurate as average markups, and asked if there was an intent to survey, at some level, the actual selling point of the commercial boiler. (AHRI, Public Meeting Transcript, No. 61 at pp. 95–96, AHRI, No. 76 at pp. 41–42, Crown, Public Meeting Transcript, No. 61 at p. 103)

In response to these comments, DOE notes that incremental markups relate the change in manufacturer selling price of higher efficiency equipment to the change in the consumer purchase price. DOE develops markups based on data on costs incurred by various entities in the distribution chain and considers that certain costs incurred by these entities would not be expected to increase due to merely increasing the efficiency of equipment. For example, salaries, benefits, and operating expenses are among those costs that would not be expected to increase with higher costs of goods sold. With respect to BHI's and AHRI's comment that incremental markups are not typically used by contractors and manufacturers, DOE notes that it does not expect that an individual manufacturer or contractor would, in its general practice,

[33] *Heating, Air Conditioning & Refrigeration Distributors International 2013 Profit Report.* Available at *https://web.archive.org/web/20130822231322/http://www.hardinet.org/Profit-Report.*

[34] Air Conditioning Contractors of America (ACCA), *Financial Analysis for the HVACR Contracting Industry: 2005.* Available at *http://www.acca.org/store/.*

[35] Census Bureau. 2012 Economic Census Data. (2012). Available at *http://www.census.gov/econ/.*

[36] Sales Tax Clearinghouse Inc. State Sales Tax Rates Along with Combined Average City and County Rates, (2016). Available at: *http://thestc.com/STrates.stm.*

differentially provide markups by efficiency level or equipment cost. The concept of incremental markups applies to an industry as a whole and serves the purpose in this rulemaking of differentiating industry costs that scale up with cost of goods sold, and those that would not, as described in the final rule TSD. DOE's intent is to accurately estimate the price of higher efficiency equipment to the consumer under an amended standards scenario, and as such DOE maintains that the markups methodology accomplishes this and is consistent with the methodology used in other rulemakings.

Chapter 6 of the final rule TSD provides details on DOE's development of markups for commercial packaged boilers.

E. Energy Use Analysis

The purpose of the energy use analysis is to determine the annual energy consumption of commercial packaged boilers in use in the United States and assess the energy savings potential of increases in efficiency (thermal efficiency (E_T) or combustion efficiency (E_C)). The energy use analysis for commercial packaged boilers seeks to estimate the range of energy consumption of the equipment in the field (*i.e.,* as they are actually used by consumers). DOE estimates the annual energy consumption of commercial packaged boilers at specified energy efficiency levels across a range of climate zones, building characteristics, and space and water heating applications. The annual energy consumption includes natural gas, liquid petroleum gas (LPG), oil, and/or electricity use by the commercial packaged boiler for space and water heating. The energy use analysis provides the basis for other analyses DOE performed, particularly assessments of the energy savings and the savings in consumer operating costs that could result from adoption of amended or new standards.

In its March 2016 NOPR, DOE estimated the energy consumption of commercial packaged boilers in commercial buildings and multi-family housing units by developing building samples for each of eight equipment classes examined based on the EIA's 2003 Commercial Building Energy Consumption Survey [37] (CBECS 2003) and EIA's 2009 Residential Energy Consumption Survey (RECS 2009). Further, DOE noted that it had used all the data available at the time from CBECS 2012 in its NOPR, which included only the building characteristics segment, to inform its analysis. However, the public use microdata files on consumption and expenditure required for developing building samples used in the LCC analysis were not yet released. During the March 2016 NOPR public meeting, and also in written comments, DOE received feedback regarding its continued use of CBECS 2003 data. SoCalGas and the Joint Utilities urged DOE to utilize CBECS 2012 data in its energy use analysis and shipments analysis, since the building energy use profile is expected to have changed significantly from data in CBECS 2003, noting as an example trends in commercial heating away from single large boilers and toward smaller modular boilers. They further encouraged DOE to utilize RECS 2015, should the data be released before the final rule is published. (SoCalGas, No. 77 at p. 6; Joint Utilities, No. 66 at p. 2) Raypak and AHRI also encouraged DOE to update its analysis based on CBECS 2012 data, noting several energy use characterization metrics that differ from those of CBECS 2003 (*e.g.,* percent of buildings using boilers as the main heating equipment and energy use intensity). In addition, AHRI commented that since significant changes in results could be expected if CBECS 2012 data are used in the analysis, DOE should consider publishing a corresponding supplemental NOPR. (AHRI, No. 76 at pp. 1, 2, 13, 14, 16; Raypak, No. 72 at pp. 1–2)

DOE understands the stakeholders' comments and requests and recognizes there is benefit to the use of more current data that better represents the energy use of commercial packaged boilers that would be installed in 2020 and beyond. In this final rule DOE updated its LCC model to use the EIA's 2012 CBECS microdata [38] that became available in May 2016 for developing building samples for each of the eight equipment classes examined. While it can be expected that such a change would impact the modeling results to some degree, this update was performed at the request of stakeholders. Consequently, DOE concluded that the analytical results of the final rule utilizing CBECS 2012 data are an improvement to the analysis, consistent with stakeholder requests, and do not warrant publication of an SNOPR. Further, DOE does not have any opportunity to use RECS 2015 data as the ongoing survey is currently in the data gathering stage.

1. Energy Use Characterization

DOE's energy characterization modeling approach calculates CPB energy use based on rated thermal efficiency and building heat load (BHL), accounting for the conversion from combustion efficiency to thermal efficiency where applicable, part-load operation (in the case of multi-stage equipment), and cycling losses (for single-stage equipment), as well as return water temperature (RWT) and climate zones. In this rulemaking, DOE analyzed CPB annual energy use based on the building sample, equipment efficiency characteristics, and equipment performance at part-load conditions.

In determining building heat load, DOE adjusted the building heat load to reflect the expectation that buildings in 2020 would have a somewhat different building heat load than buildings in the CBECS 2012 and RECS 2009 building sample. The adjustment involved multiplying the calculated BHL for each CBECS 2012 or RECS 2009 building by the building shell efficiency index from *AEO2016.* This factor differs for commercial and residential buildings as well as new construction and replacement buildings. Additionally, DOE also adjusted the building heat load computed from CBECS 2012 and RECS 2009 data for each sample building taking into account the relative ratio of heating degree days (HDD) for the CBECS or RECS year (2012 or 2009) to the corresponding 10 year average HDD, both averaged over the specific region of the building location. This ratio was computed using the HDD data from the National Oceanic and Atmospheric Administration (NOAA) and applied to the computed building heating load to reflect the heating load under historical average climate conditions.

For this rulemaking, DOE adjusted the rated thermal efficiency of evaluated commercial packaged boilers based on RWT, cycling losses, and part-load operation. High RWT is applied to all non-condensing boiler installations. For condensing boiler installations, low RWT is applied to all commercial packaged boilers in the new construction market, 25 percent of replacement boilers in buildings built on or after 1990, and 5 percent of replacement boilers in buildings built before 1990. DOE assumed that all other

[37] U.S. Energy Information Administration (EIA), *2003 Commercial Building Energy Consumption Survey (CBECS) Data,* (2003). (*http://www.eia.gov/consumption/commercial/data/2003/.*)

[38] U.S. Energy Information Administration (EIA), 2012 Commercial Building Energy Consumption Survey (CBECS) Data, (2012). Available at *https://www.eia.gov/consumption/commercial/data/2012/index.cfm?view=microdata.* Last accessed May 18, 2016.

condensing boiler installations are high RWT applications. The efficiency adjustment for low and high RWT is dependent on climate, with low RWT values resulting in the condensing CPB equipment operating in condensing mode, on average, and high RWT values resulting in the condensing CPB equipment operating in non-condensing mode, on average. See appendix 7B of the final rule TSD for the adjustment factors used for RWT, part-load operation, and cycling by climate zone. For commercial packaged boilers rated in combustion efficiency, DOE converted combustion efficiency to thermal efficiency. DOE used combustion and thermal efficiency data from the AHRI database to create a conversion factor that is representative of the range of commercial packaged boilers on the market.

DOE received comments in the March 2016 NOPR regarding the energy modeling approach. Regarding DOE's approach to converting combustion efficiency to thermal efficiency in the LCC model, Lochinvar commented that it is inappropriate to correlate combustion efficiency and thermal efficiency, as they are derived by two totally different test methods. (Lochinvar, Public Meeting Transcript, No. 61 at p. 127) Lochinvar further objected to DOE's approach of removing data samples it considered nonsensical (*i.e.,* combustion efficiency was reported as lower than thermal efficiency in an AHRI database entry) and suggested using the entire set of data in determining the relationship that would be more appropriate. (Lochinvar, Public Meeting Transcript, No. 61 at pp. 126–128) AHRI agreed with Lochinvar regarding the fact that combustion efficiency and thermal efficiency tests use different methods, and further commented that for any given boiler model, there definitely is a relationship between combustion efficiency and thermal efficiency, but that looking at aggregated datasets is not the way to derive a general relationship. Each model has to be looked at to sort out that relationship. (AHRI, Public Meeting Transcript, No. 61 at pp. 129–130)

DOE appreciates the comments regarding its approach to convert combustion efficiency to thermal efficiency. DOE notes that, as AHRI and Lochinvar have stated, combustion and thermal efficiencies are determined by two different methods. DOE understands the concerns of the commenters and in the final rule has reverted to consider a relationship utilizing the entire dataset available where both combustion and thermal efficiencies are reported in establishing a combustion to thermal efficiency conversion factor for the LCC analysis, with no filtering of data applied.

DOE received various comments regarding its return water temperature assumptions in its analysis. Lochinvar commented that it is overly optimistic to assume 25 percent of buildings constructed after 1990 are condensing and 100 percent of new construction is low temperature hydronic systems. (Lochinvar, Public Meeting Transcript, No. 61 at pp. 128–129) In its written comments, however, Lochinvar clarified that DOE's assumption that 25 percent of buildings constructed after 1990 will allow for condensing boilers to condense for a significant part of the season does not correlate to true market conditions and that their experience suggests the actual percentage of buildings with low-temperature heating systems is much lower. (Lochinvar, No. 70 at p. 2) Similarly, Weil-McLain commented that DOE's heat load estimation methodology overestimates true energy savings associated with condensing boilers at high return water temperature and overestimates the number of low temperature systems in existence. (Weil-McLain, No. 67 at pp. 6–7) ASAP, however, questioned DOE's assumption that in new construction a condensing boiler system would not be capable of condensing a significant portion of the time and whether it is more representative for new construction to assume that the system is always operating with low enough return water temperatures to be always in condensing mode. (ASAP, Public Meeting Transcript, No. 61 at pp. 133–134) Crown, in response to ASAP's comment regarding condensing boilers in new construction, commented that it would not be assumed that, even in new construction, condensing boilers would condense all the time, especially so, for example, on the coldest day of the year, noting that the availability of condensing mode and corresponding reset schedules depends on what emitters are used. (Crown, Public Meeting Transcript, No. 61 at pp. 134–137) ASAP added that the amount of time equipment operates in condensing mode seems conservative. (ASAP, Public Meeting Transcript, No. 61 at p. 136) Raypak further commented that condensing mode is dependent on user comfort, and that a boiler may be designed for condensing mode but if users are uncomfortable they will raise the water temperature. (Raypak, Public Meeting Transcript, No. 61 at p. 137)

In response to the comments regarding return water temperature and the time a commercial packaged boiler operates in condensing mode, DOE points out that the LCC model does not establish a given amount of time a commercial packaged boiler will condense. The model develops a thermal efficiency adjustment that is an average based on various factors as described in appendix 7B of the final rule TSD. For condensing boilers, DOE does consider the fact that some commercial packaged boilers will be operating with low return water temperatures, and the rest will operate with high return water temperatures, in the field. DOE notes that in the field, depending on the heat load and system design, the commercial packaged boiler may be operating at higher efficiencies or lower efficiencies than those established as the average adjusted efficiency in the model, but it believes its approach adequately reflects the energy use of the commercial packaged boiler throughout the entire heating season. DOE does assume that all new construction scenarios in the model (25 percent of buildings constructed on or after 1990 and 5 percent of buildings constructed before 1990) would be designed to allow for low return water temperatures, on average, and that all other scenarios would operate with high return water temperatures, on average. Regarding Lochinvar's comment that these assumptions do not correlate to true market conditions, DOE notes that neither Lochinvar, nor any other commenter, provided any data regarding the actual number of installations it expects would use low-temperature heating systems in new construction or existing buildings, but notes that DOE received additional comment indicating that even the use low temperature distribution may change over the life of the building to meet occupant comfort.

Conversely, the Joint Advocates commented that DOE's return water temperature distributions for condensing boilers represent overly conservative scenarios. Further, they point out that the default outdoor reset schedules from manufacturers of condensing boilers and real-world implementations of condensing boilers replacing non-condensing boilers suggest that condensing boilers can operate a greater portion of the heating season in condensing mode than that assumed in DOE's analysis, and that this would increase the savings from condensing boilers relative to non-condensing boilers. In support of these assertions, they cited published reports of field replacements of boilers, manufacturer data showing defaults and the range of reset schedules for condensing boilers, and various strategies in new and existing buildings to provide lower return water temperatures to enable condensing. These strategies included retrofitting heating systems with high-delta-T heating coils, lowering the design supply hot water temperature in existing systems based on the systems being oversized for heating, showing the impact of later building improvements in reducing heating load, using a load-based reset schedule, and using variable circulation pumps supplying heated water to coils to further increase temperature drops in systems. (Joint Advocates, No. 74 at pp. 2–6)

DOE agrees with the comments from the Joint Advocates in that there is a significant potential for system retrofits and system redesigns in both new and in existing buildings that could provide for better use of low return water temperatures during a larger portion of the heating season; however, these may incur additional and unknown costs that DOE has no ability to represent on an aggregate basis. The experiences and input from other parties indicate that there is strong concern that even many current condensing boiler installations do not live up to their energy savings potential. DOE concludes that its analysis (which presumes a smaller fraction of older existing buildings, a larger fraction of newer existing buildings, and all new construction designs) will be able to support, on average, low return water temperature distribution and accurately reflects the performance of condensing commercial packaged boilers in new construction and existing building stock.

AHRI commented that the energy use analysis applies residential temperature bins to estimate the loading of commercial package boilers, which results in erroneous average annual energy use values, and AHRI provided a comparison of a typical commercial office building load profile and a residential load profile. (AHRI, No. 76 at pp. 14–15)

In response to AHRI's comment, DOE notes that the model assumes the heating load for a commercial building is zero above 50 °F. The model uses the percentage of time in a year that a given climate zone spends in each of four temperature bins that are considered for the purposes of establishing the return water temperature condition, which impacts the thermal efficiency of the boiler as installed. The temperature bins in Table 7B.2.4 in appendix 7B of the final rule TSD are only used in the development of the part-load adjustment factor for condensing boilers and not the building thermal loads. DOE, in addition, understands that the load profile shared by AHRI may reflect many larger office buildings with significant internal loading and tight thermal envelopes, such as used in the standard ASHRAE 90.1–2013 analysis for new construction. However, many existing commercial buildings will have heating loads above the 30 °F level suggested by AHRI.

For the reasons noted in this section, DOE retained its methodology for adjusting the thermal efficiencies of the commercial packaged boilers, based on return water temperature conditions, in this final rule.

During the March 2016 NOPR public meeting, Lochinvar commented that DOE should consider boilers used for purposes other than space heating in its analyses. (Lochinvar, No. 61 at pp. 124–125) Spire commented that DOE, for its analysis, should use a more robust data source, specifically referencing Jurisdiction Online [39] and added that this online data source provides information about fuel consumption, age and location of installed boilers and types of entities that own commercial boilers. (Spire, No. 73 at pp. 26–27)

In response to Lochinvar's request to include in its analysis boilers that are used for purposes other than space heating, DOE retained its NOPR approach and did not include such CPB equipment in its final rule analysis because DOE was not able to obtain any data needed for the analyses. Regarding Spire's suggestion to use Jurisdiction Online, DOE investigated that data source and determined that its content is already captured in the EPA database used to inform shipments, and as such much of the available data are already taken into account in that context.

A more detailed description of the energy use characterization approach can be found in appendix 7B of the final rule TSD.

2. Building Sample Selection and Sizing Methodology

In its energy analysis for this rulemaking, DOE's estimation of the annual energy savings of commercial packaged boilers from higher efficiency equipment alternatives relied on building sample data from CBECS 2012 and RECS 2009. CBECS 2012 includes energy consumption and building characteristic data for 6,720 commercial buildings representing 5.6 million commercial buildings. RECS 2009 includes similar data from 12,083 housing units that represent almost 113.6 million residential households.

The subset of CBECS 2012 and RECS 2009 building records used in the analysis met the following criteria. The CPB application has the following characteristics:

- Used commercial packaged boiler(s) as one of the main heating equipment components in the building,
- used a heating fuel that is natural gas (including propane and LPG) or fuel oil or a dual fuel combination of natural gas and fuel oil,
- served a building with estimated design condition building heating load exceeding the lower limit of CPB qualifying size (300,000 Btu/h),
- had a non-trivial consumption of heating fuel allocable to the commercial packaged boiler.

DOE analyzed commercial packaged boilers in the qualifying building samples. DOE disaggregated the selected sample set of commercial packaged boilers into subsets based on the fuel types (gas or oil), rated input (small or large), heating medium (steam or hot water). DOE then used these CPB subsets to group the sample buildings equipped with the same class of equipment evaluated in this analysis. In the LCC analysis, DOE used the ratio of the weighted floor space of the groups of commercial and residential building samples associated with each equipment class to determine the respective sample weights for the commercial and residential sectors. DOE's new construction sample was based on the same selection algorithms as the replacement sample but included only buildings built on or after 1990, which DOE concluded would have building characteristics more similar to the new construction buildings in the start of the analysis period in 2020 (*e.g.,* building insulation, regional distribution of the buildings, etc.).

To disaggregate a selected set of commercial packaged boilers into large and small equipment classes, DOE used a sizing methodology to determine the sizes of the commercial packaged boilers installed in the building. In this final rule, DOE's sizing methodology is essentially the same as that used in the March 2016 NOPR (*i.e.,* assigning a stepwise increasing number of commercial packaged boilers for all buildings within a range of boiler sizing loads). The stepwise assignment table developed in the March 2016 NOPR used data from an EPA boiler database [40] last updated in 2005, CBECS 1979, and CBECS 1983. The same table was used for allocating the number of boilers for older buildings constructed before 1990.

[39] *http://www.praeses.com/jurisdiction-online.html.*

[40] Environmental Protection Agency, *13 State Boiler Inspector Inventory Database with Projections (Area Sources),* EPA–HQ–OAR–2006–0790–0013, (April 2010). Available at *https://www3.epa.gov/airtoxics/boiler/boilerpg.html.*

However, for buildings of newer construction, this assignment table was modified, as DOE received new data that show the average size of boilers being smaller than the average size of the sample commercial packaged boilers in the March 2016 NOPR analysis. The sizing methodology used in this rule is described in this section.

First, the total sizing of the heating equipment is determined from the heated square footage of the building, the percentage of area heated, a uniform heating load requirement of 30 Btu/h per square foot of heated area based on references for commercial building,[41] [42] and an assumed equipment efficiency mapped to the construction year. DOE's sizing methodology also takes outdoor design conditions into consideration. The outdoor design condition for the building is based on the specific weather location of the building. The estimated total CPB sizing in million Btu per hour (MBtu/h) [43] is the aggregate heating equipment sizing prorated using the area fraction heated by the commercial packaged boilers and multiplied by an oversize factor of 1.1. For the sample of residential multi-family buildings, the heating equipment sizing methodology for commercial buildings is modified to calculate the heating load for each residential unit of the multi-family buildings, and this value is multiplied by the number of units, assuming each unit to have identical area and design heating load. The modified methodology for residential multi-family buildings further assumes that a centrally located single or a multiple-boiler installation would meet the entire design heating load of the building.

DOE computed the size of each commercial packaged boiler in each sample building by dividing the aggregate CPB sizing heating load (MBtu/h) by an estimated number of boilers of equal capacity. To estimate the number of commercial packaged boilers in a given sample building, DOE assigned a variable number of commercial packaged boilers to all the qualified sample buildings of 2012 CBECS based on a predetermined allocation table. In the final rule analysis, buildings constructed before 1990 were assigned a given number of boilers based on the allocation table developed in the March 2016 NOPR analysis. However, the remaining sample buildings, constructed on or after 1990, were assigned a given number of boilers based on a modified version of the allocation table where the percentage of building samples receiving a smaller number of boilers in a given CPB sizing load range was reduced, and the percentage of sample buildings receiving a larger number of boilers was increased, relative to their respective shares used at the March 2016 NOPR. Adjustments were made to this assignment of the number of commercial packaged boilers to maximize the utility of the sampled buildings used for this analysis with respect to the size range of boilers being analyzed.

Several interested parties commented on DOE's usage of a parameter value of 30 Btu/h per square foot for estimating the building heating load under design condition. While Spire commented that this is inappropriately high, Raypak noted that this may not be acceptable for the sizing of heating equipment for commercial buildings, although it is a decent metric for residential buildings. Raypak stated that they would normally use a value of 25 Btu/h per square foot for a commercial building in Los Angeles, California, and that they would typically use approximately 100 Btu/h per square foot for 0 °F design outdoor conditions. (Spire, No. 73 at p. 25; Raypak, No. 72 at pp. 3–4) AHRI commented that the current value of this parameter at 30 Btu/h per square foot is unverified and possibly causing the LCC model to produce excessively high operating hours and distorting the LCC results. (AHRI, No. 76 at pp. 26, 32, 37–40)

For commercial buildings, DOE's methodology for estimating the design condition heating load is uniform across all outdoor conditions. It uses a uniform heating load requirement per square foot of heated area, assuming a 0 °F design outdoor condition, and then adjusts based on the outdoor design heating temperature for the building under consideration. In addition, DOE applies an oversizing factor on top of this. DOE recognizes there are simplifications in this approach; however, DOE's estimation of building heating loads stems from design data for commercial buildings taking into account the design climate conditions and adequately captures heating load design variations in the field. DOE has high confidence that its building load estimation is representative of the building loads in the field. Therefore, DOE retained its NOPR base heating load approach in its analysis for this final rule.

AHRI also commented that the energy use calculations did not incorporate the ASHRAE 90.1–2013 requirements of all boilers with an input rate of 1,000,000 Btu/h or more needed to have a turndown ratio of 3 to 1, and this will make the boilers more efficient. (AHRI, No. 76 at p. 15)

DOE points out that it did consider the 3:1 turndown ratio requirement from ASHRAE 90.1–2013 for systems greater than 1 MMBtu/h and notes that its understanding is that this requirement in ASHRAE 90.1–2013, as adopted into local building code, will not necessarily be extended to replacement boilers, and, in addition, can be met by using multiple boilers, which is already common in DOE's analysis for boiler systems with 1 MBtu/h or above combined rated input. As noted in the March 2016 NOPR, DOE assumed that all commercial packaged boilers installed in new buildings will be part of a system with at least a 3:1 turndown ratio, and DOE calculated the adjusted thermal efficiency of commercial packaged boilers in such systems accordingly. DOE concludes that its adjusted cycling loss factors designed to address multiple boiler systems will adequately represent the expected benefits to part-load performance for multi-stage boilers, as well as the ASHRAE 90.1–2013 requirement discussed.

The Joint Advocates further noted that DOE's energy use analysis is likely underestimating potential energy savings when compared to several cited studies of field installations, and that due to the impacts of high return water temperature operation and cycling, the operational efficiency of a non-condensing boiler is below that of its rated efficiency. (Joint Advocates, No. 74 at pp. 1–2, 8) Crown commented that non-condensing boilers are not only available as single-stage and that this is especially true for large boilers. (Crown, Public Meeting Transcript, No. 61 at pp. 130–131).

In response to the comments from the Joint Advocates regarding performance degradation of non-condensing boilers, DOE notes that it does consider this in its analysis by using a cycling loss adjustment factor that takes into account the impact of multiple sequenced boilers operation. With regard to Crown's comment, DOE understands that non-condensing boilers are available in other than single stage equipment, but DOE does not have data on the relative sales into the market and has insufficient data regarding their part-load performance. DOE, however, has accounted for reduced cycling losses in cases where multiple boilers may be utilized.

[41] Bell, A.A. Jr. Part 7: Heating Load Rules of Thumb. In HVAC Equations, Data, and Rules of Thumb, McGraw-Hill: San Francisco, CA (2000).

[42] *http://www.weil-mclain.com/sites/default/files/wm-boiler-replacement-guide.pdf.*

[43] The industry commonly uses MBtu to refer to one million Btu.

In the March 2016 NOPR, DOE requested for information on the extent to which hybrid configurations with both condensing and non-condensing commercial packaged boilers in a single system are prevalent in retrofit installations. Lochinvar believes that approximately 5 percent of the installations with condensing boilers are hybrid systems and urged DOE to consider this in its energy use analysis. (Lochinvar, No. 70 at p. 2) Weil-McLain commented that creating a baseline assumption about the current degree of adoption of hybrid boiler configurations in retrofit situations is unrealistic because it requires the analysis of many variables. (Weil-McLain, No. 67 at p. 7) Bradford White commented that hybrid configurations are difficult to implement because legacy installation venting systems are already established, possibly in an era before the market debut of condensing boilers. (Bradford White, No. 68 at p. 2)

In view of the uncertainty regarding the degree of adoption of hybrid configurations in retrofit situations and the difficulty in incorporating this in the energy use analysis due to the great number of variables that would need to be considered as well as the lack of data, DOE did not incorporate hybrid systems in its analysis.

Spire commented that DOE in its analysis should consider that the Federal purchase decisions are mandated by stringent and aggressive policy mandates and as such should not be included in the analysis as they would meet the stringent standards even if stringent standards are not adopted. (Spire, No. 73 at p. 13)

DOE understands that the Federal Energy Management Program (FEMP) provides acquisition guidance for commercial packaged boilers, but also provides exceptions to these Federal purchasing requirements where an agency demonstrates that selecting the FEMP recommended efficiency level may not be cost effective. DOE notes that data provided by AHRI support that a higher percentage of the gas-fired hot water CPB market is condensing equipment than was used in the March 2016 NOPR analysis and DOE has modified in the final rule its projections for the condensing boiler market into the future to show much higher adoption rates. This higher adoption rate will include many Federal buildings. However, for the remaining fraction of the market, DOE does not have sufficient information that would allow it to make comparisons between the market shares of non-condensing commercial packaged boilers purchased for Federal buildings versus commercial buildings. In addition, DOE notes that its analysis considers as potential standards levels, commercial packaged boilers with efficiencies above the FEMP guidance, and for these reasons, DOE considers Federal buildings in its analysis.

The Gas Associations commented that the energy use analysis needs to adjust potential energy savings and associated emissions for Federal buildings that will not be able to have fossil fuel-generated energy after 2030, per provisions in Section 433 of EPCA of 1975 as amended by EISA 2007. (Gas Associations, No. 69 at pp. 2–3)

DOE notes that the legislation establishing the fossil-fuel energy targets for Federal buildings has yet to be codified as a final rule in the Code of Federal Regulations at the time of this analysis. A NOPR, titled ''Fossil Fuel-Generated Energy Consumption Reduction for New Federal Buildings and Major Renovations of Federal Buildings'' was issued on October 15, 2010 and an SNOPR issued on October 15, 2014, addressing comments on the NOPR and noting that DOE has identified additional areas for clarification and consideration that would benefit from further public comment. The SNOPR particularly sought comment on additional approaches to the scope of the requirements in the context of major renovations, the potential use of renewable energy certificates for compliance, and a proposed streamlined process for agencies to seek a downward adjustment from the required reduction levels, particularly for major renovations. DOE notes that while providing for significant savings of fossil-fuel derived energy (including both on-site usage of fossil fuels and on-site usage of electricity generated from fossil fuels) in Federal buildings, the proposed rule will not likely provide a complete limitation of fossil fuel use in Federal buildings even in 2030. Federal agencies can and may be expected to petition for downward adjustments from the required reduction levels for certain buildings and building retrofits, particularly where other options to meet the requirements are technically impracticable, where these options have been considered in detail by these agencies, and where the agencies have demonstrated they have pursued other options. In addition, the SNOPR sought input on the use of renewable energy certificates as alternative options to meet the required reduction levels, which could be a more cost-effective approach to on-site fossil fuel reduction in certain situations.

Regarding regional use of commercial packaged boilers, PEM commented that the New York City area almost entirely uses field-constructed boilers except for new construction and schools. (PEM, Public Meeting Transcript, No. 61 at pp. 122–123) Similarly, AHRI commented that it could be useful to look at geographical regions represented in RECS data and that commercial packaged boilers are not typically used in New York's multi-family apartment buildings, and that including New York City and surrounding areas in the analysis inflates this rulemaking's energy savings. (AHRI, Public Meeting Transcript, No. 61 at pp. 122, 124).

In response to the comments on regional use of commercial packaged boilers, DOE inquired with the New York City Buildings Department regarding the prevalence of field constructed boilers used in heating applications in New York City (NYC). DOE was informed by the Buildings Department that based on their experience with inspections boiler installations, only about 10 percent of the commercial packaged boilers in NYC are field-constructed with a higher fraction of those (estimated as high as about 33 percent) in the large boiler category. It was also noted by the Buildings Department that a large portion of these field constructed boilers are steam boilers. Furthermore, as was noted by PEM, there are instances where commercial packaged boilers are used in the NYC area. Given both of these considerations, DOE cannot discount that commercial packaged boilers are being utilized, or newly selected, in other types of commercial buildings including multifamily buildings in NYC and surrounding areas. Given the shipment data that form the basis for DOE's overall national energy savings analysis are based on AHRI input and do not include field-constructed boilers, DOE disagrees with AHRI that including building sample data that may have come from NYC in its analysis inflates the energy savings calculations. For these reasons, DOE did not attempt to further identify or exclude any building observations specific to NYC in its analyses.

DOE has not modified the analysis to eliminate the use of commercial packaged boilers in Federal buildings after 2030, but understands that, presuming the establishment and implementation of a final rule addressing fossil fuel-generated energy consumption in Federal buildings, the likely impact of the rule will be a reduction in overall boiler shipments to commercial buildings and a consequent reduction in the projected energy savings from the CPB rule.

Building sampling methodology is detailed in chapter 7 of the final rule TSD.

3. Miscellaneous Energy Use

The annual energy used by commercial packaged boilers, in some cases, may include energy used for non-space heating use such as water heating. Based on comments received in the November 20, 2014 NODA and preliminary analysis, DOE assumed that if the CBECS data indicate that the CPB fuel is the same as the fuel used for water heating then in 20 percent of the sample buildings, the same commercial packaged boiler is also used for water heating in this final rule. 79 FR 69066.

Other associated energy consumption is due to electricity use by electrical components of commercial packaged boilers including circulating pump, draft inducer, igniter, and other auxiliary equipment such as condensate pumps. In evaluating electricity use, DOE considered electricity consumed by commercial packaged boilers both in active mode as well as in standby and off modes in the preliminary analysis.

BHI commented that the energy use analysis should consider that most condensing boiler installations require a minimum of two pumps: One to circulate water through the system, and a second to circulate water through the boiler itself. Further, BHI stated that if DOE were to adopt the 85-percent efficiency level and the test procedure as it was proposed in its NOPR, it would mean that there would be no Category I small or large hot water boilers on the market and therefore all such boilers would become mechanical draft and therefore require the associated power consumption. (BHI, No. 71 at p. 17)

As clarified in the March 2016 NOPR, DOE only considered the electricity use of pumps needed for proper operation of the commercial packaged boiler, but not the electricity use of additional pumps that may be necessary for distributing water throughout a system, since these pumps are not part of the commercial packaged boiler itself and the inclusion of distribution system pumping energy consumption would not be appropriate to the development of the standard. With respect to BHI's comment regarding the additional power consumption for mechanical draft equipment, DOE notes that the March 2016 NOPR analysis and the final rule analysis both include the additional electrical power consumption for both draft fans/blower, condensate pump, and controls, and that this power consumption is not included for natural draft commercial packaged boilers. Further, as noted previously, DOE has modified the CPB test procedure from that proposed in the 2016 CPB TP NOPR, and it is also adopting a different set of efficiency levels than was proposed in the March 2016 NOPR in this rulemaking. DOE's analysis adequately addresses the concerns expressed by BHI.

In its final rule analysis, DOE maintained the electricity use analysis method used in the March 2016 NOPR analysis.

F. Life-Cycle Cost and Payback Period Analysis

DOE conducted LCC and PBP analyses to evaluate the economic impacts on individual consumers of potential energy conservation standards for commercial packaged boilers. The effect of new or amended energy conservation standards on individual consumers usually involves a reduction in operating cost and an increase in purchase cost.

The LCC is the total consumer cost of owning and operating an appliance or equipment, generally over its lifetime. The LCC calculation includes total installed cost (equipment manufacturer selling price, distribution chain markups, sales tax, and installation costs), operating costs (energy, repair, and maintenance costs), equipment lifetime, and discount rate. Future operating costs are discounted to the time of purchase and summed over the lifetime of the appliance or equipment. The PBP is the amount of time (in years) it takes consumers to recover the assumed higher purchase price of more energy-efficient equipment through reduced operating costs. DOE calculates the PBP by dividing the change in total installed cost (normally higher) due to a standard by the change in annual operating cost (normally lower) that result from the standard.

For any given efficiency level, DOE measures the PBP and the change in LCC relative to an estimate of the no-new-standards case efficiency distribution. The no-new-standards estimate reflects the market in the absence of amended energy conservation standards, including market trends for equipment that exceed the current energy conservation standards.

DOE analyzed the net effect of potential amended CPB standards on consumers by calculating the LCC and PBP for each efficiency level of each sample building using the engineering performance data, the energy use data, and the markups. DOE performed the LCC and PBP analyses using a spreadsheet model combined with Crystal Ball™ (a commercially available software program used to conduct stochastic analysis using Monte Carlo simulation and probability distributions) to account for uncertainty and variability among the input variables (*e.g.,* energy prices, installation cost, and repair and maintenance costs). The spreadsheet model uses weighting factors to account for distributions of shipments to different building types and different states to generate LCC savings by efficiency level. Each Monte Carlo simulation consists of 10,000 LCC and PBP calculations using input values that are either sampled from probability distributions and building samples or characterized with single point values. The analytical results include a distribution of 10,000 data points showing the range of LCC savings and PBPs for a given efficiency level relative to the no-new-standards case efficiency forecast. In performing an iteration of the Monte Carlo simulation for a given consumer, equipment efficiency is chosen based on its probability. If the chosen equipment efficiency is greater than or equal to the efficiency of the standard level under consideration, the LCC and PBP calculation reveals that a consumer is not impacted by the standard level. By accounting for consumers that already purchase more-efficient equipment, DOE avoids overstating the potential benefits from increasing equipment efficiency.

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 then multiplying that amount by the average energy price forecast for the year in which compliance with the amended standards would be required.

DOE calculated the LCC and PBP for all consumers of commercial packaged boilers as if each were to purchase new equipment in the first year of required compliance with new or amended standards. The projected compliance date for amended standards is late 2019. Therefore, for purposes of its analysis, DOE used January 1, 2020 as the beginning of compliance with potential amended energy standards for commercial packaged boilers.

As noted in this section, DOE's LCC and PBP analysis generates values that calculate the payback period for consumers of potential energy conservation standards, which includes, but is not limited to, the 3-year payback period contemplated under the rebuttable presumption test. However, DOE routinely conducts a full economic analysis that considers the full range of impacts, including those to the consumer, manufacturer, Nation, and environment. The results of the full economic 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).

Inputs to the LCC and PBP analysis are categorized as (1) inputs for establishing the purchase cost, otherwise known as the total installed cost, and (2) inputs for calculating the operating cost (*i.e.,* energy, maintenance, and repair costs). The following sections contain brief discussions of comments on the inputs and key assumptions of DOE's LCC and PBP analysis and explain how DOE took these comments into consideration.

1. Equipment Costs

For each distribution channel, DOE derived the consumer equipment cost for the baseline equipment by multiplying the baseline equipment manufacturer sale price and the baseline overall markup (including any applicable sales tax). For each efficiency level above the baseline, DOE derived the consumer equipment cost by adding baseline equipment consumer cost to the equipment of incremental manufacturer sale price and the appropriate incremental overall markup (including any applicable sales tax). This consumer equipment cost is reflective of the representative equipment size analyzed for each equipment class in the engineering analysis. Since the LCC analysis considers consumers whose CPB capacities vary from the representative equipment size, the consumer equipment cost is adjusted to account for this.

DOE examined whether CPB equipment prices changed over time. DOE determined that there is no clear historical price trend for CPB equipment and used costs established in the engineering analysis directly for determining 2020 equipment prices for the LCC and PBP analysis.

DOE notes that it received a comment from Bradford White that the cost to manufacture a given unit increases over time, noting the increase in labor and overhead rates over time due to healthcare, utility and fuel costs, etc. (Bradford White, No. 68 at p. 5) In response, DOE wishes to clarify that its price trend analysis reflects the real, inflation adjusted, examination of equipment price, and such factors identified by Bradford White would already be incorporated in the real equipment price.

2. Installation Costs

The installation cost is the cost incurred by the consumer for installing the commercial packaged boiler. The cost of installation covers all labor and material costs associated with the replacement of an existing commercial packaged boiler or the installation of a commercial packaged boiler in a new building, removal of the existing boiler, and any applicable permit fees. DOE estimated the installation costs of the representative capacity boiler at each considered efficiency level using a variety of sources, including RS Means 2016 facilities construction cost data, manufacturer literature, and information from expert consultants.[44] DOE adjusted the basic installation cost for a boiler of a given rated input, relative to the installation cost of the representative capacity boiler, by using adjustment factors developed using trends observed in the RS Means data. Appendix 8D of the final rule TSD contains a detailed discussion of the development of installation costs and adjustment factors.

With regard to installation costs, DOE received comments from stakeholders during the March 2016 NOPR in two general areas: (1) The general cost to install a boiler, including components, labor, and accessories needed; and (2) the cost and impacts with regard to venting materials and upgrades necessary. DOE addresses both groups of comments in the following paragraphs. In addition, certain general comments reflecting the impact of high installation costs are addressed in section IV.F.2.c of this document.

a. Base Boiler Installation

DOE received several comments regarding installation costs. AHRI expressed that the costing methods used by DOE are simplistic and inaccurate, resulting in incorrect estimates of consumer economics. AHRI commented that DOE's current process of building up costs from assumed installation situations is incorrect, as has been demonstrated through contractor survey data in other rulemakings, and misses much of the subtlety in installation and venting conditions. (AHRI, No. 76 at p. 27, 42–43)

DOE understands the comments from AHRI and notes that it has modified its venting logic and installation costs in this final rule to address specific concerns brought up by stakeholders. This is discussed in detail in section IV.F.2 of this document.

PEM commented that there is no correlation between boiler cost and installation cost. (PEM, Public Meeting Transcript, No. 61 at p. 98) Raypak commented that there is probably no incremental cost associated with installing a boiler at different efficiency levels, for example an 82 percent efficient boiler versus an 86 percent efficient boiler. However, there will be cost differential for replacement parts. (Raypak, Public Meeting Transcript, No. 61 at p. 101) ABMA commented that larger boilers not only have significantly different applications and features but also carry an exponentially higher cost for transportation, installation, and start-up. ABMA also commented that in attempting to develop installation costs, it is important that the magnitude of work involved in installing the large and very large boilers is greater than that for small and light weight boilers and may involve the use of fork lifts and delivery trucks, and that these are extra expenses and as such should not be based on extrapolating the installation cost of smaller boilers. (ABMA, No. 64 at pp. 1–2) ABMA expressed concerns regarding the extrapolation of RS Means data for small boilers into large boilers, and wonders if a more appropriate set of estimating data had been considered, noting Mechanical Contractors Association of America (MCAA) as a potential source. (ABMA, No. 64 at p. 1)

Regarding PEM's comment, DOE notes that the installation costs are derived directly from RS Means 2016 Mechanical Cost Data, which indicates a strong correlation between boiler size and its installation cost. With respect to Raypak's comment that there is no incremental cost for installing boilers at different efficiency levels, DOE's estimated basic installation costs for the commercial packaged boilers at different efficiency levels, within an equipment class, do not vary with efficiency, except for condensing boilers where additional costs are incurred specific to such installations. With respect to Raypak's comment about repair costs, DOE notes that its annualized repair cost estimates do increase with efficiency. Regarding ABMA's comment about very large boilers, DOE reiterates that very large boiler equipment classes (>10 MBtu/h) are not being analyzed in this rulemaking. With regard to installation cost differences because of transportation, magnitude of work, and use of extra equipment for large boilers, DOE notes that RS Means captures these costs in its estimation of basic installation costs and, as such, DOE is not changing the base installation cost

[44] RS Means, *Facilities Maintenance & Repair Cost Data 2015,* 73rd ed (2014).

approach in this final rule. However, DOE notes that, at the March 2016 NOPR stage, for each equipment class, the installation cost was estimated only for the representative rated input. For the final rule, DOE incorporated an adjustment factor based on trends noted in RS Means that would scale the basic installation cost up or down, depending on the capacity of the chosen boiler to more accurately reflect the absolute cost for installation of the selected boiler in this analysis. Although this is a modification to the general approach, the incremental cost from the baseline does not change, and thus this change does not have any impact on the LCC savings. With respect to MCAA, DOE explored this source as a possible alternative and more appropriate data source. Based on conversations with MCAA, DOE learned that MCAA data is not derived from time studies, but is an empirical approach, and that MCAA recommends utilizing one of their affiliate companies which utilize their data to determine the time requirements to complete a task, rather than directly referencing their data. DOE inquired of MCAA regarding the comparison between MCAA and RS Means data, and was informed that while methods take different approaches, both data sets are accurate. DOE has determined that RS Means can serve as an appropriate source of estimating data for this rulemaking and has updated the data sources in this analysis to RS Means 2016.

BHI commented that DOE has not considered that most condensing boilers require two pumps, an associated ''primary-secondary'' piping system, and ''Y strainers'' to keep out system sediment. BHI noted that only in some cases pump(s) are supplied with the boiler while the piping system upgrade is carried out by the installer. (BHI, No. 71 at p. 18)

In response to comments from BHI, DOE notes that such system costs may be incurred by a consumer as part of a heating system upgrade, which DOE understands could result in condensing commercial packaged boilers operating at higher efficiencies, on average. DOE considers in its analysis that many, if not most, boilers (*e.g.,* 95% of cases for buildings built before 1990) in a standards-case scenario may be installed in systems that do not provide for low return water temperature conditions, on average, and are thus assigned high return water temperature operating conditions. As such, DOE already takes into account the impact to the consumer, in terms of lost potential for additional energy savings, of using an unmodified distribution system when it assigns a high return water temperature condition in those cases. Regarding inclusion of the Y-strainer cost in the installation cost, DOE is aware that some CPB manufacturers, both condensing and non-condensing, may recommend the use of a Y-strainer or dirt separator for the purpose of dirt elimination, but did not identify requirements for this technology. DOE observed that a large percentage of condensing CPB equipment manuals recommend the use of Y-strainers, but also notes that many existing CPB systems may already have one installed. As such, DOE included in its analysis the cost of a Y-strainer in an incremental manner for condensing commercial packaged boilers. For CPB equipment classes that contain condensing equipment, DOE's analysis includes a 33 percent higher incidence of Y-strainer usage with condensing equipment.

b. Venting

Crown commented that proposed standard levels for some boilers rule out Category I chimney venting and therefore make boiler installation in certain areas not cost effective. (Crown, No. 61 at p. 13) Other commenters noted that the proposed standards would eliminate the possibility of cheaper Category I venting. Weil-McLain noted that proposed standards will create the need to install new venting systems, essentially eliminate Category III boilers, operate higher power boiler pumps, and operate venting blowers/fans that are necessary for most condensing and near-condensing equipment to operate and safely vent flue gases. (Crown, No. 61 at p. 148; Raypak, No. 61 at p. 145–146; Weil-McLain, No. 67 at pp. 2, 6) AHRI noted that the installation codes that apply to gas and oil boilers today are significantly different from those that existed 50 or 60 years ago. The installation codes are currently more detailed and specific and recognize that boilers operating at steady state efficiencies in the mid-1980s represent the near condensing range of efficiency and that the venting requirements are determined accordingly. (AHRI, No. 76 at p. 15–16) Weil-McLain notes that DOE's own analysis shows very few equipment offerings at near-condensing efficiencies, and that this is because the market has determined that it is not economically feasible to install such commercial packaged boilers due to higher cost of venting. (Weil-McLain, No. 67 at p. 3) Raypak noted that even though boilers with 85-percent E_T (or 85-percent E_C) are available in the market, DOE should not assume that all boiler installations will be capable of having these commercial packaged boilers installed and safely operated. (Raypak, No. 72 at p. 3)

DOE understands the concerns from stakeholders and notes that the standards being adopted in this final rule, and more particularly the adopted standard for SGHW CPB equipment, are lower than that proposed during the March 2016 NOPR. Further, revisions made to the proposed test procedure (81 FR 89276, 89289–89290 (December 9, 2016)) address significant concerns raised by stakeholders regarding potential impact on ratings. Notwithstanding this, DOE recognizes that under the adopted standards, there may be migration between Category I boilers and other boiler categories. However, DOE does not believe that the standard being adopted eliminates all Category I equipment, based on their existence in the market at these efficiency levels. Furthermore, AHRI's own data demonstrates that, with regard to gas-fired hot water boilers, efficiencies between 85-percent and 86-percent E_T and E_C for small and large hot water boilers, respectively, represent a maximum in the efficiency distributions of models provided to DOE. (AHRI, No. 76 at p. 16) DOE has determined that the efficiency levels being adopted in this rulemaking have adequately considered stakeholder comments. DOE has subsequently refined its analysis and considers that the standards being adopted in this final rule are justified.

DOE received multiple comments regarding its handling of venting costs, in particular those associated with 85-percent efficient boiler systems. Raypak commented that replacing existing boilers lower than 85-percent efficiency will require new venting and that DOE should take the associated costs into account. (Raypak, No. 61 at p. 153, 155) Crown commented that every commercial install at 85-percent efficiency will get a different venting system. (Crown, No. 61 at p. 152) NEEA noted that some existing boilers that have greater than 85-percent efficiency would already have venting that would not need replacing, and that the DOE's analysis takes that into account, to which Raypak agreed that systems with boilers of 85-percent efficiency and above would not require venting upgrades in such cases. (NEEA, No. 61 at p. 154; Raypak, No. 61 at p. 155) BHI commented that the costs of vent systems will increase far more than reflected in the cost estimates in the DOE models, as a result of a shift away from Category I vent systems. (BHI, No. 71 at p. 2, 7, 10, and 11) Weil-McLain noted that qualified contractors will want to make sure that a replacement boiler is safely installed and should require the additional steps needed for those installations that are on the near-condensing/condensing efficiency borderline, and that this imposes significant costs. (Weil-McLain, No. 67 at p. 2)

Relative to the March 2016 NOPR public meeting comments, DOE notes that in its analysis it does consider the potential for a boiler to be replaced that is already at or above the 85-percent efficiency level, and that the venting costs would be lower in such a scenario when compared with a similar scenario where the existing boiler being replaced is below 85-percent efficiency. Further, DOE has considered venting costs that would result in safe installation of commercial packaged boilers at all efficiency levels in its analysis, refining the LCC model to select materials for venting that represent the concerns of stakeholders.

BHI and AHRI commented on DOE's venting logic that allowed lower cost Category-I/III venting options for SGHW commercial packaged boilers at the 85-percent efficiency level proposed by DOE in the NOPR. BHI also noted that 85-percent efficiency non-condensing boilers may result in operation in the Category II/IV regime instead of Category I/III assumed by DOE. (BHI, No. 71 at p. 8–10; AHRI, No. 76 at p. 16) AHRI expressed similar concerns that a Category II/IV vent may be needed for gas boilers in the 83.5-percent to 85-percent efficiency levels. (AHRI, No. 76 at p. 16) BHI further commented that even some Category III boilers must be vented with expensive stainless steel option (*i.e.,* AL29–4C), particularly for small commercial packaged boilers. (BHI, No. 71 at p. 18). Lochinvar commented that venting at 85-percent efficiency level should be assumed to be corrosion resistant, a position they say is shared by Raypak and Crown Boiler. (Lochinvar, No. 70 at p. 3) Crown also noted that anything above 85-percent thermal efficiency would not be an option for Category I venting. (Crown, No. 61 at p. 148). Crown commented that even if newer high-efficiency boilers do not need their full vent system replaced, they are going to need terminals, vent adaptors, and gaskets replaced. (Crown, No. 61 at p. 158) AHRI questioned whether 8-inch PVC venting was available on the market. (AHRI, No. 61 at p. 150–151)

In response to comments received, DOE included upgrades to stainless steel venting materials, in some cases selecting AL29–4C, for non-condensing boilers at the 85-percent efficiency level and included, in the case of small gas-fired commercial packaged boilers, a cost transition at 84% efficiency which reflects the cost of mechanically vented CPB equipment where natural draft equipment remains available on the market. This latter approach is conservative with regard to overall installation costs. Analysis of the market efficiencies continues to show that there are Category I small gas-fired commercial packaged boilers at the 85-percent efficiency level, and not all equipment will transition to mechanically vented equipment. As noted previously, however, DOE is adopting in this final rule an 84-percent E_T level for SGHW and 85-percent E_C level for LGHW, and this, in conjunction with the aforementioned modifications to DOE's test procedure final rule (81 FR 89276, (December 9, 2016)), will address many of the concerns of stakeholders regarding the standard levels that were being proposed in the NOPR. In response to Lochinvar's comment about costs incurred even when a full vent system is not replaced, DOE does consider partial costs for venting in its final rule analysis in cases where a vent is determined to be re-usable by replacing a portion of the existing venting system. The details of these costs may be found in appendix 8D of the final rule TSD. With respect to AHRI's question about 8-inch PVC venting availability, DOE notes that at the time the March 2016 NOPR model was developed, DOE was aware of manufacturers that specified 8-inch PVC venting for commercial packaged boilers. However, DOE has revised the venting logic in its final rule to not consider plastic venting on or above 8-inch diameter in order to better reflect typical industry venting practices.

DOE received several comments regarding special situations that require consideration in DOE's venting logic. AHRI commented that the vent systems in older buildings may be of excessive length and convoluted configuration to properly vent by natural draft an 85-percent efficient gas fired commercial packaged boiler, or oil-fired hot water boiler at the 86-percent and 87-percent efficiency levels. (AHRI, No. 76 at p. 1, 15–16, and 26–27) Weil-McLain commented that retrofitting an existing building with a condensing commercial packaged boiler usually involves running venting over extended lengths and usually becomes prohibitively expensive. Weil-McLain further expressed doubts whether DOE's installation cost model has captured all costs, including additional components, venting materials and system engineering/design costs. (Weil-McLain, No. 67 at p. 2, 7) BHI noted that multiple-boiler installations requiring Category III or IV venting are required to have dedicated venting for each boiler, effectively multiplying the cost several times. (BHI, No. 71 at p. 13) In the same note, Lochinvar commented that CPB installations with condensing boilers often require the vent system to be engineered and noted that DOE in its cost model should include custom engineering fees for these systems. (Lochinvar, No. 70 at p. 3) Crown commented that there are terra-cotta lined chimneys that are allowed to use Category I equipment, but the modeling assumption assumes they will need a B-vent. (Crown, No. 61 at p. 148) Spire commented that the effect of the proposed standard would be to eliminate natural vent gas-fired boilers, which can impose substantial additional costs. (Spire, No. 73 at p. 24) BHI cites various requirements and restrictions regarding horizontal venting that may make it difficult to horizontally vent Category III or IV gas-fired commercial packaged boilers in many cases. (BHI, No. 71 at p. 12–13)

In response to comments about common venting, DOE notes that, while model does not explicitly address common venting, DOE has not received any data on the relative prevalence of common vented Category I boilers on the market. In addition, DOE notes that its analysis, which presumes individually vented boilers, also presumes that in the case of boiler replacements, where needed a venting replacement is done for each boiler in the building individually—a cost which may, in effect, exceed that of replacing a single common vent in a multiple boiler installation. Given the lack of detail in the relative frequency of common venting and the potential additional costs that DOE's method incurs, DOE feels that its approach is adequate for its analysis. With respect to the comments about terra-cotta lined chimneys, DOE concludes that due to the relative costs of lining chimney with terra-cotta liners, as opposed to metal liners, the latter would be much more reflective of the option selected in the current replacement boiler market. More broadly, the general comments noted herein have been mitigated by DOE's adoption of an 84-percent level for SGHW CPB equipment, which is lower than that presented at the March 2016 NOPR.

BHI commented that DOE needs to include the additional installation costs associated with complete replacement of ''orphan water heaters'' [45] (*i.e.,* not just vent modifications) on a fraction of installations. (BHI, No. 71 at p. 18)

DOE notes that it does not have data on the relevant frequency of boiler vent systems that are also used to vent water heaters, but received comment at the preliminary analysis stage on this issue. DOE notes that the primary application of common venting is with category I equipment. Comments on the frequency were inconsistent; however, AHRI stated that they believed that common venting of commercial boilers and commercial water heaters may in fact be relatively rare given the size mismatch between commercial boilers and commercial water heaters, such that common venting would be more than problematic because the common vent size would be so large that when the boiler wasn't firing there would be venting problems on the water heater. (AHRI, Public Meeting Transcript, No. 39 at pp. 140–141). Based on input from AHRI, common venting with water heaters would be negligible for large CPB equipment and would be uncommon for small CPB equipment. For small CPB equipment, to the extent that common venting with water heaters does occur, the standards adopted in this final rule and the revisions made to and adopted in DOE's CPB test procedure final rule will allow the continued use of Category I commercial packaged boilers in many commonly vented systems and thus remove concerns with orphaned water heaters in common vented systems.

DOE received various comments regarding the safety of venting options used in the NOPR analysis. AHRI commented that a variety of venting installation issues arise as potential standards are at, or near, condensing levels and noted that both manufacturers and installers use caution in their venting installation (AHRI, No. 76 at p. 42–43) BHI commented that DOE's proposed standards for SGHW and LGHW boilers demonstrates insufficient consideration for the safety consequences of attempting to vent gas-fired boilers at this efficiency level into some chimneys in full compliance with nationally recognized safety standards, such as the National Fuel Gas Code. Further, BHI commented that DOE needs to weigh carefully the levels at which it sets minimum efficiency standards so that it does not inadvertently tip across a technology divide, creating: Serious increased costs to the consumer, the application of marginal technology (which is beyond the control of the manufacturer), utility issues, and even safety issues. (BHI, No. 71 at p. 2, 7, 10, and 11) BHI posits that many of the same issues regarding venting of gas-fired boilers apply to oil-fired boilers at the efficiency levels proposed, and that it is unaware of any analysis performed by DOE to evaluate the effect of the proposed levels for oil-fired hot water and steam commercial packaged boilers to safely and cost-effectively vent oil boilers into existing chimneys. (BHI, No. 71 at p. 16) BHI commented that with an 85-percent gas-fired hot water boiler standard there are too many potential installations which breach acceptable safety levels (*e.g.,* reduction in flue gas buoyancy, operation closer to flue gas dew point, flue gas leakage into the structure as a result of inadequate draft and/or vent system deterioration), and responsible manufacturers and installers will not install 85-percent boilers in these situations and will force consumers into condensing equipment. (BHI, No. 71 at p. 7, 10)

With respect to the comments from AHRI, DOE concludes that CPB equipment manufacturers will provide adequate guidance for installers to ensure that the venting system is safe, and that the installers used to install commercial packaged boilers and their associated vent systems will follow such guidance, and leverage their expertise, to mitigate the dangers of potential corrosion issues. With respect to venting costs, DOE notes that it reviewed and updated the venting costs in the LCC model based on comments and data received from stakeholders and believes that its analysis is now more representative of the costs associated with near-condensing and condensing CPB equipment. Regarding BHI's comments that DOE needs to weigh carefully the levels at which it sets its minimum efficiency standards, DOE's analysis weighs carefully the costs and other issues associated with setting a minimum efficiency standard in this rulemaking, and has been conducted in an open and transparent manner, incorporating input from interested parties throughout this rulemaking. Furthermore, because there are manufacturers actively manufacturing and marketing equipment within the efficiency range in question, both natural draft and mechanical draft, DOE must evaluate and consider such efficiency levels as options within the analysis. Manufacturers are not required to provide equipment at any specific efficiency level, only that equipment must meet or exceed the minimum efficiency level for the equipment class under consideration. Relative to BHI's comment about oil-fired boilers having similar venting issues as gas boilers at the efficiency levels proposed and not being aware of any analysis by DOE to ensure safe and cost-effective venting of oil boilers into existing chimneys, DOE points out that it has considered the cost to remove and replace a chimney with adequate venting for both gas-fired and oil-fired boilers when necessary. As such, it has considered the economic cost to the consumer to ensure safe venting of the commercial packaged boilers.

Several commenters noted the impact of building codes on type of venting allowed in the installation of condensing units. Bradford White expressed reservation that DOE's installation cost model may not address strict installation codes for CPB installations of high rise buildings in New York, Boston and Chicago. (Bradford White, No. 68 at p. 3) BHI commented that many manufacturers and installers do not view practices that are technically possible and may meet the letter of some building codes as safe. While these margins of safety can evolve as manufacturers and installers gain more experience, there will always be a point where a manufacturer will set installation requirements or installers will set practices such that a ''technically compliant'' installation will not be allowed. (BHI, No. 71 at p. 7) In addition, DOE received comment from Raypak that until regulations regarding boiler maintenance in the United States achieve a level of sophistication and stringency similar to those in Europe to ensure that the boilers will operate properly, safely and efficiently, the minimum efficiency levels proposed could result in unsafe and dangerous installations. (Raypak, No. 72 at p. 3) Lochinvar noted that some jurisdictions have enacted rules that prevent installation of non-metallic vents and estimates that the installation costs for approximately 5 percent of installations nationwide that would have selected PVC venting should be recalculated to needing to select AL29–4C instead, as a result. (Lochinvar, No. 70 at p. 3)

With regard to the impact of building codes on the installation of new and replacement boilers, DOE understands that local building codes can have specific and unique requirements regarding termination of venting, both for condensing and for non-condensing CPB equipment that can affect costs. However, due to the localized and building-specific aspects of these

[45] A service hot water heater that shared a vent with a boiler is said to be ''orphaned'' when a high efficiency boiler is installed with which it can no longer share such vent.

requirements, DOE has no ability to quantify their impact on its analysis. DOE notes, however, that it is not adopting any condensing levels in this final rule that would precipitate these costs. DOE notes, with regard to boiler maintenance, that while commercial packaged boilers in the United States may not have national regulations requiring annual boiler inspections and service, many local jurisdictions require safety inspections. Furthermore, it is in the interest of commercial entities using CPB equipment to continue to operate equipment in a safe manner. DOE concludes that equipment at the efficiency levels in its final rule can be installed and operated safely over the life of the equipment. Regarding Lochinvar's comment that approximately 5 percent of installations that would have selected PVC venting should be recalculated as having needed to select AL29–4C due to jurisdictions that may not permit the use of non-metallic vents, DOE notes that its analysis already assigns a 50 percent probability, for vent sizes in the 4-inch to less than 8-inch range, that venting materials for condensing boiler installations will be using AL29–4C. DOE understands that for the smallest boilers, it did not include a probability, however small (*i.e.,* 5 percent), that a consumer might be required to utilize AL29–4C, but as noted above DOE is not adopting a condensing level in this final rule and the marginal incremental cost that would have been associated with this factor would not have impacted the standard levels adopted.

c. Other

AHRI urged DOE to avoid standards that would require difficult and costly installations, or that would remove equipment technologies that are used in the market place to meet consumer requirements, until it has a clear understanding of installation issues via a survey of buildings. (AHRI, No. 76 at p. 44). Spire stated that the end result of the proposed standards would skew the market in favor of electrical equipment over gas-fired equipment based on what Spire referred to as ''an apparent and unrealistic theory'' that these electric boilers will be powered by renewable energy in the distant future. Spire added that ''this does not just lessen competition; it eliminates competition by eliminating the main alternative to electricity.'' (Spire, No. 73 at p. 30)

Regarding AHRI's comment, DOE understands the potential for difficult and costly installations at all efficiency levels, and accounts for a wide variation in costs in installations through consideration of varying vent lengths and base case conditions in its Monte Carlo analysis. DOE disagrees with Spire's contention that revised standards, such as those proposed during the March 2016 NOPR, eliminate competition by eliminating use of the main alternative to electricity. The standards adopted in this final rule are readily available on the market through most, if not all, CPB manufacturers, and higher efficiency levels are in fact being readily incorporated in the existing market. This standard will not eliminate the use of gas in commercial buildings.

See chapter 8 and appendix 8D of the final rule TSD for details on DOE's analysis of installation costs including venting costs.

3. Annual Per-Unit Energy Consumption

DOE estimated annual natural gas, fuel oil, and electricity consumed by each class of CPB equipment, at each considered efficiency level, based on the energy use analysis described in section IV.E of this document and in chapter 7 of the final rule TSD.

DOE conducted a literature review on the direct rebound effect in commercial buildings, and found very few studies, especially with regard to space heating and cooling. In a paper from 1993, Nadel describes several studies on takeback in the wake of utility lighting efficiency programs in the commercial and industrial sectors.[46] The findings suggest that in general the rebound associated with lighting efficiency programs in the commercial and industrial sectors is very small.[47] In a 1995 paper, Eto *et al.*[48] state that changes in energy service levels after efficiency programs have been implemented have not been studied systematically for the commercial sector. They state that while pre-/post-billing analyses can implicitly pick up the energy use impacts of amenity changes resulting from program participation, the effect is usually impossible to isolate. A number of programs attempted to identify changes in energy service levels through consumer surveys. Five concluded that there was no evidence of takeback, while two estimated small amounts of takeback for specific end uses, usually less than 10-percent. A recent paper by Qiu,[49] which describes a model of technology adoption and subsequent energy demand in the commercial building sector, does not present specific rebound percentages, but the author notes that compared with the residential sector, rebound effects are smaller in the commercial building sector. An important reason for this is that in contrast to residential heating and cooling, HVAC operation adjustment in commercial buildings is driven primarily by building managers or owners. The comfort conditions are already established in order to satisfy the occupants, and they are unlikely to change due to installation of higher-efficiency equipment. While it is possible that a small degree of rebound could occur for higher-efficiency commercial packaged boilers, *e.g.,* building managers may choose to increase the operation time of these heating units, there is no basis to select a specific value. Because the available information suggests that any rebound would be small to negligible, DOE did not include a rebound effect for this rule.

During the March 2016 NOPR, DOE requested comments and data on the assumption that a rebound effect is unlikely to occur for these commercial applications. ASAP, Bradford White, Lochinvar, the Joint Utilities, SoCalGas, and Weil-McLain agreed with DOE's findings that a rebound effect is unlikely to occur for commercial packaged boilers. Weil-McLain added that even if it did occur, it would be at insignificant levels. (ASAP, Public Meeting Transcript, No. 61 at p. 178; Bradford White, No. 68 at p. 2; Lochinvar, No. 70 at p. 3; Joint Utilities, No. 65 at p. 2; SoCalGas, No. 77 at pp. 5–6; Weil-McLain, No. 67 at p. 8)

DOE appreciates the comments provided by stakeholders with respect to rebound effect for CPB equipment, and notes that it has not applied a rebound effect in this final rule.

4. Energy Prices and Energy Price Trends

DOE derived average monthly energy prices for a number of geographic areas in the United States using the latest data from EIA and monthly energy price factors that it develops. The process then assigned an appropriate energy

[46] S. Nadel, The Take-back Effect: Fact or Fiction? Conference paper: American Council for an Energy-Efficient Economy, (1993).

[47] The rebound effect accounts for increased usage of equipment by consumers after the implementation of a standard, reducing the energy savings attributed to a standard. That is, the savings from energy-efficient equipment may lead to additional use of that equipment. However, the take-back in energy consumption associated with the rebound effect generally provides consumers with increased value.

[48] Eto *et al.,* Where Did the Money Go? The Cost and Performance of the Largest Commercial Sector DSM Programs. LBL–38201, Lawrence Berkeley National Laboratory, Berkeley, CA (1995).

[49] Y. Qui, Energy Efficiency and Rebound Effects: An Econometric Analysis of Energy Demand in the Commercial Building Sector, Environmental and Resource Economics, 59(2): 295–335 (2014).

price to each commercial and residential building in the sample based on its location. DOE derived 2015 annual electricity prices from EIA Form 826 data.[50] DOE obtained the data for natural gas prices from EIA's Natural Gas Navigator, which includes monthly natural gas prices by state for residential, commercial, and industrial consumers.[51] DOE collected 2014 average commercial fuel oil prices from the consumption, price, and expenditure estimates from the EIA's State Energy Data System (SEDS) and adjusts it using GDP Implicit Price Deflator factors to reflect 2015 prices.[52] DOE developed the LCC analysis using a marginal fuel price approach to convert fuel savings into corresponding financial benefits for the different equipment classes. This approach was based on the development of marginal price factors for gas and electric fuels based on historical data relating monthly expenditures and consumption. For details of DOE's marginal fuel price approach, see chapter 8 of the final rule TSD.

To arrive at prices in future years, DOE multiplied the marginal fuel prices by the projection of annual average price changes in *AEO2016,* which has an end year of 2040. To estimate the trend after 2040, DOE uses the average rate of change during 2030–2040.

DOE received comments on marginal prices and, in particular, on the accuracy of the tariff rates paid by larger load consumers. The Gas Associations commented that the analysis should adjust the energy price calculation methodology using marginal prices to a use a tariff-based approach to make the analysis more robust. (Gas Associations, No. 69 at p. 3) Spire commented that DOE used erroneous utility marginal energy pricing and forecasts in its analysis resulting in overstated benefits. (Spire, No. 73 at pp. 17–19) AHRI asked if consumers with large loads pay the same marginal rates as an average commercial consumer, and Spire responded that they do not and referenced their comment submission in the Residential Furnaces NOPR. (AHRI, Public Meeting Transcript, No. 61 at p. 171; Spire/Laclede, Public Meeting Transcript, No. 61 at p. 171) PG&E agreed with Spire that larger consumers pay less for utilities. (PG&E, Public Meeting Transcript, No. 61 at p. 172) AHRI commented that the marginal gas rates do not accurately reflect what larger consumers pay. (AHRI, Public Meeting Transcript, No. 61 at p. 172) Spire commented that EIA data is completely inaccurate for its largest consumers and that transport rates are typically used. (Spire/Laclede, Public Meeting Transcript, No. 61 at p. 172) PEM commented that the largest consumers also hedge gas prices by buying and selling futures and noted that it is extremely difficult to figure out what the true cost of the energy is, also pointing out that there are consumers utilizing interruptible service accounts. (PEM, Public Meeting Transcript, No. 61 at p. 173) Spire commented that DOE could accurately reflect the marginal prices large consumers pay by looking at the incremental cost per therm[53] in hedge contracts. (Spire/Laclede, Public Meeting Transcript, No. 61 at p. 173)

DOE appreciates the stakeholders comments on the energy prices used in the economic analysis. EIA historical energy prices and *AEO* price trends are the best aggregate sources for energy prices currently available to DOE. DOE understands the importance of accurately representing the energy prices for the consumers in the economic analysis and incorporates many adjustment factors to the average price data and the price trend data to account for the price differences due to variations in locations, seasons, and market sectors and to ensure that the energy prices are properly accounted for in the economic analysis.

Lastly, AHRI commented that the exclusion of dual-fuel capable boilers overstates the effective prices for natural gas since consumers can make use of interruptible natural gas rates. (AHRI, No. 76 at p. 42)

With regard to consumers who may be on interruptible rates, DOE examined CBECS 2012 ''consumption and expenditure'' data and observed that the weighted average cost of natural gas for buildings with commercial packaged boilers using both natural gas and fuel oil is lower by about 6.5 percent compared to the average natural gas price for ''gas only'' buildings. This compares well with a similar statistic referenced by AHRI, who posited that the use of ''interruptible supply'' contracts by consumers would result in rates that result in a 7-percent savings versus ''uninterruptible supply'' rates. Since 95 percent of these observations had gas as the principal fuel, and given that no separate equipment class exists for dual fuel boilers, DOE counted them as gas boilers. However these boilers contribute only 3.5 percent to the total gas boiler sample weights used in the LCC analysis. DOE also noted that nearly 67 percent of the sample buildings using both gas and oil continue to use significant quantities of the higher cost fuel oil, which more than offsets a 7-percent reduction in the natural gas price paid. Further, DOE used gas price data from EIA in its LCC analysis and notes that these prices are based on aggregate revenue and sales, which already include sales for both interruptible and uninterruptible supply. In view of the above, DOE did not pursue development of separate gas price estimates for consumers using dual fuel boilers.

Appendix 8C of the final rule TSD includes more details on energy prices and trends.

5. Maintenance Costs

The maintenance cost is the routine cost incurred by the consumer for maintaining equipment operation. The maintenance cost depends on CPB capacity and heating medium (hot water or steam). DOE used the most recent RS Means Facility Maintenance and Repair Cost Data to determine labor and materials costs and maintenance frequency associated with each maintenance task for each CPB equipment class analyzed.[54] Within an equipment class, DOE assumed that the maintenance cost is the same at all non-condensing efficiency levels, and that the maintenance cost at condensing efficiency levels is slightly higher.

Raypak commented that their Service Department has estimated that approximately 5 percent of current technicians are capable of servicing new technology, higher efficiency equipment, and that DOE should account for this in its rulemaking process. (Raypak, No. 72 at p. 3) DOE notes that in comments received in the November 20, 2014 NODA and preliminary analysis, Raypak commented that although they do not have specific data, they believe that the vast majority of maintenance/service is performed by manufacturer factory-trained personnel due to the specialized equipment and expertise required to properly diagnose and repair current commercial packaged boilers. (Raypak,

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[50] U.S. Energy Information Administration, *Form EIA–826 Monthly Electric Utility Sales and Revenue Report with State Distributions* (EIA–826 Sales and Revenue Spreadsheets). Available at *http://www.eia.gov/electricity/data/eia826/.*

[51] U.S. Energy Information Administration, *Natural Gas Prices.* Available at: *http://www.eia.gov/dnav/ng/ng_pri_sum_a_EPG0_PCS_DMcf_a.htm.*

[52] Source: GDP Implicit Price Deflator factors derived from U.S. Department of Commerce, Bureau of Economic Analysis. Available at *http://www.bea.gov/iTable/iTable.cfm?ReqID=9&step=1#reqid=9&step=1&isuri=1.*

[53] A therm is a unit of heat equivalent to 100,000 Btu or 1.055×10^8 joules.

[54] RS Means, 2016 Facilities Maintenance & Repair Cost Data. Available at: *http://rsmeans.com/60305.aspx.*

No. 35 at p. 5) AHRI similarly noted that the industry trend for boiler maintenance is toward using external contractors who specialize in servicing advanced design boilers or boiler systems. (AHRI, No. 37 at p. 5)

DOE understands that with any change in technology, there will be an adjustment time needed to develop the skills and expertise within the workforce to adequately service and maintain such technology. However, the comments received at preliminary analysis indicated that the maintenance and service markets were already in transition and DOE does not believe that there is basis for presuming that the service market would not adapt under a new standard scenario at any of the efficiency levels considered.

ABMA commented that the maintenance tasks for large boilers may be more involved and may need to be performed from a ladder or catwalk and as such, the maintenance cost should not be based on extrapolating the maintenance cost for smaller boilers. (ABMA, No. 64 at pp. 2–3)

DOE's LCC model does attempt to develop a maintenance cost for large boilers using data for multiple size categories found in the RS Means Facilities Maintenance and Repair Data manual, recognizing that some tasks may be more involved for larger boilers, as noted by ABMA. The largest size category referenced did not have an upper size limit, but DOE believes that the DOE developed costs, which extrapolates costs for commercial packaged boilers beyond the largest size category available from RS Means, are likely more appropriate for the large CPB equipment classes. However, DOE notes that there is no difference in maintenance cost for a given size boiler based on its efficiency, with the exception that condensing boilers have a slight incremental cost due to condensate neutralizer replacement and thus the magnitude of the maintenance cost would not play a significant role in the LCC savings analysis. DOE concludes that its maintenance approach and costs for larger boilers is appropriate for this rulemaking.

Appendix 8E of the final rule TSD includes more details on maintenance costs.

6. Repair Costs

The repair cost is the cost to the commercial consumer for replacing or repairing components that have failed in the commercial packaged boiler (such as the ignition, controls, heat exchanger, mechanical vent damper, or power vent blower). DOE used the latest version of the RS Means Facility Maintenance and Repair Cost Data to determine labor and materials costs associated with repairing each CPB equipment class analyzed.

DOE sought input from manufacturers regarding the representativeness of using 1-year as warranty for parts and labor and 10-years as warranty for the heat exchanger and received comments from interested parties. Crown commented that manufacturer warranties are a good metric for equipment lifetime and suggested condensing and non-condensing boilers have very different warranties. Further, Crown noted that many warranties are prorated so that a 10-year warranty might actually be a 5-year warranty with 5 years of pro-rated warranty coverage. (Crown, Public Meeting Transcript, No. 61 at pp. 165–166) Raypak commented that many manufacturers do not include labor as part of their warranties, and that a 1-year warranty on the heat-exchanger might be more appropriate. (Raypak, Public Meeting Transcript, No. 61 at p. 163) However, ABMA commented that 5-years may be a better warranty period for heat exchangers especially for larger sizes (ABMA, Public Meeting Transcript, No. 61 at pp. 162–163) and both Bradford White and Lochinvar agreed with DOE's assumptions regarding warranties, adding that the heat exchanger warranty can be prorated for a period of time beyond the non-prorated warranty period. (Bradford White, No. 68 at p. 2, Lochinvar, No. 70 at p. 3)

DOE reviewed the warranty terms of various manufacturers and determined that the vast majority of manufacturers offer at least ten years of coverage for heat exchangers and that both condensing and non-condensing warranties may use prorating as part of their terms. Based on this observation and comments received, DOE determined a 10-year warranty is representative for parts coverage. This review also found that labor is generally called out as not being covered by manufacturer warranties. However, DOE considered that other players in the distribution chain may provide such labor cost coverage within the first year of operation. DOE performed a sensitivity analysis of the LCC model where the consumer would cover labor costs for any instances of heat exchanger failure within the first year and determined that there is no impact to the results and has retained the assumption of parts and labor coverage within one year of installation. With respect to the comments suggesting warranties as an indicator of lifetime, DOE encountered similar warranty terms for condensing and non-condensing boilers and did not attempt to extrapolate lifetime differences from warranty terms. Further, as noted during the CPB NODA and availability of Preliminary Analysis TSD, DOE agreed with commenters that it is difficult to estimate lifetime of a technology that has only been broadly available on the market for about 15 years, and DOE concludes that the values captured in survey results may be more representative of early experience based on new technology or installation issues. DOE expects that, as condensing boiler technology matures and installers become better trained at installing and maintaining condensing boilers, lifetime of condensing commercial packaged boilers sold and installed in 2020 and beyond would be expected to be similar to their non-condensing counterparts.

Crown commented that condensing boilers would be more susceptible to poor water-quality related failures due to their smaller piping, and that warranties take that into account. (Crown, Public Meeting Transcript, No. 61 at pp. 166–167) ASAP and the Joint Advocates commented that DOE is overestimating the repair costs for condensing boilers and that DOE should assume the same heat exchanger failure rates for condensing and non-condensing boilers in the absence of data to the contrary. (ASAP, Public Meeting Transcript, No. 61 at p. 164, Joint Advocates, No. 74 at p. 1, 7)

DOE notes that it considered the potential failures and failure probabilities particular to condensing commercial package boilers in the estimates of repair and maintenance costs, in particular assigning the heat exchanger, a major component of the boiler system, a higher probability of failure than for a non-condensing commercial packaged boiler. DOE appreciates ASAP's and the Joint Advocates' comment positing that DOE should use the same heat exchanger failure rates for condensing and non-condensing boilers in the absence of data to the contrary. However, DOE concludes it is a reasonable assumption given the level of maturity of condensing CPB technology relative to non-condensing commercial packaged boilers and the level of exposure a condensing heat exchanger has to potentially damaging condensate. DOE's assumption provides for a more conservative approach to the calculation of benefits relative to the proposed method suggested by ASAP and the Joint Advocates.

DOE used the latest RS Means Facility Maintenance and Repair Cost Data to determine labor and materials costs associated with repairing each CPB equipment class analyzed. DOE assumed that all commercial packaged boilers have a 1-year warranty for parts and labor and a 10-year warranty on the heat exchanger. For a detailed discussion of repair costs, see appendix 8E of the final rule TSD.

7. Lifetime

Equipment lifetime is defined as the age at which equipment is retired from service. DOE used national survey data, published studies, and projections based on manufacturer shipment data to calculate the distribution of CPB lifetimes. DOE based equipment lifetime on a retirement function, which was based on the use of a Weibull probability distribution, with a resulting mean lifetime of 24.8 years. DOE assumed that the lifetime of a commercial packaged boiler is the same across the different equipment classes and efficiency levels. For a detailed discussion of CPB lifetime, see appendix 8F of the final rule TSD. In its March 2016 NOPR, DOE considered the potential impact of condensate on heat exchangers in commercial packaged boilers that operate in condensing mode and established a higher likelihood and sooner time-to-failure for CPB heat exchangers that are exposed to such condensate.

DOE received various comments regarding CPB equipment lifetime. Bradford White commented that while 24.8 years is a fair estimate for copper and cast iron commercial packaged boilers, it was unsure if it is also a fair estimate for newer, high efficiency condensing models, noting that this equipment has not been around long enough to understand what is typical versus where local adverse conditions may have prematurely caused the boiler to fail. (Bradford White, No. 68 at p. 4) PEM commented that the average life of the New York City field constructed boiler is about 25 years with a maximum of 30 years. (PEM, Public Meeting Transcript, No. 61 at p. 123) ABMA expressed concern regarding the use of EPA–DEFRA reference in the analysis that states that with proper maintenance condensing and non-condensing boilers should have similar life expectancy, and inquired whether the difference in maintenance standards between the two countries was ever considered. (ABMA, No. 64 at p. 1) BHI commented that the life expectancy of condensing and non-condensing boilers is different and that DOE needs to look at warranty information for different commercial boilers to get some evidence in this regard. (BHI, No. 71 at p. 17) Similarly, Crown noted that manufacturer warranties are a good, impartial metric of boiler lifetimes, and that DOE will find there are pretty stark differences between those warranties for condensing and non-condensing boilers. (Crown, Public Meeting Transcript, No. 61 at p. 165) Also commenting on warranties, ABMA commented that a 10-year warranty on the heat exchanger for steam boilers would be foolhardy since the equipment is usually poorly maintained and the life of the boilers are highly dependent upon prevailing operating and maintenance conditions. (ABMA, No. 64 at p. 3)

After carefully considering these comments, DOE has concluded that there is not enough data available to accurately distinguish the lifetime of condensing boilers because, as Bradford White stated, they have not been around long enough to understand what is typical versus where local adverse conditions may cause premature boiler failure. In addition, condensing boiler technologies have been improving since their introduction to the U.S. market; therefore, the lifetime of the earliest condensing boilers, and thus the perception by those surveyed, may not be representative of current or future condensing boiler designs. However, DOE did retain its additional repair costs for condensing boilers by assuming different service lifetimes for heat exchangers for condensing boilers and non-condensing boilers, and this is intended to capture all factors that may lead to shorter heat exchanger life for condensing boilers. Regarding ABMA's comment about 10-year warranties on heat exchangers for steam boilers, DOE reviewed manufacturer warranties and determined that some steam boilers warranties cover the heat exchanger for 10 years.

Details on how DOE adjusted the repair costs for heat exchangers may be found in appendix 8E of the final rule TSD. For more details on how DOE derived the CPB lifetime, see appendix 8F of the final rule TSD.

8. Discount Rates

The discount rate is the rate at which future expenditures and savings are discounted to establish their present value. DOE estimated discount rates separately for commercial and residential end users.

For residential consumers, DOE applies weighted average discount rates calculated from consumer debt and asset data, rather than marginal or implicit discount rates.[55] DOE notes that the LCC does not analyze the appliance purchase decision, so the implicit discount rate is not relevant in this model. The LCC estimates net present value over the lifetime of the equipment, so the appropriate discount rate will reflect the general opportunity cost of household funds, taking this time scale into account. Given the long time horizon modeled in the LCC, the application of a marginal interest rate associated with an initial source of funds is inaccurate. Regardless of the method of purchase, consumers are expected to continue to rebalance their debt and asset holdings over the LCC analysis period, based on the restrictions consumers face in their debt payment requirements and the relative size of the interest rates available on debts and assets. DOE estimates the aggregate impact of this rebalancing using the historical distribution of debts and assets.

To establish residential discount rates for the LCC analysis, DOE identified all relevant household debt or asset classes in order to approximate a consumer's opportunity cost of funds related to appliance energy cost savings. It estimated the average percentage shares of the various types of debt and equity by household income group using data from the Federal Reserve Board's Survey of Consumer Finances[56] (SCF) for 1995, 1998, 2001, 2004, 2007, 2010, and 2013. Using the SCF and other sources, DOE developed a distribution of rates for each type of debt and asset by income group to represent the rates that may apply in the year in which amended standards would take effect. DOE assigned each sample household a specific discount rate drawn from one of the distributions. The average rate across all types of household debt and equity and income groups, weighted by the shares of each type, is 4.4 percent.

For commercial end users, DOE calculated commercial discount rates as the weighted average cost of capital (WACC), using the Capital Asset Pricing Model (CAPM). DOE derived the discount rates by estimating the cost of capital of individual companies that purchase commercial packaged boilers. Damodaran Online is a widely used source of information about company debt and equity financing for most types of firms and was the primary source of

[55] The implicit discount rate is inferred from a consumer purchase decision between two otherwise identical goods with different first cost and operating cost. It is the interest rate that equates the increment of first cost to the difference in net present value of lifetime operating cost, incorporating the influence of several factors: Transaction costs; risk premiums and response to uncertainty; time preferences; interest rates at which a consumer is able to borrow or lend.

[56] The Federal Reserve Board, *Survey of Consumer Finances,* (1989, 1992, 1995, 1998, 2001, 2004, 2007, 2010, 2013). Available at *http://www.federalreserve.gov/pubs/oss/oss2/scfindex.html.*

data for the commercial discount rate analysis.[57] After DOE estimated WACC values for individual companies, the results were condensed into distributions by building type and the LCC model selects discount rates from the distributions corresponding to the building types being modeled.

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

DOE received several comments regarding its use of discount rates in this rulemaking. Raypak and Spire commented that residential discount rates should not be used and that using commercial discount rates would be better for the residential sector, noting that the discount rate that should apply is that of the debt and equity of the owner of the buildings, not of the people that live in them. (Raypak, Public Meeting Transcript, No. 61 at pp. 176–177; Spire/Laclede, Public Meeting Transcript, No. 61 at p. 176; Spire, No. 73 at p. 27) AHRI agreed with comments from Raypak and Spire, and added that commercial packaged boilers used in residential settings are typically used in large apartment buildings or complexes where heating costs are included in the rent and associated fees. (AHRI, No. 76 at p. 41) However, AHRI commented that consumer discount rates used in the LCC analysis are incorrectly computed and used due to the use of average rather than marginal discount rates, while also noting that previous rulemaking comments that DOE should use marginal discount rates for consumers have little actual relevance in this rulemaking, since AHRI finds that the average and marginal discount rates may be approximately the same. (AHRI, No. 76 at p. 40) NEEA commented that energy bills have no influence on rent prices for multi-family housing, reflecting a similar concern in how costs are transferred in the multi-family housing market. (NEEA, Public Meeting Transcript, No. 61 at pp. 182–183)

With respect to the use of residential discount rates in its analysis, DOE considered the question whether a commercial discount rate should be used for residential, multi-family buildings. DOE understands that a commercial discount rate might apply in some cases, but in other cases, while the upfront purchase is funded by a building owner or entity, ultimately income from the renters pay for the CPB equipment through rent paid to the owner or entity and additionally ultimately pay for the operating and maintenance cost of the CPB equipment. Further, the discount rate is not used in conjunction with the purchase of the equipment, but is used to determine a present value for a future stream of ongoing operating and maintenance costs and benefits. DOE understands that the principal time a commercial discount rate would apply is when an owner or entity can exert market power and claim the financial benefits as excess profits. Such rental markets do exist, but not for the long run. Either new rental units get built until supply and demand are in balance, or some external shock upsets the owner's or entity's ability to reap excess profits. As such, for this final rule analysis, DOE is using updated residential discount rates for the CPB equipment used in the residential sector.

More details regarding DOE's estimates of consumer discount rates are provided in chapter 8 of the final rule TSD.

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

To accurately estimate the share of consumers that would be affected by a potential energy conservation standard at a particular efficiency level, DOE analyzed the considered efficiency levels relative to a no-new-standards case (*i.e.,* the case without amended energy efficiency standards). This analysis requires an estimate of the distribution of equipment efficiencies in the no-new-standards case (*i.e.,* what consumers would have purchased in the compliance year in the absence of amended standards). DOE refers to this distribution of equipment energy efficiencies as the no-new-standards-case efficiency distribution.

Regarding DOE's use of the AHRI database to establish the no-new-standards case efficiency distribution in its NOPR analysis, AHRI commented that the analysis should consider the number of basic models and their distribution by efficiency level, which differs from the number of listings, for its economic analysis. (AHRI, No. 76 at pp. 12, 17–24) In written and oral comments, manufacturers stated that the distribution of CPB equipment models, based on efficiency, is not a fair assessment on how the market shipments are distributed. (Lochinvar, No. 70 at p. 6; BHI, No. 71 at p. 17; Raypak, No. 72 at p. 2) Manufacturers expressed that the scope of available equipment is covered by the AHRI database, however, the distribution of equipment is not representative of the volume of sales as actual shipments will be more biased toward high efficiency equipment than is indicated by available models.

DOE requested shipment information from stakeholders at the NOPR phase. In response, AHRI submitted shipment information for SGHW and LGHW equipment classes that was broken down by efficiency and rated input (for SGHW only). AHRI also submitted historical annual shipment information for gas-fired hot water (including condensing boilers), gas-fired steam, oil-fired hot water and oil-fired steam equipment classes. DOE used the AHRI database and equipment shipment data by efficiency provided by AHRI to analyze trends within equipment classes, as it relates to efficiency levels, to determine the anticipated no-new-standards case efficiency distribution in 2020, the assumed compliance year for amended standards. The trends show the market moving toward higher efficiency commercial packaged boilers, as noted by stakeholders, and DOE accounted for these trends in its no-new-standards case projection. DOE used this information for updating the final rule analysis. For equipment classes that lacked shipment information, DOE used publicly available modeling listing and efficiency information in its analysis. In the absence of shipment information, the distribution of model listings provides a reasonable proxy for shipments for each equipment class. In general, manufacturers are likely to offer models with rated inputs and efficiencies where demand is highest, therefore DOE assumed modeling listing and efficiency information would hold as a proxy for efficiency distribution of shipments.

Regarding AHRI's comment that DOE use basic models only in its analysis, as opposed to the entire database, DOE does not filter the AHRI directory to capture only basic models and notes that the AHRI database does not facilitate the differentiation between basic models within their model listings. DOE is concerned with attempting to infer which models in the database represent basic models, using only the data available in the AHRI database. However, DOE did perform an analysis of the distribution of efficiency levels, and it showed only a minimal difference between DOE's distributions, as captured in 2016 (*i.e.,* an updated dataset obtained since that used during the March 2016 NOPR), and those provided by AHRI. Further, DOE understands that some models may have more equipment units listed than the others, correlating to a demand in the market for variations from basic models, which may reflect consumer demand for such equipment. Since DOE uses

[57] Damodaran Online. *Data* page: *Cost of Capital by Industry Sector.* (2004–2013). Available at: *http://pages.stern.nyu.edu/~adamodar/.*

historical versions of the AHRI database to develop projected distributions for 2020, it would be impractical to attempt to reassess these distributions in terms of basic models, with little to no improvement in the accuracy of the actual distribution. Lastly, DOE notes that stakeholders have expressed concerns historically regarding the ability to infer a distribution of shipments by efficiency based on a distribution of available models and/or listing. As noted in this section, DOE received and considered historical shipment data by efficiency for the gas-fired hot water CPB equipment classes in its determination of the no-new-standards efficiency distributions. However it did retain its methodology from the NOPR, of using the AHRI database on the other six equipment classes analyzed, as it did not have data on shipments by efficiency to inform its analysis. For the purpose of this final rule, DOE did a general data update to capture AHRI 2016 equipment models data and adjusted the gas-fired hot water CPB equipment condensing market share approach and its projection of the no-new-standards case efficiency distributions for the year 2020 based on the availability of historical shipments data. For all other equipment classes analyzed, and for portions of the SGHW and LGHW CPB equipment classes (not including the year 2020 and its condensing market share approach for which shipment data was used), DOE retained its NOPR methodology for developing the no-new-standards case efficiency distribution, and considered all the equipment listed in the AHRI database.

Also providing comment, Spire stated that there is no basis to assume that purchases of higher-efficiency commercial packaged boilers that would provide net economic benefits to the purchaser would not occur even in the absence of the proposed standard. (Spire, No. 73 at p. 15) DOE makes no such assertion, but notes that its analysis assesses the impact of standards on consumers, but does not further assess the net economic impacts on consumers who voluntarily select higher efficiency equipment in the absence of standards.

Table IV.6 presents the estimated no-new-standards case efficiency market shares for each analyzed CPB equipment class in 2020. Appendix 8H of the final rule TSD contains more information regarding DOE's development of the efficiency distributions in the no-new-standards case.

TABLE IV.6—ESTIMATED NO-NEW-STANDARDS CASE BOILER EFFICIENCY DISTRIBUTION * OF ANALYZED COMMERCIAL PACKAGED BOILER EQUIPMENT CLASSES ** IN 2020

Efficiency	SGHW (%)	LGHW (%)	SOHW (%)	LOHW (%)	SGST (%)	LGST (%)	SOST (%)	LOST (%)
77					46	13		
78					6	31		
79					15	13		
80	9				16	21		
81	4				12	5	27	35
82	5	1	32			11		
83		1	24		5		53	38
84	4	4	12	40		7	14	
85	8	15	17					26
86				45			6	
87			10					1
88			3	10				
89				1				
90								
91								
92								
93	36							
94		77						
95	28							
96								
97		2	3	3				
98								
99	5							

* Results may not add up to 100% due to rounding.
** SGHW = Small Gas-fired Hot Water; LGHW = Large Gas-fired Hot Water; SOHW = Small Oil-fired Hot Water; LOHW = Large Oil-fired Hot Water; SGST = Small Gas-fired Steam; LGST = Large Gas-fired Steam; SOST = Small Oil-fired Steam; LOST = Large Oil-fired Steam.

DOE calculated the LCC and PBP for all consumers as if each were to purchase new equipment in the year that compliance with amended standards is required. EPCA directs DOE to publish a final rule amending the standard for the equipment not later than 2 years after a notice of proposed rulemaking is issued. (42 U.S.C. 6313(a)(6)(C)(iii)) As discussed previously in section III.A of this document, for purposes of its analysis, DOE used 2020 as the first year of compliance with amended standards.

10. Payback Period Inputs

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

The inputs to the PBP calculation are the total installed cost of the equipment to the consumer 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.

Lochinvar commented that DOE should not consider a payback period over 7 years as acceptable in this rulemaking, noting that commercial buildings are sold just like consumer property and owners will not accept a payback period longer than their expected length of ownership. (Lochinvar, No. 70 at p. 6)

DOE notes that, in general, rulemakings have selected levels with payback periods within the lifetime of the equipment. However, DOE's LCC analysis and development of full life-cycle-cost and life-cycle-cost savings values considers additional detail and economic factors and DOE considers it a more robust assessment of the economic impact on consumers.

11. General Comments

DOE received several comments regarding complexity of the LCC Model. AHRI, through its consultant Shorey Consulting, Inc., commented that the use of distributions, and not single point values, makes the model more complex and less transparent and suggested that DOE should have a dialogue with key stakeholders to determine whether the apparent sophistication that comes from the Monte Carlo process is worth the loss in transparency. In addition, they suggest that DOE should also engage stakeholders to determine whether the assumptions inside the LCC model are either necessary or correct. (AHRI, No. 76 at pp. 28–29) In particular, AHRI expressed concern that the random no-new-standards case assignment of efficiencies is thoroughly embedded in DOE's model logic and is not reflective of a functioning marketplace. (AHRI, No. 76 at p. 31 and 45) Spire similarly commented that DOE overstated benefits by assuming purchasing decisions that do not make economic sense will occur. (Spire, No. 73 at p. 16) AHRI suggested a need for a more straightforward, less complex and more understandable approach to modeling. They assert that a core issue is the use of the Monte Carlo simulation approach, and while recognizing that many inputs are distributions rather than single point values, assert that gaining the ability to use distributions has come at the cost of clarity and traceability and the ability to audit the model. (AHRI, No. 76 at p 28) AHRI, through its consultant, provides an example as an illustrative modeling approach that is deterministic, as opposed to using Monte Carlo analysis, utilizes a narrower set of assumptions, and whose implementation resulted in substantively different economic results. Specific aspects of these results are presented in AHRI's comment. AHRI emphasizes that this model is an alternative working model, but states it is in no way suggested as a direct substitute for DOE's LCC, but rather represents a pathway towards a more effective model. (AHRI, No. 76 at pp. 2–3). Spire also commented that DOE's spreadsheets and Monte Carlo software were unreasonably complicated and prone to errors and lacks transparency. (Spire, No. 73 at p. 26).

In response to the comments on the LCC model complexity, DOE welcomes feedback and data supporting modeling changes in its analysis, but, in general believes that it is valuable to capture variation in inputs to help establish variation in LCC and LCC savings in the output. DOE has found that the examination of the fraction of a user base which is negatively impacted by possible standards is an important consideration in setting new standards. DOE notes that the LCC model using the Crystal Ball software can output the assumed values and results of each assumption and provide forecasted results for each iteration in the Monte Carlo simulation if desired by stakeholders to review or trace the output. In addition, it is possible to modify directly the assumption cells in the model to examine impacts of changes to assumptions on the LCC and in fact DOE relies both of these techniques for model testing. DOE notes that the model provided as an example by AHRI limited in many important ways the scope of the market being examined, including omission of any use of RECS data, ignoring new construction, assumes all condensing boilers operate in the high return water temperature scenario, ordering the efficiency distribution in the no-new-standards case as a function of calculated payback, and excluding the incremental costs of venting or maintenance and repair. In addition, a fundamental difference was in the base case assumption where the AHRI model presumed that where the analysis showed the shortest paybacks, consumers were presumed to purchase the highest efficiency boilers in the no-new-standards case distribution. (AHRI, No. 76 at p. 31) This reflects an overly optimistic and unrealistic working market, presumes information that may not be available to all purchasers and, while informative, may unreasonably bias the results as presented by AHRI. While DOE appreciates the feedback from AHRI and recognizes the value of clarity and traceability, it has not deviated from the use of the Monte Carlo approach for the final rule. DOE addresses specific modeling assumptions in the discussion surrounding those variables in the LCC inputs discussion that follows.

AHRI posited that either due to DOE's sizing assumption and/or due to the use of the CBECS energy use data in the sample itself, the energy use model produced excessively high operating hours in some instances and that these distort the economic results. (AHRI, No. 76 at pp. 37–40) AHRI's consultant suggest that a more logical approach for estimating may be to use directly measured data or estimated load data (AHRI, No. 76 at p. 40). DOE has not identified a source of comprehensive burner operating hour (BOH) data for commercial boilers that could be used for such an analysis nor was such identified to DOE by stakeholders. Estimated BOH data from other sources, such as whole building simulation modeling of commercial buildings is another approach that has been considered by DOE, but could result in the need to resolve an even larger number of building-level modeling details and assumptions. DOE received no early guidance from stakeholders and accordingly did not propose the use of whole building simulation at the November 2014 NODA and preliminary analysis or March 2016 NOPR stages. Consequently, DOE has updated the model to use the most recent CBECS 2012 data and made other adjustments, but has not abandoned the use of CBECS energy data nor its sizing methodology. DOE also notes that certain results that are presented by AHRI for the SGHW class reflect the removal of the upper 10 percent of the calculated BOH. DOE concludes that while there is value in reviewing the BOH results, there is no basis to assume that the very highest level of BOH seen in the buildings examined should be simply removed from the LCC analysis.

AHRI also commented that combining the results for natural and mechanical draft commercial packaged boilers, particularly for SGHW boilers, disguises the effects of market adoption of higher efficiency equipment and demonstrates this with the results obtained with their modeling approach and assumptions. (AHRI, No. 76 at pp. 32–33) DOE, however, notes that it considers that there is variation in equipment design, including draft type, in the market. However, as has been noted by DOE in this rulemaking, draft type does not define a unique utility for commercial packaged boilers and consequently there is only one equipment class for the SGHW CPB equipment class. Thus, DOE's LCC analysis aggregates sample selection both for consumers using natural draft equipment and mechanical draft equipment.

AHRI and BHI commented that the random assignment of no-new-standards case efficiencies in the LCC model is not correct, as this inherently assumes that the purchasers do not pay attention to costs and benefits in a world without standards. AHRI further stated that approximately 75 percent of commercial buildings which use boilers are buildings where the end user either pays, or has significant control, over the decision to purchase a new boiler. (AHRI, No. 76 at p. 26, 29, 30; BHI, No. 71 at p. 16)

In response, DOE notes that development of a complete consumer choice model, to support an alternative to random assignment in the no-new-standards case, for boiler efficiency would require data that are not currently available, as well as recognition of the various factors that impact the purchasing decision, such as incentives, the value that some consumers place on efficiency apart from economics (*i.e.,* ''green behavior''), and whether the purchaser is a building owner/occupier or landlord. For the final rule, DOE used the same general method to assign boiler efficiency in the no-new-standards case.

G. Shipments Analysis

In its shipments analysis, DOE developed shipment projections for commercial packaged boilers and, in turn, calculated equipment stock over the course of the analysis period. DOE used the shipments projection and the equipment stock to calculate the national impacts of potential amended or new energy conservation standards on energy use, NPV, and future manufacturer cash flows. DOE developed shipment projections based on estimated historical shipment and an analysis of key market drivers for each kind of equipment. DOE did not find any evidence nor was provided any data during the public comment period that indicates fuel switching from oil or gas-fired commercial packaged boilers to electric commercial packaged boilers occurred in the market for these products. Therefore DOE did not modify the shipments analysis to include fuel switching beyond what the historical shipments trend might imply. Furthermore, CBECS 2012 data indicate that 7 percent of commercial buildings use electric boilers (not necessarily packaged boilers) for primary space heating.

In the final rule DOE revised its estimates of historical shipments and shipment projections as additional data became available. The additional data include public use microdata files on the ''Consumption and Expenditure'' segment of EIA's CBECS 2012. AHRI also provided confidential historical shipment data to DOE's contractors under confidentiality arrangement. DOE estimated historical shipments from stock estimates based on the CBECS data series from 1979 to 2012. Since no CBECS survey was conducted prior to 1979, DOE used the trends in historical shipment data for residential boilers to estimate the historical shipments for the 1960–1978 time period. For estimation of stocks of gas and oil boilers, DOE used the data on growth of commercial building floor space for nine building types from *AEO* reports, percent floor space heated by CPB data from CBECS for these building types, and estimated saturations of commercial packaged boilers in these building types. From these stock estimates, DOE derived the shipments of gas-fired and oil-fired commercial packaged boilers using correlations between stock and shipment for gas and oil boilers. As noted in section IV.E.2 of this document, to obtain individual equipment class shipments from the aggregate values, DOE used the steam to hot water shift trends from the EPA database for space heating boilers. The oil to gas shift trends were derived from CBECS data for historical shipments and from *AEO2016* for projected shipments. The equipment class shipments were further disaggregated between shipment to new construction and replacement/switch shipments.

To project equipment class shipments for new construction, DOE relied on building stock and floor space data obtained from the *AEO2016.* DOE assumed that CPB equipment is used in both commercial and residential multi-family dwellings. DOE estimated a total saturation rate for each equipment class based on prior CBECS data and a modeled size distribution of commercial packaged boilers in commercial buildings with a given design heating load. As new data from CBECS 2012 became available, DOE modified its approach to calculate the saturation rates for new construction used in the March 2016 NOPR stage. For estimation of saturation rates in the new commercial construction, DOE calculated saturation rates averaged over a period of 9 years from 2004 through 2012 from the estimated CPB stock for buildings constructed during the reference period. The new construction saturation rates were projected from 2013 till the end of the analysis period considering currently observed trends from CBECS 2012 and *AEO2016* (for oil to gas shifts). For residential multi-family units, DOE used RECS 2009 data and considered multi-family buildings constructed in the 9 year period from 2001 to 2009 as new construction for calculating the new construction saturation. DOE assumed that the new construction saturation in multi-family buildings are nearing their minimum threshold values and would remain unchanged during the analysis period. DOE applied these new construction saturation rates to new building additions in each year over the analysis period (2020–2049), yielding shipments to new buildings. The building stock and additions projections from the *AEO2016* are shown in Table IV.7.

DOE estimated the percent share of different efficiency bins across the equipment classes as detailed in chapter 9 of the final rule TSD.

TABLE IV.7—BUILDING STOCK PROJECTIONS

Year	Total commercial building floor space (million sq. ft.)	Commercial building floor space additions (million sq. ft.)	Total residential building stock (millions of units)	Residential building additions (millions of units)
2015	82,176	1,659	115.39	1.18
2020	86,661	2,079	120.41	1.74
2025	91,888	2,149	126.03	1.71
2030	97,148	2,210	131.39	1.67
2035	102,364	2,266	136.35	1.64
2040	107,552	2,337	141.35	1.65
2045	113,164	2,403	146.66	1.74
2049	117,864	2,458	151.06	1.79

Source: EIA *AEO2016*.

Commercial consumer purchase decisions are influenced by the purchase price and operating cost of the equipment, and therefore may be different across standards levels. To estimate the impact of the increase in relative price from a particular standard level on CPB shipments, DOE assumed that a portion of affected consumers are more price-sensitive and would repair equipment purchased prior to enactment of the standard rather than replace it, extending the life of the equipment by 6 years. DOE modeled this impact using a relative price elasticity approach. When the extended repaired units fail after 6 more years, DOE assumed they will be replaced with new ones. A detailed description of the extended repair calculations is provided in chapter 9 of the final rule TSD.

In the March 2016 NOPR, DOE sought feedback on the assumptions used to develop historical and projected shipments of commercial packaged boilers and the representativeness of its estimates of projected shipments. DOE also requested information on historical shipments of commercial packaged boilers including shipments by equipment class for small, large, and very large commercial packaged boilers. In the March 2016 NOPR analysis, as a required input to the NIA model, DOE had estimated historical shipments of commercial packaged boilers for over 50 years through 2012. AHRI commented that DOE's estimates of historical shipments are lower than the actual historical shipments and furnished confidential historical shipment data for a limited period to DOE's contractors in support of its assertion. (AHRI, No. 76 at p. 13) DOE appreciates the efforts of AHRI and its members to help better inform this rulemaking. The data provided were used to calibrate and refine DOE's shipments model for estimation of historical shipments.

Several commenters further pointed out that the projected shipments of commercial packaged boilers show an unrealistic growth trend that could not be observed in DOE's historical shipment estimates from 1960 through 2012. (AHRI, Public Meeting Transcript, No. 61 at p. 191; Raypak, Public Meeting Transcript, No. 61 at p. 193; Raypak, No. 72 at p. 2; Lochinvar, No. 70 at p. 4; Crown, Public Meeting Transcript, No. 61 at pp. 191–192) NEEA, however, pointed out that the growth in DOE's projected shipments could be attributed to replacements of existing boiler stock and growth in commercial building stock, which should track the trends of new construction of commercial floor space captured in the economic models of the EIA. (NEEA, Public Meeting Transcript, No. 61 at pp. 192–194)

In response to the comments received on projected shipments, DOE updated its shipments model, the results of which display lower growth of projected shipments. In particular, for the March 2016 NOPR, DOE used constant values for percent floor space heated by boiler and CPB saturation (*i.e.,* number of units per million square feet of floor space heated) during the entire analysis period for estimating the projected shipments. In the final rule, DOE used a declining trend in area heated by boiler (0.25 percent per year) but constant saturation resulting in only a more modest growth in shipments.

Lochinvar commented that DOE should consider publishing all the data and model parameters of the shipment model. (Lochinvar, No. 70 at p. 4)

In light of shipment data having been received under confidentiality agreement, DOE is unable to publish the shipment data furnished by AHRI. However, DOE has provided an updated version of the shipments model description and the model parameters in chapter 9 and appendix 9A of the TSD, and shipments data from DOE's calibrated model may be found in the NIA model.

DOE also received various general comments regarding its March 2016 NOPR shipments approach and shipments by efficiency level. BHI commented that DOE should rely on models sold, and not model availability, in its analyses. (BHI, No. 71 at p. 17) Similarly, Lochinvar commented that equipment databases are not representative of the distribution of sales. (Lochinvar, Public Meeting Transcript, No. 61 at p. 208) Bradford White noted that distribution of models based on efficiency is not a fair assessment of how CPB shipments are distributed, and further questions whether standards are truly necessary if, as DOE's own shipments projections show for condensing boilers, the market is already moving towards these higher efficiency equipment on its own. (Bradford White, No. 68 at p. 2) Weil-McLain commented that DOE should look at actual shipments to get a realistic idea of the distribution of boilers installed today based on efficiency levels, rather than total number of models available in each category. (Weil-McLain, No. 67 at p. 8) Raypak commented that it takes exception with the DOE's use of the number of models listed in the AHRI directory as representing the actual shipments of commercial packaged boilers as no such correlation existed and recommended that DOE use data that is more reflective of the marketplace. (Raypak, No. 72 at p. 2) Lochinvar commented that DOE has consistently projected shipments that exceed industry expectations and seem unjustified by existing market data, and that DOE underestimated market trends toward condensing boilers. (Lochinvar, No. 70 at pp. 4, 8) Weil-McLain expressed their belief that the impact of the proposed efficiency standards on natural draft and steam boiler shipments could be significant and that consumers will often decide to repair the existing boiler and delay replacement, creating an unintended consequent reduction in energy savings. (Weil-McLain, No. 67 at pp. 4, 8)

DOE notes that while models throughout most of this rulemaking had relied to some degree on indirect methods to estimate historical and projected shipments, in this final rule the shipments model has been calibrated utilizing shipments data provided to inform the analysis. Based on the availability of these shipments data and the calibration of the shipments model to better reflect the marketplace, DOE concludes that it has adequately addressed the stakeholders' concerns in this final rule. Regarding Bradford White's comments whether standards are truly necessary, DOE notes that the shipments data it received allowed DOE to better inform its analysis and to make that determination based on a more accurate assessment of the national energy savings potential, among other factors it considered. With regard to Weil-McLain's comment about repair versus replace under new standards, DOE assumed that a portion of affected consumers are more price-sensitive and would repair equipment purchased prior to enactment of the standard (in 2019) rather than replace it, extending the life of the equipment by 6 years. DOE modeled this impact using a relative price elasticity approach. When the extended repaired units fail after 6 more years, DOE assumed they will be replaced with new ones. Regarding Weil-McLain's specific comment about natural draft boilers, DOE notes that the standards for small gas-fired hot water commercial packaged boilers in the final rule are lower than proposed at March 2016 NOPR and should alleviate the impact on natural draft shipments. Regarding steam boilers, while DOE understands the observation voiced by Weil-McLain, no new data was provided as to the driving force or likely significance of the impact on the overall steam boiler shipments. Consequently, DOE was not able to further calibrate the shipments model for the impact of standard levels analyzed for steam boilers.

The projected shipments at 5 year intervals during the analysis period starting from 2020 and a few key years are shown in Table IV.8.

TABLE IV.8—SHIPMENTS OF COMMERCIAL PACKAGED BOILER EQUIPMENT

[Thousands]

Year	SGHW CPB *	LGHW CPB	SOHW CPB	LOHW CPB	SGST CPB	LGST CPB	SOST CPB	LOST CPB
2015	25,634	2,112	4,156	298	2,313	260	1,240	93
2020	24,582	2,025	2,238	161	1,927	216	1,189	89
2025	23,979	1,976	2,159	155	1,551	174	1,140	85
2030	26,734	2,203	2,061	148	1,143	128	1,093	82
2035	28,524	2,350	1,945	140	685	77	1,045	78
2040	27,918	2,300	1,827	131	432	49	981	73
2045	28,874	2,379	1,718	123	415	47	922	69
2049	29,980	2,470	1,627	117	401	45	874	65

* SGHW = Small Gas-fired Hot Water; LGHW = Large Gas-fired Hot Water; SOHW = Small Oil-fired Hot Water; LOHW = Large Oil-fired Hot Water; SGST = Small Gas-fired Steam; LGST = Large Gas-fired Steam; SOST = Small Oil-fired Steam; LOST = Large Oil-fired Steam.

Given the comments regarding the impact of increased repairs on shipments, DOE determined that use of price elasticity to model the extended repair option should be maintained in this final rule. DOE used the price elasticity from a residential product study to use sales and price data for commercial unitary air conditioners[58] to more closely approximate an elasticity for commercial equipment (data specific to commercial packaged boilers were not available). DOE notes that it performed two sensitivity analyses—one without the use of the price elasticity, and one in which the price elasticity was increased ten-fold. The results of the sensitivity analyses are presented in appendix 10D of the final rule TSD.

Because the estimated energy usage of CPB equipment differs by commercial and residential setting, the NIA employed the same fractions of shipments (or sales) to consumers as is used in the LCC analysis. The fraction of shipments by type of commercial consumer is shown in Table IV.9.

TABLE IV.9—SHIPMENT SHARES BY TYPE OF COMMERCIAL CONSUMER

Equipment class	Commercial (%)	Residential (%)
Small Gas-Fired Hot Water Commercial Packaged Boiler	89	11
Large Gas-Fired Hot Water Commercial Packaged Boiler	99	1
Small Oil-Fired Hot Water Commercial Packaged Boiler	74	26
Large Oil-Fired Hot Water Commercial Packaged Boiler	96	4
Small Gas-Fired Steam Commercial Packaged Boiler	90	10
Large Gas-Fired Steam Commercial Packaged Boiler	99	1
Small Oil-Fired Steam Commercial Packaged Boiler	90	10
Large Oil-Fired Steam Commercial Packaged Boiler	99	1

H. National Impact Analysis

The NIA assesses the national energy savings (NES) and the national net present value (NPV) from a national perspective of total consumer costs and savings that would be expected to result from new or amended standards at specific efficiency levels.[59] The NES and NPV were analyzed at specific efficiency levels (*i.e.,* TSLs) for each equipment class of CPB equipment. DOE calculated the NES and NPV based on projections of annual equipment shipments, along with the annual energy consumption and total installed cost data from the LCC analysis. In this rulemaking, DOE projected the energy savings, operating cost savings, equipment costs, and NPV of commercial consumer benefits for equipment sold from 2020 through 2049—the year in which the last standards-compliant equipment would be shipped during the 30-year analysis period.

To make the analysis more accessible and transparent to all interested parties, DOE uses a computer spreadsheet model to calculate the energy savings and the national consumer costs and savings from each TSL.[60] Chapter 10 and appendix 10A of the final rule TSD explain the model and provide instructions. Interested parties can review DOE's analyses by interacting with this spreadsheet. The model and documentation are available on DOE's website.[61] The NIA calculations are based on the annual energy consumption and total installed cost data from the energy use analysis and the LCC analysis.

DOE evaluates the impacts of new or amended standards for commercial packaged boilers by comparing no-new-standards-case projections with standards-case projections. The no-new-standards-case projections characterize energy use and consumer costs for each equipment class in the absence of new

[58] U.S. Department of Energy. *Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Distribution Transformers, Chapter 9 Shipments Analysis.* April 2013.

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

[60] DOE understands that Microsoft Excel is the most widely used spreadsheet calculation tool in the United States and there is general familiarity with its basic features. Thus, DOE's use of Excel as the basis for the spreadsheet models provides interested parties with access to the models within a familiar context.

[61] DOE's webpage on commercial packaged boiler equipment is available at *https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=8.*

and amended energy conservation standards. DOE compared these projections with those characterizing the market for each equipment class if DOE were to adopt amended standards at specific energy efficiency levels (*i.e.,* the standards cases) for that class. For the standards cases, DOE used a ''roll-up'' scenario in which equipment at efficiency levels that do not meet the standard level under consideration would ''roll up'' to the efficiency level that just meets the amended standard level, and equipment already being purchased at efficiency levels at or above the amended standard level would remain unaffected.

Unlike the LCC analysis, the NIA analysis does not use distributions for inputs or outputs, but relies on national average equipment costs and energy costs. DOE used the NES spreadsheet to perform calculations of energy savings and NPV using the annual energy consumption, maintenance and repair costs, and total installed cost data from the LCC analysis. The NIA also uses projections of energy prices and building stock and additions consistent with various *AEO2016* Economic Growth cases. NIA results based on these cases are presented in chapter 10 and appendix 10D of the final rule TSD.

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

TABLE IV.10—SUMMARY OF INPUTS AND METHODS FOR THE NATIONAL IMPACT ANALYSIS

Inputs	Method
Shipments	Annual shipments from shipments model.
First Year of Analysis Period	2020.
No-New-Standards Case Forecasted Efficiencies.	Efficiency distributions are forecasted based on historical efficiency data.
Standards Case Forecasted Efficiencies	Used a ''roll-up'' scenario.
Annual Energy Consumption per Unit	Annual weighted-average values are a function of energy use at each TSL.
Total Installed Cost per Unit	Annual weighted-average values are a function of cost at each TSL. Incorporates forecast of future equipment prices based on historical data.
Annual Energy Cost per Unit	Annual weighted-average values as a function of the annual energy consumption per unit, and energy prices.
Energy Prices	*AEO2016* no-CPP case prices projections (to 2040) and extrapolation through 2100.
Energy Site-to-Source Conversion Factors	A time-series conversion factor based on *AEO2016.*
Discount Rate	3- and 7-percent real.
Present Year	Future expenses discounted to 2016, when the final rule will be published.

1. Equipment Efficiency in the No-New-Standards Case and Standards Cases

As described in section IV.F.9 of this document, DOE used a no-new-standards-case distribution of efficiency levels to project what the CPB equipment market would look like in the absence of amended standards. DOE applied the percentages of models within each efficiency range to the total unit shipments for a given equipment class to estimate the distribution of shipments for the no-new-standards case. Then, from those market shares and projections of shipments by equipment class, DOE extrapolated future equipment efficiency trends both for a no-new-standards-case scenario and for standards-case scenarios.

For the standards cases, DOE used a ''roll-up'' scenario to establish the shipment-weighted efficiency for the year that standards are assumed to require compliance (2020). In this scenario, the market of equipment in the no-new-standards case that do not meet the standard under consideration would ''roll up'' to meet the new standard level, and the market share of equipment above the standard would remain unchanged.

Lochinvar commented that Tables 10.3.1 and 10.3.2 in the March 2016 NOPR TSD contain clerical errors and provided corrections in written comments. (Lochinvar, No. 70 at p. 4) Furthermore, Lochinvar commented that the roll-up analysis does not show any reduction in the sales of commercial packaged boilers as the minimum efficiency levels are increased, and that reduced sales would be expected since as the price of baseline boilers increase, some projects will no longer be affordable and that would impact the number of boilers shipped. (Lochinvar, No. 70 at pp. 5–6) BHI expressed concern that DOE's roll-up assumption that shipments of equipment at efficiencies above the proposed standard would be unaffected is inconsistent with how SGHW boilers are used. Further, BHI noted that if DOE were to adopt the 85-percent level for SGHW commercial packaged boilers, there is reason to believe that most of the ''substandard'' SGHW sales would move to the condensing level due to the inability to use Category I venting and the added cost of venting materials, citing the disappearance of sales of SGHW models at efficiencies between 85 percent and 90 percent. (BHI, No. 71 at p. 14)

After reviewing the tables identified by Lochinvar, DOE determined that those tables were a close match to the tables from the preliminary analysis TSD, and not the March 2016 NOPR TSD. The March 2016 NOPR TSD does not contain Table 10.3.1 or Table 10.3.2, nor does it have no-new-standards case and standards case efficiency distribution tables for equipment classes separated by draft type as noted in comments from Lochinvar. However, DOE carefully examined the tables that were the closest match in the March 2016 NOPR TSD, and it was unable to identify any discrepancies. With respect to Lochinvar's comments regarding the roll-up scenario and accounting for reductions in boiler sales, DOE notes that the roll-up tables represent percentages of the market for each efficiency level, with the entire market for a given equipment class defined as 100 percent. DOE does account for reductions in boiler sales that may result from amended standards by considering a price elasticity factor, hence already accounting for shipment impacts due to increased equipment prices. Regarding BHI's comments on roll-up, DOE appreciates the insight into BHI's experience regarding historical sales of SGHW commercial packaged boilers in the 85 percent to 90 percent E_T. While DOE's roll-up approach does assume that sale shares of lower efficiency equipment would roll-up to the 85 percent E_T level, as proposed at the March 2016 NOPR, the SGHW level adopted in this final rule is 84 percent E_T.

The estimated efficiency trends in the no-new-standards case and standards cases are described in chapter 10 of the final rule TSD.

2. National Energy Savings

The national energy savings analysis involves a comparison of national energy consumption of the considered equipment between each potential standards case also known as Trial Standard Level (TSL) and the case with no new or amended energy conservation standards. DOE calculated the national energy consumption by multiplying the number of units (stock) of each equipment (by vintage or age) by the unit energy consumption (also by vintage). DOE calculated annual NES based on the difference in national energy consumption for the no-new-standards case and for each higher efficiency standard case. DOE estimated energy consumption and savings based on site energy and converted the electricity consumption and savings to primary energy (*i.e.,* the energy consumed by power plants to generate site electricity) using annual conversion factors derived from *AEO2016.* Cumulative energy savings are the sum of the NES for each year over the timeframe of the analysis.

In 2011, in response to the recommendations of a committee on ''Point-of-Use and Full-Fuel-Cycle Measurement Approaches to Energy Efficiency Standards'' appointed by the National Academy of Sciences, DOE announced its intention to use 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 (Aug. 18, 2011). After evaluating the approaches discussed in the August 18, 2011 notice, DOE published a statement of amended policy in which DOE explained its determination that EIA's National Energy Modeling System (NEMS) is the most appropriate tool for its FFC analysis and its intention to use NEMS for that purpose. 77 FR 49701 (Aug. 17, 2012). NEMS is a public domain, multi-sector, partial equilibrium model of the U.S. energy sector [62] that EIA uses to prepare its *Annual Energy Outlook.* The FFC factors incorporate losses in production and delivery in the case of natural gas (including fugitive emissions) and additional energy used to produce and deliver the various fuels used by power plants. The approach used for deriving FFC measures of energy use and emissions is described in appendix 10B of the final rule TSD.

3. Net Present Value of Consumer Benefit

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

a. Total Annual Cost

DOE determined the difference between the equipment costs under the standard-level case and the no-new-standards case in order to obtain the net equipment cost increase resulting from the higher standard level. As noted in section IV.F.1 of this document, DOE used a constant real price assumption as the default price projection; the cost to manufacture a given unit of higher efficiency neither increases nor decreases over time.

b. Total Annual Operating Cost Savings

The operating cost savings are energy cost savings, which are calculated using the estimated energy savings in each year and the projected price of the appropriate form of energy. To estimate energy prices in future years, DOE multiplied the average regional energy prices by the projection of annual national-average commercial energy price changes consistent with the projections found on page E–8 in *AEO 2016.*[63] *AEO2016* has an end year of 2040. To estimate price trends after 2040, DOE used the average annual rate of change in prices from 2020 through 2040. As part of the NIA, DOE also analyzed scenarios that used inputs from variants of the *AEO2016* case that have lower and higher economic growth. Those cases have lower and higher energy price trends and the NIA results based on these cases are presented in appendix 10B of the final rule TSD.

c. Discount Rate

In calculating the NPV, DOE multiplies the net savings in future years by a discount factor to determine their present value. For this final rule, DOE estimated the NPV of consumer benefits using both a 3-percent and a 7-percent real discount rate. DOE uses these discount rates in accordance with guidance provided by the Office of Management and Budget (OMB) to Federal agencies on the development of regulatory analysis.[64] The discount rates for the determination of NPV are in contrast to the discount rates used in the LCC analysis, which are designed to reflect a consumer's perspective. The 7-percent real value is an estimate of the average before-tax rate of return to private capital in the U.S. economy. The 3-percent real value represents the ''social rate of time preference,'' which is the rate at which society discounts future consumption flows to their present value.

I. Consumer Subgroup Analysis

In analyzing the potential impacts of new or amended standards on consumers, DOE evaluates impacts on identifiable groups (*i.e.,* subgroups) that may be disproportionately affected by a new or amended national standard. For this final rule, DOE analyzed the impacts of the considered standard levels on ''low-income households for residential'' and ''small businesses for commercial sectors''.

With regard to its subgroup analysis, DOE received comments regarding the appropriateness of the use of residential discount rates to analyze the impact of the amended standard on the ''low income households for residential'' subgroup. Raypak commented that the LCC results in the subgroup analysis and the National level results are being significantly overstated due to the use of residential discount rates for the residential installations, since the equipment under consideration is installed in a commercial setting. (Raypak, Public Meeting Transcript, No. 61 at p. 188) Spire commented that some subgroups would be

[62] For more information on NEMS, refer to *The National Energy Modeling System: An Overview 2009,* DOE/EIA-0581(October 2009). Available at *http://www.eia.gov/forecasts/aeo/index.cfm.*

[63] The standards finalized in this rulemaking will take effect a few years prior to the 2022 commencement of the Clean Power Plan compliance requirements. As DOE has not modeled the effect of CPP during the 30 year analysis period of this rulemaking, there is some uncertainty as to the magnitude and overall effect of the energy efficiency standards. These energy efficiency standards are expected to put downward pressure on energy prices relative to the projections in the *AEO2016* case that incorporates the CPP. Consequently, DOE used the energy price projections found in the *AEO2016* No-CPP case as these energy price projections are expected to be lower, yielding more conservative estimates for consumer savings due to the energy efficiency standards.

[64] United States Office of Management and Budget. *Circular A–4: Regulatory Analysis.* September 17, 2003. Section E. Available at *www.whitehouse.gov/omb/memoranda/m03-21.html.*

disproportionately burdened. (Spire, No. 73 at p. 24)

With respect to Raypak's comment, DOE has addressed the appropriateness of the use of residential discount rates for the residential sector in the national level LCC analysis in this final rule, and notes that the same reasoning for use of residential discount rates applies to the subgroup analysis as well. As such, DOE is retaining the same residential sector discount rate methodology used during the March 2016 NOPR in this final rule. With respect to the comment from Spire, DOE undertook this analysis to evaluate the impacts to subgroups that may be disproportionately affected by a new or amended national standard, and sought comments from stakeholders throughout this rulemaking to help identify potential subgroups. DOE has concluded that the identified subgroups will not be significantly impacted by the new standards.

The consumer subgroup analysis is discussed in detail in chapter 11 of the final rule TSD.

J. Manufacturer Impact Analysis

1. Overview

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

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

The qualitative part of the MIA addresses manufacturer characteristics and market trends. Specifically, the MIA considers such factors as a potential standard's impact on manufacturing capacity, competition within the industry, the cumulative impact of equipment-specific Federal regulations, and impacts on manufacturer subgroups. The complete MIA is outlined in chapter 12 of the 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 CPB manufacturing industry based on the market and technology assessment, preliminary manufacturer interviews, and publicly available information. This included a top-down analysis of CPB manufacturers that DOE used to derive preliminary financial inputs for the GRIM (*e.g.,* revenues; materials, labor, overhead, and depreciation expenses; selling, general, and administrative expenses (SG&A); and R&D expenses). DOE also used public sources of information to further calibrate its initial characterization of the CPB manufacturing industry, including company filings of form 10–K from the SEC,[65] corporate annual reports, and the U.S. Census Bureau's ''Economic Census'',[66] and Hoover's reports [67] to conduct this analysis.

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

In addition, during Phase 2, DOE developed interview guides to distribute to manufacturers of commercial packaged boilers in order to develop other key GRIM inputs, including product and capital conversion costs, and to gather additional information on the anticipated effects of energy conservation standards on revenues, direct employment, capital assets, industry competitiveness, and subgroup impacts.

In Phase 3, 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 final rule TSD.

2. Government Regulatory Impact Model

DOE uses the GRIM to analyze the financial impacts of amended energy conservation standards on the CPB industry. Standards will potentially require additional investments, raise production costs, and affect revenue through higher prices and, possibly, lower sales. The GRIM is designed to take into account several factors as it calculates a series of annual cash flows for the year standards take effect and for several years after implementation. These factors include annual expected revenues, costs of sales, increases in labor and assembly expenditures, selling and general administration costs, and taxes, as well as capital expenditures, depreciation and maintenance related to new standards. Inputs to the GRIM include manufacturing costs, shipments forecasts, and price forecasts developed in other analyses. DOE also uses industry financial parameters as inputs

[65] U.S. Securities and Exchange Commission, Annual 10–K Reports (Various Years) (Available at: *http://www.sec.gov/edgar/searchedgar/companysearch.html*).

[66] U.S. Census Bureau, Annual Survey of Manufacturers: General Statistics: Statistics for Industry Group and Industries (2014) (Available at *http://factfinder2.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t*).

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

for the GRIM analysis, which it develops by collecting and analyzing publicly available industry financial information. The GRIM spreadsheet uses the inputs to arrive at a series of annual cash flows, beginning in 2016 (the reference year of the manufacturer impact analysis) and continuing to 2049 (the end of the analysis period). DOE calculated INPVs by summing the stream of annual discounted cash flows during this period. For CPB manufacturers, DOE used a real discount rate of 9.5 percent, which was derived from industry financials and then modified according to feedback received during manufacturer interviews. DOE also used the GRIM to model changes in costs, shipments, investments, and manufacturer margins that could result from amended energy conservation standards.

After calculating industry cash flows and INPV, DOE compared changes in INPV between the no-new-standards case and each standard level. 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 at a particular TSL. As discussed previously, DOE collected this information on GRIM inputs from a number of sources, including publicly available data and confidential interviews with a number of manufacturers. GRIM inputs are discussed in more detail in the next section. The GRIM results are discussed in section V.B.2. Additional details about the GRIM, discount rate, and other financial parameters can be found in chapter 12 of the final rule TSD.

a. Government Regulatory Impact Model Key Inputs

Manufacturer Production Costs

Manufacturing higher-efficiency 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 cost (MPC) of the analyzed equipment can affect the revenues, gross margins, and cash flow of the industry, making the equipment cost data key GRIM inputs for DOE's analysis.

In the MIA, DOE used the MSPs for each considered efficiency level that were calculated in the engineering analysis, (section IV.C.5 of this final rule) and further detailed in chapter 5 of the final rule TSD. To determine the manufacturer selling price-efficiency relationship, DOE used the equipment database from the market and technology assessment, and pricing data received from manufacturers, distributors, and contractors. Using these inputs, DOE used the methodology described in section IV.C.1 of this final rule, to calculate manufacturer selling prices of commercial packaged boilers for a given rated input (representative capacity) for each equipment class at different efficiency levels spanning from the minimum allowable standard (*i.e.,* baseline) to the maximum technologically feasible efficiency level. DOE then used equipment markups along with the equipment pricing to determine MPCs for each efficiency level. These cost breakdowns and equipment markups were validated and revised with input from manufacturers during manufacturer interviews.

Shipments Projections

The GRIM estimates manufacturer revenues based on total unit shipment projections and the distribution of these values by efficiency level. Changes in sales volumes and efficiency mix over time can significantly affect manufacturer finances. For this analysis, the GRIM uses the NIA's annual shipment projections derived from the shipments analysis from 2016 to 2049. The shipments model divides the shipments of commercial packaged boilers into specific market segments. The model starts from a historical reference year and calculates retirements and shipments by market segment for each year of the analysis period. This approach produces an estimate of the total equipment stock, broken down by age or vintage, in each year of the analysis period. In addition, the equipment stock efficiency distribution is calculated for the no-new-standards case and for each standards case for each equipment class. The NIA shipments forecasts are, in part, based on a roll-up scenario. The forecast assumes that equipment in the no-new-standards case that does not meet the standard under consideration would ''roll up'' to meet the amended standard beginning in the compliance year of 2020. In this scenario, the market share of equipment above the standard would remain unchanged. See section VI.G of this document and chapter 9 of the final rule TSD for additional details.

Product and Capital Conversion Costs

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

To evaluate the level of capital conversion expenditures, manufacturers would likely incur to comply with amended energy conservation standards, DOE used manufacturer interviews to gather data on the anticipated level of capital investment that would be required at each efficiency level. Based on equipment listings, provided by the engineering analysis, DOE developed industry average capital expenditure by weighting manufacturer feedback based on model offerings as a proxy for market share. DOE supplemented manufacturer comments and tailored its analyses with information obtained during engineering analysis described in chapter 5 of the final rule TSD.

DOE assessed the product conversion costs at each considered efficiency level by integrating data from quantitative and qualitative sources. DOE received feedback regarding the potential costs of each efficiency level from multiple manufacturers to estimate product conversion costs (*e.g.,* research & development (R&D) expenditures, certification costs). DOE combined this information with product listings to estimate how much manufacturers would have to spend on product development and product testing at each efficiency level. Manufacturer data was aggregated to better reflect the industry as a whole and to protect confidential information.

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 amended standards. The conversion cost figures used in the GRIM can be found in section V.B.2 of this document. DOE received limited information on the conversion costs for oil-fired equipment in interviews. Using equipment listing counts, DOE scaled the feedback on gas-fired equipment to estimate the conversion cost for oil-fired equipment. For additional information on the estimated product and capital conversion costs, see chapter 12 of the final rule TSD.

b. Government Regulatory Impact Model Scenarios

Manufacturer Markup Scenarios

As discussed in the previous section, MSPs include direct manufacturing production costs (*i.e.,* labor, materials, and overhead estimated in DOE's MPCs) and all non-production costs (*i.e.,* SG&A, R&D, and interest), along with profit. To calculate the MSPs in the GRIM, DOE applied manufacturer markups to the MPCs estimated in the engineering analysis for each equipment 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 manufacturer markup scenarios to represent the uncertainty regarding the potential impacts on prices and profitability for manufacturers following the implementation of amended energy conservation standards: (1) A preservation of gross margin percentage markup scenario; and (2) a preservation of per-unit operating profit markup scenario. These scenarios lead to different manufacturer markup values that, when applied to the inputted MPCs, result in varying revenue and cash-flow impacts.

Under the preservation of gross margin percentage markup scenario, DOE applied a single uniform ''gross margin percentage'' manufacturer markup across all efficiency levels, which assumes that following amended standards, manufacturers would be able to maintain the same amount of profit as a percentage of revenue at all efficiency levels within an equipment 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 commercial packaged boilers, as well as comments from manufacturer interviews, DOE assumed the average manufacturer markup—which includes SG&A expenses, R&D expenses, interest, and profit—to be 1.41 for small gas-fired hot water, small gas-fired steam boilers, large gas-fired hot water boilers, and large oil-fired hot water boilers; 1.40 for small oil-fired hot water boilers; 1.38 for small oil-fired steam boilers; and 1.37 for large gas-fired and oil-fired steam boilers. During manufacturer interviews, manufacturers noted that they would not expect to maintain their current margins under a stringent energy conservation standard. Thus, this manufacturer markup scenario represents the upper bound of the CPB industry's profitability in the standards case.

DOE includes the preservation of per-unit operating profit scenario in its analysis to reflect manufacturer concern that would not be able to maintain current markups in the standards case, given the highly competitive nature of the CPB market. In this scenario, manufacturer markups are set so that operating profit one year after the compliance date of amended energy conservation standards is the same as in the no-new-standards case on a per-unit basis. In other words, manufacturers are not able to garner additional operating profit from the higher production costs and the investments that are required to comply with the amended standards; however, they are able to maintain the same per-unit operating profit in the standards case that was earned in the no-new-standards case. Therefore, operating margin in percentage terms is reduced between the no-new-standards case and standards case. DOE adjusted the manufacturer markups in the GRIM at each TSL to yield approximately the same earnings before interest and taxes in the standards case as in the no-new-standards case. The preservation of per-unit operating profit markup scenario represents the lower bound of industry profitability in the standards case. In this scenario, similar to the preservation of gross margin percentage markup scenario, manufacturers are not able to fully pass through to consumers the additional costs necessitated by CPB standards.

3. Discussion of Comments

During the notice of proposed rulemaking public meetings, and in written comments in the response to the March 2016 NOPR, interested parties commented on the assumptions and results of the manufacturer impact analysis. Oral and written comments addressed several topics, including concerns regarding the elimination of natural draft equipment, impacts on employment, conversion costs, cumulative regulatory burden, impacts on small businesses, equipment distribution, and the lessening of competition. Comments regarding the impacts on small businesses are discussed in section V.B.2, all other MIA-related comments are discussed below.

a. Elimination of Natural Draft Equipment

Several stakeholders expressed concern that setting a standard at or near condensing levels would force the obsolescence of certain types of commercial packaged boilers. One manufacturer commented that if a condensing level is adopted by DOE, it is possible that natural draft boilers and steam boilers will become obsolete in the CPB industry. (Spire, No. 73, at pp. 23–24) Spire stated that purchasers would be limited to mechanical draft boilers using condensing combustion technology, which are significantly more costly to purchase, maintain and install. BHI commented that in the small gas hot water equipment class in particular, it is possible that a stringent standard will result in large scale obsolescence of existing cast iron boilers since there are many technical constraints for marginal gains in efficiency, such as venting restrictions. (BHI, No. 71 at p. 20) To limit significantly negative industry impacts on manufacturers and equipment offerings, Lochinvar recommended that DOE does not set a standard that requires condensing technology. (Lochinvar, No. 31 at p. 6)

Additionally, during the preliminary stage, Lochinvar stated that a majority of heat exchangers for condensing technology are imported. Lochinvar believes overhead and equipment used to produce non-condensing heat exchangers may become obsolete if condensing technology is effectively mandated. (Lochinvar, Public Meeting Transcript, No. 39 at p. 205)

DOE understands that a stringent standard, specifically condensing technology, may negatively impact INPV and limit industry equipment offerings. The adopted standards do not mandate condensing technology for any equipment class. This final rule adopts a standard lower than the proposed levels in the NOPR for small gas hot water, in part to mitigate the potential for negative impacts on manufacturers and end-users.

b. Impacts on Direct Employment

AHRI and ABMA asserted concerns about DOE's direct employment estimates being too low. Two stakeholders, representing industry trade associations, representing industry trade associations, stated that the amended rule will decrease employment, contrary to DOE's analysis. (AHRI, Public Meeting Transcript, No. 61 at p. 220) (ABMA, Public Meeting Transcript, No. 61 at p. 222) In written comments, AHRI submitted estimates for HVAC manufacturing employment but did not present employment impacts specific to the covered equipment, commercial packaged boilers. (AHRI, No. 78 at p. 12)

At the NOPR stage, DOE estimated production employment to be 464 production workers in the no-new-standards case for the CPB industry in 2019. For the final rule, DOE updated its analysis based on 2014 U.S. Census data, the updated engineering analysis, and the updated shipments analysis. DOE's revised final rule analysis forecasts that the industry will employ 594 production and 360 non-production workers in the no-new-standards case in 2020. The final rule analysis presents an updated set of direct employment impacts that range from a potential net loss of 484 jobs to a potential net gain of 7 at the amended level. Therefore, DOE's analysis agrees with statements from the industry that there is a risk of decreasing the number of manufacturing jobs related to the covered equipment.

In terms of estimating manufacturing jobs, DOE's direct employment analysis is based on three primary inputs: CPB shipments in the standards year from the shipments analysis, labor content of the covered equipment from the engineering analysis, and an average production worker wage level based on U.S. Census Bureau's 2014 Annual Survey of Manufacturers (ASM)[68] data for NAICS Code 333414.[69] In the final rule analysis, DOE estimates there are 32,416 unit shipments in 2020 at the amended standard level. The engineering analysis shows that labor content can range from 6 percent to 20 percent of the MPC, depending on the equipment class and model. Combining unit shipments and labor content, DOE estimates industry production labor expenditures of $21.2 million. Based on 2014 ASM data, DOE estimates average production workers wages of $21.06 an hour, with an average of 1,880 production hours worked in a year. Combining these inputs, DOE estimates 954 domestic workers supporting the manufacture and assembly of covered equipment in the CPB industry in 2020 in the no-new-standards case.

This estimated number of domestic production workers only accounts for the labor required to manufacture the most basic equipment that meets the applicable standard—it does not take into account additional features that manufacturers use to differentiate premium equipment, add-ons, or components that do not contribute to heating function. Additional detail on the direct employment analysis can be found in chapter 12 of the final rule TSD.

Furthermore, AHRI stated, ''DOE notes that 'if a CPB manufacturer chose to keep their current production in the U.S., domestic employment could increase at each TSL.' 81 FR 15899. Given the current issues with outsourcing, including that DOE in past rules has concluded manufacturers may move production abroad in response to increased production costs, this is a huge assumption for which DOE provides no basis in fact.'' (AHRI, No. 78 at p. 7)

DOE presents a range of results for direct employment. At the upper bound, DOE presents direct employment based on current production locations, estimated sales figures from the shipments analysis, labor expenditures from the GRIM, and production labor wage rates from the U.S. Census Annual Survey of Manufacturers. Currently, the vast majority of CPB equipment sold into the domestic market is manufactured in the United States and Canada. While some components are imported, the CPB industry has not seen the dramatic shift to overseas manufacturing associated with many consumer appliances. At the adopted level, the production worker skills and the capital equipment necessary to produce minimally compliant equipment does not vary significantly from the no-new-standards case. At the lower bound, DOE presents a loss of employment where job losses scale with the portion of equipment that does not meet the standard. Additional information and full calculations are presented in section V.B.2 of this document.

Additionally, BHI stated in a written comment that the standard will shift the market away from cast iron commercial boilers, which will ultimately reduce the production volume at Casting Solutions, a cast iron foundry and subsidiary of BHI. The amended standard would result in job losses, including eliminating 80 union manufacturing jobs and 20 managerial jobs at Casting Solutions. (BHI, No. 71 at p. 20)

In response, DOE's direct employment analysis presents a range of potential impacts and includes the potential for job loss. The lower bound shows a loss of 484 jobs, including both production and non-production workers, at TSL 2 for manufacturers of the covered equipment. However, these job impacts do not include employment from suppliers or distributors. DOE's production worker analysis focuses on direct employment, as defined in section V.B.2.b of this document and chapter 12 of the final rule TSD.

c. Conversion Costs

AHRI notes that while it supports the use of alternative efficiency determination methods (AEDMs) for certification, the creation, validation, and maintenance of AEDMs is an additional burden and cost to manufacturers. They believe the additional burden and cost should be included in DOE's analysis. (AHRI, No. 76 at p. 8)

At this time, DOE does not include AEDMs as an additional cumulative burden or cost to manufacturers in its analysis. For certain consumer products and commercial equipment, DOE's existing testing regulations include allowing the use of an AEDM, in lieu of action testing, to simulate the energy consumption or efficiency of certain basic models of covered equipment under DOE's test procedure conditions. The use of AEDMs is optional and, for compliance certification purposes, reduces the need for sample units and the overall testing burden for manufacturers of expensive or highly custom basic models.

≤d. Cumulative Regulatory Burden

With regard to the rulemakings DOE identified under cumulative regulatory burden, AHRI states that five of the nine identified rulemakings do not have known expected conversion costs. (AHRI, No. 76 at p. 8) Furthermore Weil-McLain commented that DOE's simultaneous and cumulative rulemaking creates a significant burden for consumers and the industry. (Weil-McLain, No. 67 at p. 4)

In response, DOE has performed an analysis of cumulative regulatory burden (CRB) in section V.B.2.e of this document. Cumulative burden is a factor DOE considers in its weighting of costs and benefits. The five rules identified by AHRI do not yet have a published NOPR. Any estimation of burdens before a standard level is proposed would be speculative. Consumer burden is discussed in section IV.H.3.

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

[68] U.S. Census Bureau, Annual Survey of Manufacturers: General Statistics: Statistics for Industry Groups and Industries (2014) (Available at: *http://factfinder2.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t*).

[69] At the March 2016 NOPR stage, DOE used NAICS code 333415. For the final rule, DOE determined that NAICS Code, 333414 ''Heating Equipment (except Warm Air Furnaces) Manufacturing Industry,'' is more appropriate and relied on U.S. Census data from this code for its analyses.

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 that were derived from data in *AEO2016,* as described in section IV.M of this document. The methodology is described in chapter 13 and chapter 15 of the 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.[70] The FFC upstream emissions are estimated based on the methodology described in appendix 10D of the final rule TSD. 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 MBtu 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 gas by the global warming potential (GWP) of the gas over a 100-year time horizon. Based on the Fifth Assessment Report of the Intergovernmental Panel on Climate Change,[71] DOE used GWP values of 28 for CH_4 and 265 for N_2O.

Because the on-site operation of commercial packaged boilers requires combustion of fossil fuels and results in emissions of CO_2, NO_X, and SO_2 at the sites where these appliances are used, DOE also accounted for the reduction in these site emissions and the associated upstream emissions due to potential standards. Site emissions of the above gases were estimated using emissions intensity factors from an EPA publication.[72]

The *AEO* incorporates the projected impacts of existing air quality regulations on emissions. *AEO2016* generally represents current legislation and environmental regulations, including recent government actions, for which implementing regulations were available as of October 31, 2015. 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 (D.C.). (42 U.S.C. 7651 *et seq.*) SO_2 emissions from 28 eastern states and D.C. were also limited under the Clean Air Interstate Rule (CAIR). 70 FR 25162 (May 12, 2005). CAIR created an allowance-based trading program that operates along with the Title IV program. In 2008, CAIR was remanded to EPA by the U.S. Court of Appeals for the D.C. Circuit, but it remained in effect.[73] In 2011, EPA issued a replacement for CAIR, the Cross-State Air Pollution Rule (CSAPR). 76 FR 48208 (Aug. 8, 2011). On August 21, 2012, the D.C. Circuit issued a decision to vacate CSAPR,[74] and 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.[75] On October 23, 2014, the D.C. Circuit lifted the stay of CSAPR.[76] Pursuant to this action, CSAPR went into effect (and CAIR ceased to be in effect) as of January 1, 2015.[77] *AEO2016* incorporates implementation of CSAPR.

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 years, 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 fall as a result of the Mercury and Air Toxics Standards (MATS) for power plants. 77 FR 9304 (Feb. 16, 2012). In the MATS final rule, EPA established a standard for hydrogen chloride as a surrogate for acid gas hazardous air pollutants (HAP), and also established a standard for SO_2 (a non-HAP acid gas) as an alternative equivalent surrogate standard for acid gas HAP. The same controls are used to reduce HAP and non-HAP acid gas; thus, SO_2 emissions 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. *AEO2016* 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 CSAPR, 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.[78] Therefore, DOE

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

[71] Intergovernmental Panel on Climate Change. Anthropogenic and Natural Radiative Forcing. Chapter 8 in *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P.M. Midgley, Editors. 2013. Cambridge University Press: Cambridge, United Kingdom and New York, NY, USA.

[72] U.S. Environmental Protection Agency, External Combustion Sources, In *Compilation of Air Pollutant Emission Factors,* AP–42, Fifth Edition, Volume I: Stationary Point and Area Sources, Chapter 1. Available at *www3.epa.gov/ttn/chief/ap42/index.html.*

[73] *See North Carolina* v. *EPA,* 550 F.3d 1176 (D.C. Cir. 2008); *North Carolina* v. *EPA,* 531 F.3d 896 (D.C. Cir. 2008).

[74] *See EME Homer City Generation, LP* v. *EPA,* 696 F.3d 7, 38 (D.C. Cir. 2012), *cert. granted,* 81 U.S.L.W. 3567, 81 U.S.L.W. 3696, 81 U.S.L.W. 3702 (U.S. June 24, 2013) (No. 12–1182).

[75] *See EPA* v. *EME Homer City Generation,* 134 S.Ct. 1584, 1610 (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.

[76] See *Georgia* v. *EPA,* Order (D.C. Cir. filed October 23, 2014) (No. 11–1302).

[77] On July 28, 2015, the D.C. Circuit issued its opinion regarding the remaining issues raised with respect to CSAPR that were remanded 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).

[78] 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

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concludes that energy conservation standards that decrease electricity generation will generally reduce SO_2 emissions in 2016 and beyond.

CSAPR established a cap on NO_X emissions in 28 eastern states and the District of Columbia. Energy conservation standards are expected to have little effect on NO_X emissions in those states covered by CSAPR 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 reductions from the standards considered in this document for these states.

The MATS limit mercury emissions from power plants, but they do not include emissions caps and, as such, DOE's energy conservation standards would likely reduce Hg emissions. DOE estimated mercury emissions reduction using emissions factors based on *AEO2016,* which incorporates the MATS.

The *AEO2016* Reference case (and some other cases) assumes implementation of the Clean Power Plan (CPP), which is the EPA program to regulate CO_2 emissions at existing fossil-fired electric power plants.[79] DOE used the *AEO2016* No-CPP case as a basis for developing emissions factors for the electric power sector to be consistent with its use of the No-CPP case in the NIA.[80]

Spire questioned DOE's benefit analyses period and argues that DOE calculates benefits over an unreasonably long period of time. Spire asserts that DOE's approach assumes that the proposed standard—once adopted—would remain unaltered once it is adopted, and believes that this assumption is not credible, and further states that DOE assumes that there will be no material advance in efficiency over the next 30 years, and that DOE will not be triggered to review the standard in the future due to a 6-year review or an ASHRAE 90.1 update trigger over the next 30 years. Further, Spire questions DOE's ability to make predictions regarding items such as energy prices or equipment sales 30 years from now, and thus it believes the analysis cannot be described as clear and convincing evidence of the benefits of the proposed standards. Spire states that DOE should focus not just on the projected life of the equipment, but on the projected life of the standard it proposes. (Spire, No. 73 at pp. 19–21) AHRI commented that DOE violates EPCA requirements for the benefits of a proposed standard to exceed its burden by giving emissions savings disproportionate weight over other factors, noting that there is nothing in the statute that indicates that Congress indicated that this be anything other than an equal weighting of factors, and that the global indirect emissions and SCC reductions extend well beyond the life of the equipment and the relevant period for measuring benefits relative to costs, thus implying disproportionate weighting for these benefits. (AHRI, No. 76 at pp. 11–12) AHRI specifically points out that the benefits from SCC extend through 2300, and that benefits to consumers accrue after 2050 for equipment purchased in 2019–2048, and that incremental variable and fixed costs incurred by manufacturers are included in earlier years in preparation for the rule. AHRI states that DOE provides no justification for the exclusion of many costs that manufacturers might incur after 2050, in harmony with the time period DOE uses to measure benefits. (AHRI, No. 76 at p. 11)

In response, DOE considers the impacts over the life of the commercial packaged boiler equipment units shipped in the 30-year analysis period. With respect to energy cost savings, impacts continue to be accumulated until all of the equipment shipped in the 30-year analysis period is retired from service. Regarding the statement that there would be no material advance over the next 30 years, DOE's no-new-standards case assumptions shows a continued improvement in efficiency over the analysis period. In addition, if DOE is triggered to review, and if it ultimately amends standards, the benefits calculated are based only on the additional improvements in efficiency since the previous standards were established. Hence, DOE does not over-estimate the benefits as implied by Spire in this regard. DOE understands the difficulty in projecting energy prices or markets and relies on the best available information, as well as the input of stakeholders, during the rulemaking process. As noted in this response to Spire's comments, DOE already does consider the projected life of the standard within its 30-year analysis period, and any further increases in future rulemakings are dealt with and accounted for correctly in those rulemakings, in essence using the efficiency standards established in this rule as the baseline levels for any new no-new-standards case analysis for those rulemakings. With regard to AHRI's comments, emissions impacts from purchased equipment continue until the emissions produced by the boilers shipped during the analysis period are essentially eliminated from the atmosphere. CO_2 that is emitted during the lifetime of the equipment has a long residence time in the atmosphere, and, thus, contributes to radiative forcing, which affects global climate, for a long time. In the case of both manufacturer economic costs and benefits and the value of CO_2 emissions reductions, DOE is accounting for the lifetime impacts of equipment shipped in the same analysis period.

L. Monetizing Carbon Dioxide and Other Emissions Impacts

As part of the development of this final 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 analogous to the calculation of the NPV of consumer benefit, DOE considered the reduced emissions expected to result over the lifetime of equipment shipped in the projection period for each TSL. This section summarizes the basis for the values used for each of these emissions and presents the values considered in this document.

For this final rule, DOE relied on a set of values for the social cost of carbon

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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.

[79] U.S. Environmental Protection Agency, ''Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units'' (Washington, DC: October 23, 2015). *https://www.federalregister.gov/articles/2015/10/23/2015-22842/carbon-pollution-emission-guidelines-for-existing-stationary-sources-electric-utility-generating.*

[80] As DOE has not modeled the effect of CPP during the 30 year analysis period of this rulemaking, there is some uncertainty as to the magnitude and overall effect of the energy efficiency standards. With respect to estimated CO_2 and NO_X emissions reductions and their associated monetized benefits, if implemented the CPP would result in an overall decrease in CO_2 emissions from electric generating units (EGUs), and would thus likely reduce some of the estimated CO_2 reductions associated with this rulemaking.

(SCC) that was developed by a Federal interagency process. The basis for these values is summarized in the next section, and a more detailed description of the methodologies used is provided as an appendix to chapter 14 of the final rule TSD.

1. Social Cost of Carbon

The SCC is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) climate-change-related 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 CO_2. A domestic SCC value is meant to reflect the value of damages in the United States resulting from a unit change in CO_2 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 (Oct. 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 CO_2 emissions into cost-benefit analyses of regulatory actions. The estimates are presented with an acknowledgement of the many uncertainties involved 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 CO_2 emissions, the analyst faces a number of challenges. A report from the National Research Council [81] 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 CO_2 emissions. Although any numerical estimate of the benefits of reducing CO_2 emissions is subject to some uncertainty, that does not relieve DOE of its obligation to attempt to factor those benefits into its cost-benefit analysis. Moreover, the interagency working group (IWG) SCC estimates are well supported by the existing scientific and economic literature. As a result, DOE has relied on the IWG SCC estimates in quantifying the social benefits of reducing CO_2 emissions. DOE estimates 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 values appropriate for that year. The NPV 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 current SCC values reflect the IWG's best assessment, based on current data, of the societal effect of CO_2 emissions. The IWG 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 from reducing CO_2 emissions. To ensure consistency in how benefits are 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 values: Global SCC estimates for 2007 (in 2006$) 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 Approaches and Key Assumptions

After the release of the interim values, the interagency group reconvened on a regular basis to generate 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.[82] 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

[81] National Research Council. 2009. *Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use.* National Academies Press: Washington, DC.

[82] The DICE (Dynamic Integrated Climate and Economy) model by William Nordhaus evolved from a series of energy models and was first presented in 1990 (Nordhaus and Boyer 2000, Nordhaus 2008). The PAGE (Policy Analysis of the Greenhouse Effect) model was developed by Chris Hope in 1991 for use by European decision-makers in assessing the marginal impact of carbon emissions (Hope 2006, Hope 2008). The FUND (Climate Framework for Uncertainty, Negotiation, and Distribution) model, developed by Richard Tol in the early 1990s, originally to study international capital transfers in climate policy is now widely used to study climate impacts (*e.g.,* Tol 2002a, Tol 2002b, Anthoff et al. 2009, Tol 2009).

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 the three integrated assessment models, at discount rates of 2.5, 3, and 5 percent. The fourth set, which represents the 95th-percentile SCC estimate across all three models at a 3-percent discount rate, was 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,[83] although preference is given to consideration of the global benefits of reducing CO_2 emissions. Table IV.11 presents the values in the 2010 interagency group report,[84] which is reproduced in appendix 14A of the final rule TSD.

TABLE IV.11—ANNUAL SCC VALUES FROM 2010 INTERAGENCY REPORT, 2010–2050

[2007$ per metric ton CO_2]

Year	Discount rate and statistic			
	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

In 2013 the IWG released an update (which was revised in July 2015) that contained SCC values that were generated using the most recent versions of the three integrated assessment models that have been published in the peer-reviewed literature.[85] DOE used these values for this final rule.

Table IV.12 shows the updated sets of SCC estimates from the latest interagency update in 5-year increments from 2010 through 2050. The full set of annual SCC estimates from 2010 through 2050 is reported in appendix 14B of the final rule TSD. 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.

Regarding the use of discount rates in the development of SCC, AHRI commented that DOE should use discount rates in the analysis consistently, noting that DOE groups results from its analysis of different factors using different discount rates into one overall result that does not portray an accurate representation of true cost to manufacturers and to consumers. Further, AHRI asserts that DOE is deviating from the guidance of OMB Circular No. A–94 to utilize a 7-percent discount rate, but goes on to say that if a different discount rate is appropriate, DOE should clearly present its reasoning so that stakeholders can understand the basis and provide comment. (AHRI, No. 76 at p. 8)

For the purposes of the development of the National NPV, DOE uses the guidance provided by OMB Circular No. A–94; however, in response to the concern raised regarding the use of different discount rates in different portions of the analysis, DOE notes that it used the specific discount rates as recommended by the interagency group that developed the SCC values for the monetization of emissions. A full discussion of these discount rates is provided in Appendix 14A of the final rule TSD.

[83] It is recognized that this calculation for domestic values is approximate, provisional, and highly speculative. There is no *a priori* reason why domestic benefits should be a constant fraction of net global damages over time.

[84] United States Government–Interagency Working Group on Social Cost of Carbon. *Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866.* February 2010. *https://www.whitehouse.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf.*

[85] 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.*

TABLE IV.12—ANNUAL SCC VALUES FROM 2013 INTERAGENCY UPDATE (REVISED JULY 2015), 2010–2050

[2007$ per metric ton CO_2]

Year	Discount rate and statistic			
	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 mentioned previously points out that there is 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 analytic 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.[86]

In summary, in considering the potential global benefits resulting from reduced CO_2 emissions, DOE used the values from the 2013 interagency report (revised July 2015), adjusted to 2015$ using the implicit price deflator for gross domestic product (GDP) from the Bureau of Economic Analysis. 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 through 2050 in each of the four cases in the interagency update.

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 site NO_X emissions nationwide and decrease power sector NO_X emissions in those 22 states not affected by the CAIR.

DOE estimated the monetized value of NO_X emissions reductions from electricity generation 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.[87] The report includes high and low values for NO_X (as $PM_{2.5}$) for 2020, 2025, and 2030 using discount rates of 3 percent and 7 percent; these values are presented in appendix 14C of the final rule TSD. DOE primarily relied on the low estimates to be conservative.[88] 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 developed values specific to the end-use category for commercial packaged boilers using a method described in appendix 14C of the final rule TSD. 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 estimated the monetized value of NO_X emissions reductions from gas commercial packaged boilers using benefit per ton estimates from the EPA's ''Technical Support Document Estimating the Benefit per Ton of Reducing $PM_{2.5}$ Precursors from 17 Sectors.''[89] Although none of the sectors refers specifically to residential and commercial buildings, DOE determined that the sector called ''Area sources'' is a reasonable proxy for residential and commercial buildings. ''Area sources'' represents all emission sources for which states do not have exact (point) locations in their emissions inventories. Since exact locations would tend to be associated with larger sources, ''area sources'' would be fairly representative of small dispersed sources like homes and businesses. The EPA Technical Support Document provides high and low estimates for 2016, 2020, 2025, and 2030 at 3- and 7-percent discount rates. As with the benefit per ton estimates for NO_X emissions reductions from

[86] 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. In July 2015 OMB published a detailed summary and formal response to the many comments that were received: this is available at *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.

[87] Available at *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.

[88] 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 final rule TSD for citations for the studies mentioned above.)

[89] *www.epa.gov/sites/production/files/2014-10/documents/sourceapportionmentbpttsd.pdf.*

electricity generation, DOE primarily relied on the low estimates to be conservative.

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 received various comments regarding its use of SCC in this rulemaking.

AHRI disputed DOE's assumption that SCC values will increase over time, because AHRI reasons that the more economic development that occurs, the more adaptation and mitigation efforts that will be undertaken. (AHRI, No. 76 at p. 11) In response, the SCC increases over time because future emissions are expected to produce larger incremental damages as physical and economic systems become more stressed in response to greater climatic change (see appendix 14A of the final rule TSD). The approach used by the Interagency Working Group allowed estimation of the growth rate of the SCC directly using the three integrated assessment models (IAMs), which help to ensure that the estimates are internally consistent with other modeling assumptions. Adaptation and mitigation efforts, while necessary and important, are not without cost, particularly if their implementation is delayed.

AHRI, IECA, Spire, and the Cato Institute (Cato) criticized DOE's use of SCC estimates that DOE has acknowledged are subject to considerable uncertainty. (AHRI, No. 76 at p. 9; IECA, No. 63 at p. 3; Spire, No. 73 at p. 21; Cato, No. 62 at pp. 1–27) Cato stated that until the IAMs are made consistent with mainstream climate science, the SCC should be barred from use in this and all other Federal rulemakings. Cato criticized several aspects of the determination of the SCC values by the Interagency Working Group as being discordant with the best climate science and not reflective of climate change impacts. (Cato, No. 62 at pp. 1–2, 4–22) AHRI, IECA, and The Associations also criticized the determination of the SCC values. (AHRI, No.76 at p. 12; IECA, No. 63 at pp. 4–5; The Associations, No. 65 at p. 4)

In conducting the interagency process that developed the SCC values, 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. Key uncertainties and model differences transparently and consistently inform the range of SCC estimates. These uncertainties and model differences are discussed in the interagency working group's reports, which are reproduced in appendices 14A and 14B of the final rule TSD, as are the major assumptions. Specifically, uncertainties in the assumptions regarding climate sensitivity, as well as other model inputs such as economic growth and emissions trajectories, are discussed and the reasons for the specific input assumptions chosen are explained. However, the three IAMs used to estimate the SCC are frequently cited in the peer-reviewed literature and were used in the last assessment of the IPCC. In addition, new versions of the models that were used in 2013 to estimate revised SCC values were published in the peer-reviewed literature (see appendix 14B of the final rule TSD for discussion). Although uncertainties remain, the revised estimates that were issued in November 2013 are based on the best available scientific information on the impacts of climate change. The current estimates of the SCC have been developed over many years, using the best science available, and with input from the public. 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. OMB also stated its intention to seek independent expert advice on opportunities to improve the estimates, including many of the approaches suggested by commenters. DOE stands ready to work with OMB and the other members of the Interagency Working Group on further review and revision of the SCC estimates as appropriate.

AHRI, IECA, The Associations, and Cato criticized DOE's use of global rather than domestic SCC values, pointing out that EPCA references weighing of the need for national energy conservation. Cato recommended reporting the results of the domestic SCC calculation in the main body of the proposed regulation. (AHRI, No. 76 at pp. 10–12; IECA, No. 63 at pp. 1–3; The Associations, No. 65 at p. 4; Cato, No. 62 at pp. 2–3)

In response, DOE's analysis estimates both global and domestic benefits of CO_2 emissions reductions. The domestic benefits are reported in chapter 14 of the final rule TSD. Following the recommendation of the Interagency Working Group, DOE places more focus on a global measure of SCC. As discussed in appendix 14A of the final rule TSD, the climate change problem is highly unusual in at least two respects. First, it involves a global externality: emissions of most greenhouse gases contribute to damages around the world even when they are emitted in the United States. Consequently, to address the global nature of the problem, the SCC must incorporate the full (global) damages caused by GHG emissions. Second, climate change presents a problem that the United States alone cannot solve. Even if the United States were to reduce its greenhouse gas emissions to zero, that step would be far from enough to avoid substantial climate change. Other countries would also need to take action to reduce emissions if significant changes in the global climate are to be avoided. Emphasizing the need for a global solution to a global problem, the United States has been actively involved in seeking international agreements to reduce emissions and in encouraging other nations, including emerging major economies, to take significant steps to reduce emissions. When these considerations are taken as a whole, the interagency group concluded that a global measure of the benefits from reducing U.S. emissions is preferable. Therefore, DOE's approach is not in contradiction of the requirement to weigh the need for national energy conservation, as one of the main reasons for national energy conservation is to contribute to efforts to mitigate the effects of global climate change.

IECA commented that the economic models used to determine the SCC did not consider industrial GHG and economic leakage. Furthermore, IECA commented that the higher SCC cost drives manufacturing companies offshore and increases imports of more carbon-intensive manufactured goods, thereby increasing global GHG emissions and that the SCC does not consider this. (IECA, No. 63 at p. 2)

The SCC, as developed in the referenced three models, represents damage assessment and expresses this in terms of dollars per ton of emissions. DOE agrees that the industrial GHG and economic leakage discussed by the commenters is not desirable, but disagrees that it should be part of the SCC calculations. Rather, it reflects the impact of potential offshore production of manufactured goods. The commenter's concern appears to be that the use of the SCC in a regulatory context may increase economic leakage and result in additional carbon emissions not captured in the analysis. DOE understands that this is a possibility, but does not have a tool to confidently assess the amount of production that may move overseas, where that production may move, and the associated carbon intensity of that production. As such, DOE only recognizes the potential for some reduction in carbon savings from what it has assessed in this rule.

DOE is evaluating appropriate monetization of reduction in other 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 *AEO2016*. NEMS produces the *AEO* Reference case, as well as a number of side cases that estimate the economy-wide impacts of changes to energy supply and demand. For the current analysis, impacts are quantified by comparing the levels of electricity sector generation, installed capacity, fuel consumption and emissions consistent with the projections described on page E–8 of *AEO2016* and various side cases. Details of the methodology are provided in the appendices to chapters 13 and 15 of the final rule TSD.

The output of this analysis is a set of time-dependent coefficients that capture the change in electricity generation, primary fuel consumption, installed capacity, and power sector emissions due to a unit reduction in demand for a given end use. These coefficients are multiplied by the stream of electricity savings calculated in the NIA to provide estimates of selected utility impacts of potential new or amended energy conservation standards.

DOE received comments on its utility impact analysis. The Gas Associations commented that DOE only assessed the impacts on the electric power industry in its utility impact analysis, and that Process Rule requires it to ''[estimate] marginal impacts on electric and gas utility costs and revenues.'' (Gas Associations, No. 69 at p. 3)

Historically, DOE's approach to the utility impact analysis, based on NEMS, has been to evaluate the impact of standards only on utility energy sales. NEMS is not suited to characterizing impacts of standards on gas utilities other than those measured by sales, and DOE is unaware of any analytical tools that would enable an analysis of financial impacts on utilities' costs and revenues at a national level. Thus, DOE was not able to perform any further evaluation of the gas utility impacts for the commercial packaged boiler standards rulemaking beyond what is described in this section.

See chapter 15 of the final rule TSD for further details regarding the utility impact analysis.

N. Employment Impact Analysis

DOE considers employment impacts in the domestic economy as one factor in selecting a standard. Employment impacts from new or amended energy conservation standards include both direct and indirect impacts. Direct employment impacts are any changes in the number of employees of manufacturers of the equipment subject to standards, their suppliers, and related service firms; the MIA addresses those impacts. Indirect employment impacts are changes in national employment that occur due to the shift in expenditures and capital investment caused by the purchase and operation of more efficient equipment. Indirect employment impacts from standards consist of the jobs created or eliminated in the national economy, other than in the manufacturing sector being regulated, caused by (1) reduced spending by consumers on energy, (2) reduced spending on new energy supply by the utility industry, (3) increased consumer spending on the purchase of new equipment to which the new standards apply and other goods and services, and (4) the effects of those three factors throughout the economy.

One method for assessing the possible effects on the demand for labor of such shifts in economic activity is to compare sector employment statistics developed by the Labor Department's Bureau of Labor Statistics (BLS).[90] 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.[91] 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 (*e.g.,* the utility sector) to more labor-intensive sectors (*e.g.,* the retail and service sectors). Thus, the BLS data suggest that net national employment may increase due to shifts in economic activity resulting from energy conservation standards.

DOE estimated indirect national employment impacts for the standard levels considered in this final rule using an input/output model of the U.S. economy called Impact of Sector Energy Technologies, version 3.1.1 (ImSET).[92] 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 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. Therefore, DOE used ImSET only to generate results for near-term timeframes (*i.e.,* through 2025), where these uncertainties are reduced.

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

V. Analytical Results and Conclusions

The following section addresses the results from DOE's analyses with respect to the considered energy conservation standards for commercial packaged boilers. It addresses the TSLs examined by DOE, the projected

[90] Data on industry employment, hours, labor compensation, value of production, and the implicit price deflator for output for these industries are available upon request by calling the Division of Industry Productivity Studies (202–691–5618) or by sending a request by email to *dipsweb@bls.gov.*

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

[92] J.M. Roop, M.J. Scott, and R.W. Schultz, *ImSET 3.1: Impact of Sector Energy Technologies,* PNNL–18412, Pacific Northwest National Laboratory (2009) (Available at: *www.pnl.gov/main/publications/external/technical_reports/PNNL-18412.pdf*).

impacts of each of these levels if adopted as energy conservation standards for CPB equipment, and the standard levels that DOE is adopting in this final rule. Additional details regarding DOE's analyses are contained in the final rule TSD supporting this document.

A. Trial Standard Levels

DOE analyzed the benefits and burdens of five TSLs for CPB equipment. These TSLs were developed by combining specific efficiency levels for each of the equipment classes analyzed by DOE. DOE presents the results for the TSLs in this document, while the results for all efficiency levels that DOE analyzed are in the final rule TSD.

Table V.1 and Table V.2 present the TSLs analyzed and the corresponding efficiency levels that DOE identified for potential amended energy conservation standards for each equipment class. The efficiency levels in each TSL can be characterized as follows:

- TSL 5 corresponds to the max-tech efficiency level for each equipment class.
- TSL 4 is composed of the efficiency levels corresponding to the maximum NPV at a 7-percent discount rate for each equipment class.
- TSL 3 is composed of a mixture of condensing and non-condensing efficiency levels.
- TSL 2 and TSL 1 are each composed of a mixture of non-condensing efficiency levels only.

A more detailed description of TSLs may be found in appendix 10C of the final rule TSD.

TABLE V.1—TRIAL STANDARD LEVELS FOR COMMERCIAL PACKAGED BOILERS BY EFFICIENCY LEVEL

Equipment class	Trial standard level				
	1	2	3	4	5
	EL	EL	EL	EL	EL
Small Gas-Fired Hot Water Commercial Packaged Boilers	3	3	6	6	7
Large Gas-Fired Hot Water Commercial Packaged Boilers	2	3	3	5	5
Small Oil-Fired Hot Water Commercial Packaged Boilers	4	4	4	6	6
Large Oil-Fired Hot Water Commercial Packaged Boilers	1	2	2	3	4
Small Gas-Fired Steam Commercial Packaged Boilers	3	4	4	5	5
Large Gas-Fired Steam Commercial Packaged Boilers	4	5	5	6	6
Small Oil-Fired Steam Commercial Packaged Boilers	1	2	2	3	3
Large Oil-Fired Steam Commercial Packaged Boilers	1	2	2	3	3

TABLE V.2—TRIAL STANDARD LEVELS FOR COMMERCIAL PACKAGED BOILERS BY THERMAL EFFICIENCY AND COMBUSTION EFFICIENCY

Equipment class	Trial standard level *									
	1		2		3		4		5	
	E_T (%)	E_C (%)	E_T (%)	E_C (%)	E_T (%)	E_C (%)	E_T (%)	E_C (%)	E_T (%)	E_C (%)
Small Gas-Fired Hot Water Commercial Packaged Boilers	84	n/a	84	n/a	95	n/a	95	n/a	99	n/a
Large Gas-Fired Hot Water Commercial Packaged Boilers	n/a	84	n/a	85	n/a	85	n/a	97	n/a	97
Small Oil-Fired Hot Water Commercial Packaged Boilers	87	n/a	87	n/a	87	n/a	97	n/a	97	n/a
Large Oil-Fired Hot Water Commercial Packaged Boilers	n/a	86	n/a	88	n/a	88	n/a	89	n/a	97
Small Gas-Fired Steam Commercial Packaged Boilers	80	n/a	81	n/a	81	n/a	83	n/a	83	n/a
Large Gas-Fired Steam Commercial Packaged Boilers	81	n/a	82	n/a	82	n/a	84	n/a	84	n/a
Small Oil-Fired Steam Commercial Packaged Boilers	83	n/a	84	n/a	84	n/a	86	n/a	86	n/a
Large Oil-Fired Steam Commercial Packaged Boilers	83	n/a	85	n/a	85	n/a	87	n/a	87	n/a

* E_T stands for thermal efficiency, and E_C stands for combustion efficiency.

B. Economic Justification and Energy Savings

1. Economic Impacts on Individual Consumers

DOE analyzed the economic impacts on CPB consumers by looking at the effects potential amended standards at each TSL will 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 equipment will affect consumers in two ways: (1) Purchase price increases, and (2) annual operating costs decrease. LCC and PBP include total installed costs (*i.e.,* equipment price plus installation costs), and operating costs (*i.e.,* annual energy use, energy prices, energy price trends, repair costs, and maintenance costs). The LCC calculation also uses equipment lifetime and a discount rate. Chapter 8 of the final rule TSD and section IV.F of this document provide detailed information on the LCC and PBP analysis.

Table V.3 through Table V.18 show the LCC and PBP results for the TSLs considered for each equipment class. In the first of each pair of tables, the simple payback is measured relative to the baseline equipment. In the second table, the impacts are measured relative to the efficiency distribution in the no-new-standards case in the compliance year (see section IV.H.1 of this document). Because some consumers purchase equipment with higher efficiency in the no-new-standards case, the average savings are less than the difference between the average LCC of EL 0 (efficiency level 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 equipment with efficiency at or above a given TSL are not affected. Consumers for whom the LCC increases at a given TSL experience a net cost.

TABLE V.3—AVERAGE LCC AND SIMPLE PBP RESULTS BY EFFICIENCY LEVEL FOR SMALL GAS-FIRED HOT WATER COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Average costs (2015$)				Simple payback period (years)	Average lifetime (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
0	0	$25,050	$10,621	$167,232	$192,282	....	24.8
	1	25,915	10,512	165,525	191,440	7.9	24.8
	2	26,857	10,406	163,862	190,718	8.4	24.8
1, 2	3	29,302	10,201	160,665	189,967	10.1	24.8
	4	31,505	10,103	159,125	190,630	12.5	24.8
	5	41,440	9,802	155,196	196,636	20.0	24.8
3, 4	6	42,337	9,626	152,449	194,786	17.4	24.8
5	7	45,399	9,297	147,356	192,755	15.4	24.8

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

TABLE V.4—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS-CASE FOR SMALL GAS-FIRED HOT WATER COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Life-cycle cost savings	
		Average life-cycle cost savings* (2015$)	% of consumers that experience a net cost
0	0	....	0
	1	$65	3
	2	164	5
1, 2	3	212	14
	4	−208	20
	5	−2,267	28
3, 4	6	−993	35
5	7	945	52

*The savings represent the average LCC for affected consumers.

TABLE V.5—AVERAGE LCC AND PBP RESULTS BY EFFICIENCY LEVEL FOR LARGE GAS-FIRED HOT WATER COMMERCIAL PACKAGED BOILERS

TSL	Combustion efficiency (E_C) level	Average costs (2015$)				Simple payback period (years)	Average lifetime (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
0	0	$96,319	$61,654	$931,329	$1,027,648	....	24.8
	1	100,141	60,911	920,158	1,020,299	5.1	24.8
1	2	104,306	60,188	909,281	1,013,587	5.4	24.8
2,3	3	111,547	59,483	898,689	1,010,236	7.0	24.8
	4	167,178	56,437	856,643	1,023,821	13.6	24.8
4,5	5	175,096	54,643	829,842	1,004,938	11.2	24.8

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline (EL 0) equipment.

TABLE V.6—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS-CASE EFFICIENCY DISTRIBUTION FOR LARGE GAS-FIRED HOT WATER COMMERCIAL PACKAGED BOILERS

TSL	Combustion efficiency (E_C) Level	Life-cycle cost savings	
		Average life-cycle cost savings* (2015$)	% of consumers that experience a net cost
0	0	....	0
	1	$588	3
1	2	1,307	4
2, 3	3	2,037	6
	4	−1,537	16
4, 5	5	16,952	33

* The savings represent the average LCC for affected consumers.

TABLE V.7—AVERAGE LCC AND PBP RESULTS BY EFFICIENCY LEVEL FOR SMALL OIL-FIRED HOT WATER COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Average costs (2015$)				Simple payback period (years)	Average lifetime (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
0	0	$27,204	$26,706	$514,805	$542,009	....	24.8
	1	28,121	26,406	508,914	537,036	3.1	24.8
	2	29,112	26,114	503,167	532,279	3.2	24.8
	3	30,607	25,828	497,558	528,165	3.9	24.8
1, 2, 3	4	33,009	25,278	486,738	519,747	4.1	24.8
	5	34,355	25,012	481,517	515,873	4.2	24.8
4, 5	6	51,713	23,819	459,234	510,947	8.5	24.8

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline (EL 0) equipment.

TABLE V.8—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS-CASE EFFICIENCY DISTRIBUTION FOR SMALL OIL-FIRED HOT WATER COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Life-cycle cost savings	
		Average life-cycle cost savings* (2015$)	% of consumers that experience a net cost
0	0	....	0
	1	$1,745	3
	2	4,445	6
	3	7,264	10
1, 2, 3	4	14,421	14
	5	18,127	17
4, 5	6	22,934	42

* The savings represent the average LCC for affected consumers.

TABLE V.9—AVERAGE LCC AND PBP RESULTS BY EFFICIENCY LEVEL FOR LARGE OIL-FIRED HOT WATER COMMERCIAL PACKAGED BOILERS

TSL	Combustion efficiency (E_C) level	Average costs (2015$)				Simple payback period (years)	Average lifetime (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
0	0	$67,485	$92,682	$1,730,005	$1,797,490	....	24.8
1	1	75,964	90,644	1,691,719	1,767,683	4.2	24.8
2, 3	2	86,757	88,697	1,655,180	1,741,937	4.8	24.8
4	3	93,198	87,756	1,637,533	1,730,731	5.2	24.8
5	4	159,246	85,255	1,590,539	1,749,785	12.4	24.8

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline (EL 0) equipment.

TABLE V.10—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS-CASE EFFICIENCY DISTRIBUTION FOR LARGE OIL-FIRED HOT WATER COMMERCIAL PACKAGED BOILERS

TSL	Combustion efficiency (E_C) level	Life-cycle cost savings	
		Average life-cycle cost savings * (2015$)	% of consumers that experience a net cost
0	0	....	0
1	1	$10,193	1
2, 3	2	31,379	7
4	3	41,902	10
5	4	23,643	57

* The savings represent the average LCC for affected consumers.

TABLE V.11—AVERAGE LCC AND PBP RESULTS BY EFFICIENCY LEVEL FOR SMALL GAS-FIRED STEAM COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Average costs (2015$)				Simple payback period (years)	Average lifetime (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
0	0	$22,734	$10,116	$159,682	$182,416	....	24.8
	1	23,553	10,020	158,140	181,693	8.5	24.8
	2	24,443	9,926	156,638	181,080	9.0	24.8
1	3	25,408	9,835	155,175	180,584	9.5	24.8
2, 3	4	26,457	9,746	153,751	180,208	10.1	24.8
4, 5	5	28,831	9,574	151,013	179,844	11.3	24.8

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline (EL 0) equipment.

TABLE V.12—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS-CASE EFFICIENCY DISTRIBUTION FOR SMALL GAS-FIRED STEAM COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Life-cycle cost savings	
		Average life-cycle cost savings * (2015$)	% of consumers that experience a net cost
0	0	....	0
	1	$241	17
	2	465	19
1	3	720	27
2, 3	4	1,002	41
4, 5	5	1,341	54

* The savings represent the average LCC for affected consumers.

TABLE V.13—AVERAGE LCC AND PBP RESULTS BY EFFICIENCY LEVEL FOR LARGE GAS-FIRED STEAM COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Average costs (2015$)				Simple payback period (years)	Average lifetime (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
0	0	$75,672	$51,229	$773,831	$849,504	....	24.8
	1	77,684	50,623	764,684	842,368	3.3	24.8
	2	79,813	50,032	755,775	835,588	3.5	24.8
	3	82,066	49,456	747,095	829,162	3.6	24.8
1	4	84,452	48,895	738,636	823,088	3.8	24.8
2, 3	5	87,665	48,347	730,390	818,056	4.2	24.8
4, 5	6	93,166	47,292	714,506	807,672	4.4	24.8

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline (EL 0) equipment.

TABLE V.14—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS-CASE EFFICIENCY DISTRIBUTION FOR LARGE GAS-FIRED STEAM COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Life-cycle cost savings	
		Average life-cycle cost savings * (2015$)	% of consumers that experience a net cost
0	0	....	0
	1	$498	1
	2	2,066	4
	3	4,239	6
1	4	7,959	11
2, 3	5	11,188	15
4, 5	6	20,291	21

* The savings represent the average LCC for affected consumers.

TABLE V.15—AVERAGE LCC AND PBP RESULTS BY EFFICIENCY LEVEL FOR SMALL OIL-FIRED STEAM COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Average costs (2015$)				Simple payback period (years)	Average lifetime (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
0	0	$24,481	$27,361	$519,200	$543,680	....	24.8
1	1	26,747	26,760	507,521	534,268	3.8	24.8
2, 3	2	28,058	26,471	501,897	529,955	4.0	24.8
4, 5	3	31,580	25,913	491,053	522,633	4.9	24.8

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline (EL 0) equipment.

TABLE V.16—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS-CASE EFFICIENCY DISTRIBUTION FOR SMALL OIL-FIRED STEAM COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Life-cycle cost savings	
		Average life-cycle cost savings * (2015$)	% of consumers that experience a net cost
0	0	....	0
1	1	$2,409	2
2, 3	2	5,839	8
4, 5	3	12,779	14

* The savings represent the average LCC for affected consumers.

TABLE V.17—AVERAGE LCC AND PBP RESULTS BY EFFICIENCY LEVEL FOR LARGE OIL-FIRED STEAM COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Average costs (2015$)				Simple payback period (years)	Average lifetime (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
0	0	$70,522	$108,788	$1,990,314	$2,060,836	....	24.8
1	1	76,661	106,219	1,943,027	2,019,688	2.4	24.8
2, 3	2	83,859	103,773	1,898,016	1,981,874	2.7	24.8
4, 5	3	92,296	101,441	1,855,125	1,947,421	3.0	24.8

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline (EL 0) equipment.

TABLE V.18—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS-CASE EFFICIENCY DISTRIBUTION FOR LARGE OIL-FIRED STEAM COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Life-cycle cost savings	
		Average life-cycle cost savings * (2015$)	% of consumers that experience a net cost
0	0	....	0
1	1	12,563	0
2, 3	2	36,832	1
4, 5	3	70,909	3

* The savings represent the average LCC for affected consumers.

b. Consumer Subgroup Analysis

In the consumer subgroup analysis, DOE estimated the impacts of the considered TSLs on low-income (*i.e.*, multi-family) residential and small business consumers. Given the magnitude of the installation and operating expenditures in question for each equipment class, the LCC savings and corresponding payback periods for low-income residential and small business consumers are generally similar to the impacts for all consumers with, for example, the residential low-income subgroup showing somewhat higher than average benefits and the small business consumers showing slightly lower benefits when compared to the overall CPB consumer population for the SGHW CPB equipment class. DOE estimated the average LCC savings and PBP for the low-income residential subgroup compared with average CPB consumers, as shown in Table V.19 through Table V.26. DOE also estimated LCC savings and PBP for small businesses, and presented the results in Table V.19 through Table V.26. Chapter 11 of the final rule TSD presents the complete LCC and PBP results for the subgroups.

TABLE V.19—COMPARISON OF LCC SAVINGS AND PBP FOR CONSUMER SUBGROUPS AND THE NATION, SMALL GAS-FIRED HOT WATER COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Average LCC savings (2015$)			Simple payback period (years)		
		Residential low-income	Commercial small business	Nation	Residential low-income	Commercial small business	Nation
	1	$108	$52	$65	5.9	8.2	7.9
	2	272	133	164	6.2	8.6	8.4
1, 2	3	602	101	212	7.5	10.4	10.1
	4	287	−354	−208	9.9	12.7	12.5
	5	−771	−2,610	−2,267	15.9	20.5	20.0
3, 4	6	1,021	−1,526	−993	13.5	17.8	17.4
5	7	4,667	−86	945	11.7	15.8	15.4

TABLE V.20—COMPARISON OF LCC SAVINGS AND PBP FOR CONSUMER SUBGROUPS AND THE NATION, LARGE GAS-FIRED HOT WATER COMMERCIAL PACKAGED BOILERS

TSL	Combustion efficiency (E_C) level	Average LCC savings (2015$)			Simple payback period (years)		
		Residential low-income	Commercial small business	Nation	Residential low-income	Commercial small business	Nation
	1	$334	$487	$588	6.9	5.1	5.1
1	2	724	1,077	1,307	7.3	5.4	5.4
2, 3	3	856	1,654	2,037	10.5	7.0	7.0
	4	−4,219	−2,921	−1,537	22.5	13.5	13.6
4, 5	5	6,339	12,524	16,952	17.6	11.2	11.2

TABLE V.21—COMPARISON OF LCC SAVINGS AND PBP FOR CONSUMER SUBGROUPS AND THE NATION, SMALL OIL-FIRED HOT WATER COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Average LCC savings (2015$)			Simple payback period (years)		
		Residential low-income	Commercial small business	Nation	Residential low-income	Commercial small business	Nation
	1	$2,741	$1,236	$1,745	2.1	3.8	3.1
	2	7,050	3,116	4,445	2.2	4.0	3.2
	3	11,490	5,112	7,264	3.0	4.6	3.9
1, 2, 3	4	23,280	9,984	14,421	3.0	4.9	4.1
	5	29,489	12,451	18,127	3.0	5.1	4.2
4,5	6	47,470	11,101	22,934	5.8	10.5	8.5

TABLE V.22—COMPARISON OF LCC SAVINGS AND PBP FOR CONSUMER SUBGROUPS AND THE NATION, LARGE OIL-FIRED HOT WATER COMMERCIAL PACKAGED BOILERS

TSL	Combustion efficiency (E_C) level	Average LCC savings (2015$)			Simple payback period (years)		
		Residential low-income	Commercial small business	Nation	Residential low-income	Commercial small business	Nation
1	1	$24,584	$7,705	$10,193	2.0	4.5	4.2
2, 3	2	79,156	23,115	31,379	2.3	5.3	4.8
4	3	108,008	30,418	41,902	2.5	5.7	5.2
5	4	141,883	3,718	23,643	5.9	13.4	12.4

TABLE V.23—COMPARISON OF LCC SAVINGS AND PBP FOR CONSUMER SUBGROUPS AND THE NATION, SMALL GAS-FIRED STEAM COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Average LCC savings (2015$)			Simple payback period (years)		
		Residential low-income	Commercial small business	Nation	Residential low-income	Commercial small business	Nation
	1	$428	$211	$241	6.0	8.7	8.5
	2	855	403	465	6.3	9.2	9.0
1	3	1,387	608	720	6.7	9.7	9.5
2, 3	4	2,083	812	1,002	7.1	10.3	10.1
4, 5	5	3,461	963	1,341	7.9	11.5	11.3

TABLE V.24—COMPARISON OF LCC SAVINGS AND PBP FOR CONSUMER SUBGROUPS AND THE NATION, LARGE GAS-FIRED STEAM COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Average LCC savings (2015$)			Simple payback period (years)		
		Residential low-income	Commercial small business	Nation	Residential low-income	Commercial small business	Nation
	1	$357	$444	$498	4.0	3.3	3.3
	2	1,449	1,791	2,066	4.2	3.5	3.5
	3	2,938	3,658	4,239	4.4	3.6	3.6
1	4	5,465	6,846	7,959	4.6	3.8	3.8
2, 3	5	6,683	9,504	11,188	5.6	4.2	4.2
4, 5	6	12,975	17,223	20,291	5.8	4.4	4.4

TABLE V.25—COMPARISON OF LCC SAVINGS AND PBP FOR CONSUMER SUBGROUPS AND THE NATION, SMALL OIL-FIRED STEAM COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Average LCC savings (2015$)			Simple payback period (years)		
		Residential low-income	Commercial small business	Nation	Residential low-income	Commercial small business	Nation
1	1	$3,848	$2,039	$2,409	2.5	4.0	3.8
2, 3	2	9,349	4,908	5,839	2.7	4.2	4.0
4, 5	3	20,877	10,572	12,779	3.3	5.1	4.9

TABLE V.26—COMPARISON OF LCC SAVINGS AND PBP FOR CONSUMER SUBGROUPS AND THE NATION, LARGE OIL-FIRED STEAM COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Average LCC savings (2015$)			Simple payback period (years)		
		Residential low-income	Commercial small business	Nation	Residential low-income	Commercial small business	Nation
1	1	$24,494	$10,960	$12,563	1.2	2.4	2.4
2, 3	2	72,382	31,813	36,832	1.4	2.7	2.7
4, 5	3	141,678	61,065	70,909	1.5	3.0	3.0

c. Rebuttable Presumption Payback

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

Table V.27 presents the rebuttable-presumption PBPs 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. 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.27—REBUTTABLE PRESUMPTION PAYBACK PERIODS FOR COMMERCIAL PACKAGED BOILER EQUIPMENT CLASSES

Equipment class	Rebuttable presumption payback (years)				
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Small Gas-Fired Hot Water Commercial Packaged Boilers	9.2	9.2	15.3	15.3	15.3
Large Gas-Fired Hot Water Commercial Packaged Boilers	4.9	5.9	5.9	10.0	10.0
Small Oil-Fired Hot Water Commercial Packaged Boilers	12.1	12.1	12.1	12.6	24.5
Large Oil-Fired Hot Water Commercial Packaged Boilers	12.0	13.6	13.6	14.6	34.3
Small Gas-Fired Steam Commercial Packaged Boilers	8.5	9.0	9.0	10.1	10.1
Large Gas-Fired Steam Commercial Packaged Boilers	3.4	3.9	3.9	4.1	4.1
Small Oil-Fired Steam Commercial Packaged Boilers	10.5	11.2	11.2	13.9	13.9
Large Oil-Fired Steam Commercial Packaged Boilers	6.5	7.2	7.2	8.0	8.0

2. Economic Impacts on Manufacturers

DOE performed an MIA to estimate the impact of amended energy conservation standards on manufacturers of commercial packaged boilers. The next section describes the expected impacts on manufacturers at each TSL. Chapter 12 of the final rule TSD explains the analysis in further detail.

a. Industry Cash-Flow Analysis Results

In this section, DOE provides GRIM results from the analysis, which examines changes in the industry that would result from a standard. Table V.28 and Table V.29 depict the estimated financial impacts (represented by changes in INPV) of potential amended energy conservation standards on manufacturers of commercial packaged boilers, as well as the conversion costs that DOE expects manufacturers of commercial packaged boilers will incur for all equipment classes at each TSL. As discussed in section IV.J.2.b, DOE modeled two different markup scenarios using different assumptions that correspond to the range of anticipated market responses to amended energy conservation standards: (1) The preservation of gross margin percentage scenario and (2) the preservation of per-unit operating profit scenario. Each of these scenarios is discussed immediately below.

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 will 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 the preservation of operating profit markup scenario, which assumes that manufacturers will not be able to generate greater operating profit on a per-unit basis in the standards case as compared to the no-new-standards case. Rather, as manufacturers make the necessary investments required to convert their facilities to produce new standards-compliant equipment and incur higher costs of goods sold, their percentage markup decreases. Operating profit does not change in absolute dollars and decreases as a percentage of revenue.

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 reference year (2016) through the end of the analysis period (2049). 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.

The results in Table V.28 and Table V.29 show potential INPV impacts for CPB manufacturers; Table V.28 reflects the upper bound of impacts and Table V.29 represents the lower bound.

TABLE V.28—MANUFACTURER IMPACT ANALYSIS FOR COMMERCIAL PACKAGED BOILERS—PRESERVATION OF GROSS MARGIN PERCENTAGE MARKUP SCENARIO *

	Units	No-new-standards case	Trial standard level				
			1	2	3	4	5
INPV	2015$ M	277.6	272.4	267.3	252.1	235.3	235.3
Change in INPV	2015$ M		(5.2)	(10.3)	(25.5)	(42.3)	(42.3)
	%		(1.9)	(3.7)	(9.2)	(15.2)	(15.2)
Product Conversion Costs	2015$ M		8.2	13.4	17.7	19.4	19.8
Capital Conversion Costs	2015$ M		5.3	7.8	22.8	35.8	36.5
Total Conversion Costs	2015$ M		13.5	21.2	40.5	55.2	56.4
Free Cash Flow (2019)	2015$ M	19.3	14.2	11.4	3.2	(3.2)	(3.7)
Change in Free Cash Flow	2015$ M		(5.1)	(8.0)	(16.1)	(22.5)	(23.0)
	%		(26.3)	(41.2)	(83.4)	(116.6)	(119.0)

* Parentheses indicate negative values. All values have been rounded to the nearest tenth. M = millions.

TABLE V.29—MANUFACTURER IMPACT ANALYSIS FOR COMMERCIAL PACKAGED BOILERS—PRESERVATION OF OPERATING PROFIT MARKUP SCENARIO *

	Units	No-new-standards case	Trial standard level				
			1	2	3	4	5
INPV	2015$ M	277.6	265.4	259.1	227.6	160.9	159.1
Change in INPV	2015$ M		(12.2)	(18.5)	(50.0)	(116.7)	(118.5)
	%		(4.4)	(6.7)	(18.0)	(42.0)	(42.7)
Product Conversion Costs	2015$ M		8.2	13.4	17.7	19.4	19.8
Capital Conversion Costs	2015$ M		5.3	7.8	22.8	35.8	36.5
Total Conversion Costs	2015$ M		13.5	21.2	40.5	55.2	56.4
Free Cash Flow (2019)	2015$ M	19.3	14.2	11.4	3.2	(3.2)	(3.7)
Change in Free Cash Flow	2015$ M		(5.1)	(8.0)	(16.1)	(22.5)	(23.0)
	%		(26.3)	(41.2)	(83.4)	(116.6)	(119.0)

* Parentheses indicate negative values. All values have been rounded to the nearest tenth. M = millions.

TSL 1 represents EL 3 (84 percent) for small gas-fired hot water boilers, EL 2 (84 percent) for large gas-fired hot water boilers, EL 4 (87 percent) for small oil-fired hot water boilers, EL 1 (86 percent) for large oil-fired hot water boilers, EL 3 (80 percent) for small gas-fired steam boilers, EL 4 (81 percent) for large gas-fired steam boilers, EL 1 (83 percent) for small oil-fired steam boilers, and EL 1 (83 percent) for large oil-fired steam boilers. At TSL 1, DOE estimates impacts on INPV for CPB manufacturers to range from −4.4 percent to −1.9 percent, or a change in INPV of −$12.2 million to −$5.2 million. At this potential standard level, industry free cash flow will be estimated to decrease by approximately 26.3 percent to $14.2 million, compared to the no-new-standards case value of $19.3 million in 2019, the year before the compliance date. Overall, DOE expects industry to incur product conversion costs of $8.2 million and capital conversion costs of $5.3 million to reach this standard level. At TSL 1, DOE also projects higher unit prices will result in a slight decrease in total shipments in the compliance year (2020). DOE estimates a change in shipments of −0.03 percent relative to the no-new-standards case.

At TSL 1, under the preservation of gross margin percentage markup scenario, the shipment-weighted average price per unit increases by 4.6 percent relative to the no-new-standards case price per unit in the year of compliance (2020). This slight price increase would mitigate a portion of the $13.5 million in conversion costs estimated at TSL 1, resulting in slightly negative INPV impacts under this scenario. Under the preservation of operating profit markup scenario, products at higher efficiency levels command a lower markup to maintain the same operating profit per unit in the no-new-standards case. At TSL 1, this markup scenario results in a weighted average price increase of 4.2 percent. This relatively modest price increase in outweighed by the expected conversion costs and slight decrease in total shipments, resulting in more severe INPV impacts.

TSL 2 sets the efficiency level at EL 3 (84 percent) for small gas-fired hot water boilers, EL 3 (85 percent) for large gas-fired hot water boilers, EL 4 (87 percent) for small oil-fired hot water boilers, EL 2 (88 percent) for large oil-fired hot water, EL 4 (81 percent) for small gas-fired steam boilers, EL 5 (82 percent) for large gas-fired steam boilers, EL 2 (84 percent) for small oil-fired steam boilers, and EL 2 (85 percent) for large oil-fired steam boilers. At TSL 2, DOE estimates impacts on INPV for CPB manufacturers to range from −6.7 percent to −3.7 percent, or a change in INPV of −$18.5 million to −$10.3 million. At this potential standard level, industry free cash flow will be estimated to decrease by approximately 41.2 percent to $11.4 million, compared to the no-new-standards case value of $19.3 million in 2019, the year before the compliance date. Overall, DOE estimates manufactures will incur product conversion costs of $13.4 million and capital conversion costs of $7.8 million at this standard level. At TSL 2, DOE also projects higher unit prices will result in a slight decrease in total shipments in the compliance year (2020). 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 markup scenario, the shipment-weighted average price per unit increases by 5.3 percent relative to the no-new-standards case price per unit in the year of compliance (2020). In this scenario, manufacturers are able to fully pass on the increase in MPC to consumers. However, this price increase in outweighed by the $21.2 million in conversion costs estimated at TSL 2, resulting in slightly negative INPV impacts under this scenario. Under the preservation of operating profit markup scenario, the weighted average price per unit increases by 4.9 percent. This price increase is offset by the expected conversion costs and slight decrease in total shipments, resulting in more severe INPV impacts.

TSL 3 represents EL 6 (95 percent) for small gas-fired hot water boilers, EL 3 (85 percent) for large gas-fired hot water boilers, EL 4 (87 percent) for small oil-fired hot water boilers, EL 2 (88 percent) for large oil-fired hot water boilers, EL 4 (81 percent) for small gas-fired steam boilers, EL 5 (82 percent) for large gas-fired steam boilers, EL 2 (84 percent) for small oil-fired steam boilers, and EL 2 (85 percent) for large oil-fired steam boilers. At TSL 3, DOE estimates impacts on INPV for CPB manufacturers to range from −18.0 percent to −9.2 percent, or a change in INPV of −$50.0 million to −$25.5 million. At this potential standard level, industry free cash flow will be estimated to decrease by approximately 83.4 percent in 2019, the year before compliance to $3.2 million compared to the no-new-standards case value of $19.3 million. DOE estimates manufactures will incur product conversion costs of $17.7 million and capital conversion costs of $22.8 million to reach this standard level. At TSL 3, DOE also projects higher unit prices will result in a slight decrease in total shipments in the compliance year (2020). DOE estimates a change in shipments of −0.12 percent relative to the no-new-standards case.

At TSL 3, under the preservation of gross margin percentage markup scenario, the shipment-weighted average price per unit increases by 19.1 percent relative to the no-new-standards case price per unit in the year of compliance (2020). In this scenario, manufacturers are able to fully pass on the increase in MPC to consumers. However, this price increase in outweighed by the $40.5 million in conversion costs estimated at TSL 3, resulting in slightly negative INPV impacts under this scenario. Under the preservation of operating profit markup scenario, the weighted average price per unit increases by 18.0 percent. This price increase is offset by the expected conversion costs and slight decrease in total shipments, resulting in more severe INPV impacts.

TSL 4 represents EL 7 (99 percent) for small gas-fired hot water boilers, EL 5 (97 percent) for large gas-fired hot water boilers, EL 6 (97 percent) for small oil-fired hot water boilers, EL 3 (89 percent) for large oil-fired hot water boilers, EL 5 (83 percent) for small gas-fired steam boilers, EL 6 (84 percent) for large gas-fired steam boilers, EL 3 (86 percent) for small oil-fired steam boilers, and EL 3 (87 percent) for large oil-fired steam boilers. At TSL 4, DOE estimates impacts on INPV for CPB manufacturers to range from −42.0 percent to −15.2 percent, or a change in INPV of −$116.7 million to −$42.3 million. At this potential standard level, industry free cash flow will be estimated to decrease by approximately 116.6 percent in the year before compliance (2019) to −$3.2 million relative to the no-new-standards case value of $19.3 million. DOE estimates that manufacturers will incur product conversion costs of $19.4 million and capital conversion costs of $35.8 million to reach this standard level. At TSL 4, DOE also projects higher unit prices will result in a slight decrease in total shipments in the compliance year (2020). DOE estimates a change in shipments of −0. 24 percent relative to the no-new-standards case.

At TSL 4, under the preservation of gross margin percentage markup scenario, the shipment-weighted average price per unit increases by 39.3 percent relative to the no-new-standards case price per unit in the year of compliance (2020). In this scenario, manufacturers are able to fully pass on the increase in MPC to consumers. However, this price increase in outweighed by the $55.2 million in conversion costs estimated at TSL 4, resulting in slightly negative INPV impacts under this scenario. Under the preservation of operating profit markup scenario, the weighted average price per unit increases by 36.1 percent. This price increase is offset by the expected conversion costs and slight decrease in total shipments, resulting in more severe INPV impacts.

TSL 5 represents EL 7 (99 percent) for small gas-fired hot water boilers, EL 5 (97 percent) for large gas-fired hot water boilers, EL 6 (97 percent) for small oil-fired hot water boilers, EL 4 (97 percent) for large oil-fired hot water boilers, EL 5 (83 percent) for small gas-fired steam boilers, EL 6 (84 percent) for large gas-fired steam boilers, EL 3 (86 percent) for small oil-fired steam boilers, and EL 3 (87 percent) for large oil-fired steam boilers. TSL 5 represents max-tech for all equipment classes. At TSL 5, DOE estimates impacts on INPV for CPB manufacturers to range from −42.7 percent to −15.2 percent, or a change in INPV of −$118.5 million to −$42.3 million. At this potential standard level, industry free cash flow will be estimated to decrease by approximately 119.0 percent in the year before compliance (2019) to −$3.7 million relative to the no-new-standards case value of $19.3 million. DOE estimates manufacturers will incur product conversion costs of $19.8 million and capital conversion costs of $36.5 million to reach this standard level. At TSL 5, DOE also projects higher unit prices will result in a slight decrease in total shipments in the compliance year (2020). DOE estimates a change in shipments of −0.24 percent relative to the no-new-standards case.

At TSL 5, under the preservation of gross margin percentage markup scenario, the shipment-weighted average price per unit increases by 40.3 percent relative to the no-new-standards case price per unit in the year of compliance (2020). In this scenario, manufacturers are able to fully pass on the increase in MPC to consumers. However, this price increase in outweighed by the $56.4 million in conversion costs estimated at TSL 5, resulting in slightly negative INPV impacts under this scenario. Under the preservation of operating profit markup scenario, the weighted average price per unit increases by 37.0 percent. This price increase is offset by the expected conversion costs and slight decrease in total shipments, resulting in more severe INPV impacts.

b. Impacts on Direct Employment

To quantitatively assess the impacts of amended energy conservation standards on direct employment in the CPB industry, DOE used the GRIM to estimate the domestic labor expenditures and number of direct employees in the no-new-standards case and in each of the standards cases in 2020. In its analysis, DOE assumed that the ratio of production workers to non-production workers remains constant. The sum of domestic production and non-production workers represent total domestic direct employment. DOE used statistical data from the U.S. Census Bureau's 2014 ASM, the results of the engineering analysis, and interviews with manufacturers to determine the inputs necessary to calculate industry-wide labor expenditures and domestic employment levels. Labor expenditures related to manufacturing of the product are a function of the labor intensity of the product, the sales volume, and an assumption that wages remain fixed in real terms over time. The total labor expenditures in each year are calculated by multiplying the MPCs by the labor percentage of MPCs.

The total labor expenditures in the GRIM are 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 ASM). The estimates of production workers in this section cover workers, including line-supervisors who are directly involved in fabricating and assembling a unit within the manufacturing facility. Workers performing services that are closely associated with production operations, such as materials handling tasks using forklifts, are also included as production labor.

To calculate non-production workers, the GRIM assumed non-production workers account for 38 percent of total direct employment, which is a ratio derived from 2014 ASM Census data. The total direct employment impacts calculated in the GRIM are the sum of the changes in the number of domestic production and non-production workers resulting from the amended energy conservation standards for CPBs, as compared to the no-new-standards case. In general, more-efficient CPBs are more complex and more labor intensive. Per-unit labor requirements and production time requirements increase with higher energy conservation standards.

DOE estimates that in the absence of amended energy conservation standards, there will be 954 domestic production and non-production workers in the CPB industry in 2020, the year of compliance. DOE estimates that approximately 80 percent of commercial packaged boilers sold in the United States are manufactured domestically. Table V.30 shows the range of the impacts of potential amended energy conservation standards on U.S. production and non-production workers of commercial packaged boilers.

TABLE V.30—POTENTIAL CHANGES IN THE TOTAL NUMBER OF COMMERCIAL PACKAGED BOILERS DIRECT EMPLOYMENT IN 2020

	Trial standard level *					
	No-new-standards case	1	2	3	4	5
Total Number of Domestic Production Workers in 2020 (without changes in production locations).	594	364 to 624	323 to 628	175 to 645	8 to 730	8 to 739.
Potential Changes in Domestic Production Workers in 2020.		(230) to 30	(301) to 4	(453) to 17	(637) to 85	(722) to 9.
Total Number of Domestic Direct Employment in 2020 **.	954	585 to 1,002	518 to 1,009	281 to 1,036	13 to 1,173	13 to 1,187.
Potential Changes in Domestic Direct Employment in 2020.		(369) to 48	(484) to 7	(728) to 27	(1,023) to 137	(1,160) to 14.

* DOE presents a range of potential employment impacts. Numbers in parentheses indicate negative numbers.

** This field presents impacts on total domestic direct employment, which aggregates production and non-production workers. Based on ASM census data, we assumed the ratio of production to non-production employees stays consistent across all analyzed TSLs, which is 38 percent non-production workers.

At the upper end of the range, all examined TSLs show positive impacts on domestic employment levels. Producing more-efficient CPBs tends to require more labor, and DOE estimates that if CPB manufacturers chose to keep their current production in the U.S., domestic employment could increase at each TSL. In interviews, some manufacturers who produce high-efficiency boiler equipment stated that a standard that went to condensing levels could cause them to hire more employees to increase their production capacity.

To establish a lower bound end of production worker employment, DOE assumes no manufacturer chooses to invest in redesign of equipment that does not meet the standard. Production worker employment drops in proportion with the percentage of equipment that is retired. Since this is a lower bound, DOE does not account for additional production labor needed for higher efficiency equipment. During interviews, several manufacturers expressed that they could lose a significant number of employees at TSL 3, TSL 4 and TSL 5, due to the fact that these TSLs contain condensing efficiency levels for the gas-fired hot water boiler equipment classes and oil-fired hot water boiler equipment classes. These manufacturers have employees who work on production lines that produce cast iron sections and carbon steel or copper heat exchangers for lower to mid-efficiency equipment. If amended energy conservation standards were to require condensing efficiency levels, these employees will no longer be needed for that function, and manufacturers will have to decide whether to develop their own condensing heat exchanger production, source heat exchangers from Asia or Europe and assemble higher efficiency equipment, or leave the market entirely.

DOE notes that the employment impacts discussed here are independent of the indirect employment impacts to the broader U.S. economy, which are documented in chapter 15 of the final rule TSD.

c. Impacts on Manufacturing Capacity

In manufacturer interviews, most CPB manufacturers stated that their current production is only running at 50-percent to 75-percent capacity and that any standard that does not propose efficiency levels where manufacturers will use condensing technology for hot water boilers will not have a large effect on capacity. The impacts of a condensing standard on manufacturer capacity are difficult to quantify. Some manufacturers who are already making condensing equipment with a sourced heat exchanger said they will likely be able to increase production using the equipment they already have by utilizing a second shift. Others said a condensing standard will idle a large portion of their business, causing stranded assets and decreased capacity. These manufacturers will have to determine how to best increase their condensing boiler production capacity. DOE believes that some larger domestic manufacturers may choose to add production capacity for a condensing heat exchanger production line.

Manufacturers stated that in a scenario where a potential standard would require efficiency levels at which manufacturers would use condensing technology, there is concern about the level of technical resources required to redesign and test all equipment. The engineering analysis shows that increasingly complex components and control strategies are required as standard levels increase. Manufacturers commented in interviews that the industry would need to add electrical engineering and control systems engineering talent beyond current staffing to meet the redesign requirements of higher TSLs. Additional training might be needed for manufacturing engineers, laboratory technicians, and service personnel if condensing equipment was broadly adopted. However, because TSL 2 (the adopted level) will not require condensing standards, DOE does not expect manufacturers to face long-term capacity constraints due to the standard levels adopted in this final rule.

d. Impacts on Subgroups of Manufacturers

Small manufacturers, niche equipment manufacturers, and manufacturers exhibiting a cost structure substantially different from the industry average could be affected disproportionately. Using average cost assumptions developed for an industry cash-flow estimate is inadequate to assess differential impacts among manufacturer subgroups.

For the CPB industry, DOE identified and evaluated the impact of amended energy conservation standards on one subgroup—small manufacturers. The SBA defines a ''small business'' as having 500 employees or less for NAICS 333414, ''Heating Equipment (except Warm Air Furnaces) Manufacturing.'' Based on this definition, DOE identified 33 manufacturers in the CPB industry that qualify as small businesses. For a discussion of the impacts on the small manufacturer subgroup, see the regulatory flexibility analysis in section VI.B of this document and chapter 12 of the final rule TSD.

e. Cumulative Regulatory Burden

One aspect of assessing manufacturer burden involves looking at the cumulative impact of multiple DOE standards and the regulatory actions of other Federal agencies and States that affect the manufacturers of a covered product or equipment. While any one regulation may not impose a significant burden on manufacturers, the combined effects of several existing or impending regulations may have serious consequences for some manufacturers, groups of manufacturers, or an entire industry. Multiple regulations affecting the same manufacturer can strain profits and lead companies to abandon equipment lines or markets with lower expected future returns than competing equipment. For these reasons, DOE conducts an analysis of cumulative regulatory burden as part of its rulemakings pertaining to equipment efficiency.

For the cumulative regulatory burden analysis, DOE looks at other regulations that could affect CPB manufacturers during the compliance period, from 2017 to 2020, or those that take effect within three years of the 2020 compliance date of amended energy conservation standards for this equipment. In interviews, manufacturers cited Federal regulations on equipment other than commercial packaged boilers 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.31. Included in the table are Federal regulations that have compliance dates beyond the six year range of DOE's analysis.

TABLE V.31—COMPLIANCE DATES AND EXPECTED CONVERSION EXPENSES OF FEDERAL ENERGY CONSERVATION STANDARDS AFFECTING COMMERCIAL PACKAGED BOILERS MANUFACTURERS

Federal energy conservation standard	Number of manufacturers *	Number of manufacturers affected from today's rule **	Approx. standards year	Industry conversion costs (millions $)	Industry conversion costs/revenue ***
Commercial Packaged Air Conditioners and Heat Pumps (Air-Cooled) 81 FR 2420 (January 15, 2016).	13	2	2018 and 2023	520.8 (2014$)	4.4%.
Residential Furnace Fans, 79 FR 38129 (July 3, 2014).	38	2	2019	40.6 (2014$)	1.6%.
Commercial Water Heaters † 81 FR 34440 (May 31, 2016).	25	17	2019	29.8 (2014$)	3.0%.
Residential Boilers 81 FR 2320 (January 15, 2016).	36	22	2020	2.5 (2014$)	Less than 1%.
Residential Furnaces † 80 FR 13120 (March 12, 2015).	12	2	2021	55.0 (2013$)	1.0%.
Central Air Conditioners and Heat Pumps § (December 5, 2016).	30	4	2023	342.6 (2015$)	Less than 1%.
Commercial Warm Air Furnaces 81 FR 2420 (January 15, 2016).	14	3	2023	7.5 to 22.2 (2014$) ‡	1.7% to 5.2% ‡.
Residential Water Heaters 75 FR 20112 (April 2016, 2010) +.	39	6	2015	17.5 (2009$)	4.9%.

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

** This column presents the number of manufacturers producing CPB equipment that are also listed as manufacturers in the listed energy conservation standard contributing to cumulative regulatory burden.

*** 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 costs investments and lasts from the announcement year of the final rule to the standards year of the final rule. This period typically ranges from 3 to 5 years, depending on the energy conservation standard.

† 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 March 2016 NOPR.)

‡ 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 has issued a pre-publication **Federal Register** direct final rule on December 5, 2016. The document can be found at: *http://energy.gov/eere/buildings/downloads/issuance-2016-12-05-energy-conservation-program-energy-conservation-0.*

+ Consistent with Chapter 12 of the TSD, DOE has assessed whether this rule will have significant impacts on manufacturers that are also subject to significant impacts from other EPCA rules with compliance dates within three years of this rule's compliance date. However, DOE recognizes that a manufacturer incurs costs during some period before a compliance date as it prepares to comply, such as by revising product designs and manufacturing processes, testing products, and preparing certifications. As such, to illustrate a broader set of rules that may also create additional burden on manufacturers, DOE has included another rule with compliance dates that fall within six years of the compliance date of this rule by expanding the timeframe of potential cumulative regulatory burden. Note that the inclusion of any given rule in this Table does not indicate that DOE considers the rule to contribute significantly to cumulative impact. DOE has chosen to broaden its list of rules in order to provide additional information about its rulemaking activities.

In addition to the Federal energy conservation standards listed in Table V.31, there are multiple appliance standards that do not have published NOPRs, including residential water heaters and residential pool heaters. DOE also identified other regulatory burdens that will affect manufacturers of commercial packaged boilers:

DOE will continue to evaluate its approach to assessing cumulative regulatory burden for use in future rulemakings to ensure that it is effectively capturing the overlapping impacts of its regulations. DOE plans to seek public comment on the approaches it has used here (*i.e.,* both the 3 and 6 year timeframes from the compliance date) in order to better understand at what point in the compliance cycle manufacturers most experience the effects of cumulative and overlapping burden from the regulation of multiple equipment classes.

DOE Certification, Compliance, and Enforcement (CC&E) Rule

The amended standard that DOE adopted will also impose accompanying CC&E requirements for manufacturers of CPB equipment. DOE conducted a rulemaking to expand AEDM coverage to commercial HVAC, including commercial packaged boilers and issued a final rule on December 31, 2013. (78 FR 79579). An AEDM is a computer modeling or mathematical tool that predicts the performance of non-tested basic models. For this final rule, DOE permits manufacturers of commercial packaged boilers to rate basic models using AEDMs for compliance certification purposes, reducing the need for sample units and reducing burden on manufacturers. The final rule establishes revised verification tolerances CPB manufacturers. More information can be found at *http://energy.gov/eere/buildings/implementation-certification-and-enforcement.*

3. National Impact Analysis

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

a. Significance of Energy Savings

To estimate the energy savings attributable to potential amended standards for commercial packaged boilers, DOE compared their energy consumption under the no-new-standards case to their anticipated energy consumption under each TSL. The savings are measured over the entire lifetime of equipment purchased in the 30-year period that begins in the year of anticipated compliance with amended standards (2020–2049). Table V.32 presents DOE's projections of the national energy savings for each TSL considered for commercial packaged boilers. The savings were calculated using the approach described in section IV.H.2 of this final rule.

TABLE V.32—CUMULATIVE NATIONAL ENERGY SAVINGS FOR COMMERCIAL PACKAGED BOILERS; 30 YEARS OF SHIPMENTS
[2020–2049]

	Trial standard level				
	1	2	3	4	5
	(quads)				
Primary Energy	0.202	0.242	0.721	1.885	1.894
FFC Energy	0.227	0.272	0.803	2.096	2.107

Circular A–4 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.[93] Circular A–4 also directs agencies to consider the variability of key elements underlying the estimates of benefits and costs. For this rulemaking, DOE undertook a sensitivity analysis using 9 years, rather than 30 years, of equipment shipments. The choice of a 9-year period is a proxy for the timeline in EPCA for the review of certain energy conservation standards and potential revision of and compliance with such revised standards.[94] The review timeframe established in EPCA is generally not synchronized with the equipment lifetime, equipment manufacturing cycles, or other factors specific to commercial packaged boilers. Thus, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology. The NES sensitivity analysis results based on a 9-year analytical period are presented in Table V.33. The impacts are counted over the lifetime of equipment purchased in 2020–2028.

TABLE V.33—CUMULATIVE NATIONAL ENERGY SAVINGS FOR COMMERCIAL PACKAGED BOILERS; 9 YEARS OF SHIPMENTS
[2020–2028]

	Trial standard level				
	1	2	3	4	5
	(quads)				
Primary Energy	0.065	0.079	0.218	0.550	0.553
FFC Energy	0.073	0.089	0.243	0.611	0.615

b. Net Present Value of Consumer Costs and Benefits

DOE estimated the cumulative NPV of the total costs and savings for consumers that will result from the TSLs considered for commercial packaged boilers. In accordance with OMB's guidelines on regulatory analysis,[95] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate.

Table V.34 shows the consumer NPV results at 3-percent and 7-percent discount rates respectively for each TSL considered for commercial packaged boilers covered in this rulemaking. In each case, the impacts cover the lifetime of equipment purchased in 2020–2049.

TABLE V.34—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR COMMERCIAL PACKAGED BOILER EQUIPMENT; 30 YEARS OF SHIPMENTS
[2020–2049]

Discount rate	Trial standard level				
	1	2	3	4	5
	(billion 2015$)				
3 percent	1.607	1.977	3.323	9.347	9.361
7 percent	0.451	0.558	0.606	1.997	1.966

[93] U.S. Office of Management and Budget. *Circular A–4: Regulatory Analysis.* September 17, 2003. *www.whitehouse.gov/omb/circulars_a004_a-4/.*

[94] EPCA requires DOE to review its standards at least once every 6 years, and requires, for certain equipment, 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. (42 U.S.C. 6313(a)(6)(C)) 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 commercial equipment, the compliance period is 5 years rather than 3 years.

[95] Office of Management and Budget. *OMB Circular A–4, Regulatory Analysis.* Section E. 2003. Washington, DC. September 17, 2003. *https://www.whitehouse.gov/omb/circulars_a004_a-4/.*

The NPV results based on the aforementioned 9-year analytical period are presented in Table V.35. The impacts are counted over the lifetime of commercial packaged boilers purchased in 2020–2028. As mentioned previously, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology or decision criteria.

TABLE V.35—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR COMMERCIAL PACKAGED BOILER EQUIPMENT; 9 YEARS OF SHIPMENTS

[2020–2028]

Discount rate	Trial standard level				
	1	2	3	4	5
	(billion 2015$)				
3 percent	0.545	0.675	0.952	2.665	2.663
7 percent	0.204	0.254	0.197	0.705	0.685

c. Indirect Impacts on Employment

DOE expects that amended energy conservation standards for commercial packaged boilers would reduce energy expenditures for consumers of the equipment, with the resulting net savings being redirected to other forms of economic activity. These expected shifts in spending and economic activity could affect the demand for labor. As described in section IV.N of this document, DOE used an input/output model of the U.S. economy to estimate indirect employment impacts of the TSLs that DOE considered 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 generated results for near-term timeframes (2020–2025), where these uncertainties are reduced.

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

4. Impact on Utility or Performance

As discussed in section III.E.1.d of this final rule, DOE has concluded that the standards adopted in this final rule will not reduce the utility or performance of commercial packaged boilers under consideration in this rulemaking. Manufacturers of the equipment currently offer units that meet or exceed the adopted standards.

5. Impact of Any Lessening of Competition

DOE considered any lessening of competition that would be likely to result from new or amended standards. As discussed in section III.E.1.e, the Attorney General of the United States (Attorney General) determines the impact, if any, of any lessening of competition likely to result from an adopted standard and transmits 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 such impact.

To assist the Attorney General in making this determination, DOE provided the Department of Justice (DOJ) with copies of the 2016 CPB NOPR and the NOPR TSD for review. In its assessment letter responding to DOE, DOJ concluded that the proposed energy conservation standards for commercial packaged boilers are unlikely to have a significant adverse impact on competition. DOE is publishing the Attorney General's assessment at the end of this 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 (costs) of energy production. Reduced electricity demand due to energy conservation standards is also likely to reduce the cost of maintaining the reliability of the electricity system, particularly during peak-load periods. As a measure of this reduced demand, chapter 15 in the final rule TSD presents the estimated reduction in generating capacity, relative to the no-new-standards case, for the TSLs that DOE considered in this rulemaking.

Energy conservation resulting from amended standards for commercial packaged boilers is expected to yield environmental benefits in the form of reduced emissions of certain air pollutants and greenhouse gases. Table V.36 provides DOE's estimate of cumulative emissions reductions expected to result from the TSLs considered in this rulemaking. The table includes both power sector emissions and upstream emissions. The emissions were calculated using the multipliers discussed in section IV.K of this document. DOE reports annual emissions reductions for each TSL in chapter 13 of the final rule TSD.

TABLE V.36—CUMULATIVE EMISSIONS REDUCTION FOR COMMERCIAL PACKAGED BOILERS SHIPPED IN 2020–2049

	TSL				
	1	2	3	4	5
Power Sector Emissions					
CO_2 (*million metric tons*)	11.99	14.48	40.01	104.03	104.73
NO_X (*thousand tons*)	10.57	12.77	35.35	91.61	92.24
Hg (*tons*)	0.00	0.00	(0.00)	(0.00)	(0.00)
N_2O (*thousand tons*)	0.10	0.13	0.18	0.44	0.46

TABLE V.36—CUMULATIVE EMISSIONS REDUCTION FOR COMMERCIAL PACKAGED BOILERS SHIPPED IN 2020–2049—Continued

	TSL				
	1	2	3	4	5
CH_4 (*thousand tons*)	0.30	0.37	0.85	2.28	2.30
SO_2 (*thousand tons*)	2.26	2.93	2.54	6.66	7.03
Upstream Emissions					
CO_2 (*million metric tons*)	1.65	2.01	5.32	13.72	13.83
NO_X (*thousand tons*)	23.32	28.11	79.79	206.51	207.85
Hg (*tons*)	0.00	0.00	0.00	0.00	0.00
N_2O (*thousand tons*)	0.01	0.01	0.02	0.04	0.04
CH_4 (*thousand tons*)	118.36	138.58	492.36	1,289.41	1,290.98
SO_2 (*thousand tons*)	0.14	0.19	0.20	0.47	0.49
Total FFC Emissions					
CO_2 (*million metric tons*)	13.65	16.49	45.33	117.75	118.57
NO_X (*thousand tons*)	33.90	40.88	115.15	298.12	300.09
Hg (*tons*)	0.00	0.00	(0.00)	(0.00)	(0.00)
N_2O (*thousand tons*)	0.11	0.14	0.19	0.48	0.49
N_2O (*thousand tons CO_2eq*) *	29.11	37.20	50.61	126.68	130.98
CH_4 (*thousand tons*)	118.66	138.95	493.21	1,291.69	1,293.28
CH_4 (*thousand tons CO_2eq*) *	3,322.44	3,890.66	13,809.78	36,167.26	36,211.79
SO_2 (*thousand tons*)	2.40	3.11	2.74	7.13	7.52

* CO_2eq is the quantity of CO_2 that would have the same global warming potential (GWP).
Note: Parentheses indicate negative values. Negative values refer to an increase in emissions.

As part of the analysis for this final rule, DOE estimated monetary benefits likely to result from the reduced emissions of CO_2 and NO_X estimated for each of the TSLs considered for commercial packaged boilers. As discussed in section IV.L of this document, 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 correspond to the average values from a distribution that uses a 5-percent discount rate, the average values from a distribution that uses a 3-percent discount rate, the average values from a distribution that uses a 2.5-percent discount rate, and the 95th-percentile values from a distribution that uses a 3-percent discount rate. For emissions in 2015, the SCC values (expressed in 2015$) are represented by $12.4/t, $40.6/t, $63.2/t, and $118/t, respectively. The values for later years are higher due to increasing damages (public health, economic and environmental) as the projected magnitude of climate change increases.

Table V.37 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 final rule TSD.

TABLE V.37—ESTIMATE OF GLOBAL PRESENT VALUE OF CO_2 EMISSIONS REDUCTION FOR COMMERCIAL PACKAGED BOILERS SHIPPED IN 2020–2049

TSL	SCC scenario *			
	5% Discount rate, average	3% Discount rate, average	2.5% Discount rate, average	3% Discount rate, 95th percentile
	(million 2015$)			
Power Sector Emissions				
1	73	350	565	1,066
2	88	424	683	1,289
3	240	1,161	1,874	3,533
4	621	3,010	4,860	9,160
5	625	3,031	4,893	9,223
Upstream Emissions				
1	10	48	78	147
2	12	59	95	179
3	32	154	249	470
4	82	397	641	1,208

TABLE V.37—ESTIMATE OF GLOBAL PRESENT VALUE OF CO_2 EMISSIONS REDUCTION FOR COMMERCIAL PACKAGED BOILERS SHIPPED IN 2020–2049—Continued

TSL	SCC scenario *			
	5% Discount rate, average	3% Discount rate, average	2.5% Discount rate, average	3% Discount rate, 95th percentile
	(million 2015$)			
5	83	400	646	1,218
Total FFC Emissions				
1	83	399	643	1,213
2	100	482	777	1,468
3	272	1,316	2,123	4,003
4	703	3,407	5,501	10,368
5	708	3,431	5,539	10,441

* 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 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 reduced 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 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 the considered TSLs for commercial packaged boilers. The dollar-per-ton value that DOE used is discussed in section IV.L of this document. Table V.38 presents the cumulative present values for NO_X emissions reductions for each TSL calculated using 7-percent and 3-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.40. Detailed discussions on NO_X emissions reductions are available in chapter 14 of the final rule TSD.

TABLE V.38—ESTIMATES OF PRESENT VALUE OF NO_X EMISSIONS REDUCTION FOR COMMERCIAL PACKAGED BOILERS SHIPPED IN 2020–2049

TSL	3% Discount rate	7% Discount rate
	(million 2015$)	
Power Sector Emissions		
1	44	15
2	53	19
3	146	51
4	376	129
5	379	130
Upstream Emissions		
1	37	13
2	45	16
3	126	45
4	325	114
5	327	114
Total FFC Emissions		
1	81	29
2	99	35
3	273	95
4	701	243
5	706	245

7. Other Factors

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

8. Summary of 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.39 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 considered in this rulemaking, at both a 7-percent and 3-percent discount rate. The CO_2 label values used in the columns correspond to the 2015 values in the four sets of SCC values discussed in section IV.L.1 of this document. The dollar-per-ton values that DOE used for NO_X emissions are presented in the final rule TSD chapter 14 of the final rule TSD.

TABLE V.39—COMMERCIAL PACKAGED BOILERS TSLS: NET PRESENT VALUE OF CONSUMER SAVINGS COMBINED WITH NET PRESENT VALUE OF MONETIZED BENEFITS FROM CO_2 AND NO_X EMISSIONS REDUCTIONS

TSL	Consumer NPV at 3% discount rate added with:			
	SCC value of \$12.4/t CO_2* and 3% low NO_X value	SCC value of \$40.6/t CO_2* and 3% low NO_X value	SCC value of \$63.2/t CO_2* and 3% low NO_X value	SCC value of \$118/t CO_2* and 3% low NO_X value
	(billion 2015$)			
1	1.772	2.088	2.331	2.902
2	2.176	2.558	2.853	3.543
3	3.867	4.911	5.718	7.599
4	10.751	13.455	15.549	20.416
5	10.776	13.499	15.607	20.509

TSL	Consumer NPV at 7% discount rate added with:			
	SCC value of \$12.4/t CO_2* and 7% low NO_X value	SCC value of \$40.6/t CO_2* and 7% low NO_X value	SCC value of \$63.2/t CO_2* and 7% low NO_X value	SCC value of \$118/t CO_2* and 7% low NO_X value
	(billion 2015$)			
1	0.563	0.879	1.123	1.693
2	0.693	1.075	1.370	2.060
3	0.973	2.017	2.824	4.705
4	2.943	5.647	7.741	12.608
5	2.918	5.641	7.749	12.651

* These label values represent the global SCC in 2015, in 2015$. The present values have been calculated with scenario-consistent discount rates.

In considering the results in Table V.39, two issues are relevant. First, the national operating cost savings are domestic U.S. monetary savings that occur as a result of purchasing the covered commercial packaged boilers. The national operating cost savings is measured for the lifetime of units shipped in 2020–2049. 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 for commercial packaged boilers, the standards that DOE adopts must be designed to achieve significant improvement in energy efficiency and be technologically feasible and economically justified. (42 U.S.C. 6313(a)(6)(A)(ii) and (C)(i)) 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. 6313(a)(6)(B)(ii)(I)–(VII) and (C)(i))

For this final rule, DOE considered the impacts of amended standards for commercial packaged boilers 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 TSL that is both technologically feasible and economically justified and saves a significant amount of energy.

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

1. Benefits and Burdens of Trial Standard Levels Considered for Commercial Packaged Boiler Standards

Table V.40, Table V.41, and Table V.42 summarize the quantitative impacts estimated for each TSL for commercial packaged boilers. The national impacts are measured over the lifetime of commercial packaged boilers purchased in the 30-year period that begins in the anticipated year of compliance with amended standards (2020–2049). The energy savings, emissions reductions, and value of emissions reductions refer to full-fuel-cycle results. The efficiency levels contained in each TSL are described in section V.A of this final rule.

TABLE V.40—SUMMARY OF ANALYTICAL RESULTS FOR COMMERCIAL PACKAGED BOILER TSLS: NATIONAL IMPACTS

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Cumulative FFC National Energy Savings (*quads*)	0.227	0.272	0.803	2.096	2.107.
NPV of Commercial consumer Benefits (billion 2015$)					
3% discount rate	1.607	1.977	3.323	9.347	9.361.
7% discount rate	0.451	0.558	0.606	1.997	1.966.
Cumulative Emissions Reduction (Total FFC Emissions)					
CO_2 (*million metric tons*)	13.65	16.49	45.33	117.75	118.57.
NO_X (*thousand tons*)	33.90	40.88	115.15	298.12	300.09.
Hg (*tons*)	0.000	0.00	0.00	0.00	0.00.
N_2O (*thousand tons*)	0.11	0.14	0.19	0.48	0.49.
N_2O (*thousand tons CO_2eq*) *	29.11	37.20	50.61	126.68	130.98.
CH_4 (*thousand tons*)	118.66	138.95	493.21	1,291.69	1,293.28.
CH_4 (*thousand tons CO_2eq*) *	3,322.44	3,890.66	13,809.78	36,167.26	36,211.79.
SO_2 (*thousand tons*)	2.40	3.11	2.74	7.13	7.52.
Value of Emissions Reduction (Total FFC Emissions)					
CO_2 (*million 2015$*) **	83 to 1,213	100 to 1,468	272 to 4,003	703 to 10,368	708 to 10,441.
NO_X—3% discount rate (*million 2015$*)	81 to 168	99 to 201	273 to 595	701 to 1,535	706 to 1,543.
NO_X—7% discount rate (*million 2015$*)	29 to 66	35 to 80	95 to 215	243 to 549	245 to 553.

Parentheses indicate negative (−) values.
* 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.

TABLE V.41—NPV OF COMMERCIAL CONSUMER BENEFITS BY EQUIPMENT CLASS

Equipment class	Discount rate (%)	Trial standard level				
		1	2	3	4	5
		(billion 2015$)				
Small Gas-Fired Hot Water	3	0.527	0.527	1.873	4.986	4.986
Commercial Packaged Boilers	7	0.114	0.114	0.163	0.898	0.898
Large Gas-Fired Hot Water	3	0.115	0.183	0.183	2.009	2.009
Commercial Packaged Boilers	7	0.032	0.047	0.047	0.491	0.491
Small Oil-Fired Hot Water	3	0.770	0.770	0.770	1.405	1.405
Commercial Packaged Boilers	7	0.242	0.242	0.242	0.324	0.324
Large Oil-Fired Hot Water	3	0.044	0.140	0.140	0.190	0.205
Commercial Packaged Boilers	7	0.014	0.042	0.042	0.056	0.025
Small Gas-Fired Steam	3	0.019	0.040	0.040	0.082	0.082
Commercial Packaged Boilers	7	0.005	0.010	0.010	0.017	0.017
Large Gas-Fired Steam	3	0.027	0.043	0.043	0.084	0.084
Commercial Packaged Boilers	7	0.010	0.015	0.015	0.029	0.029
Small Oil-Fired Steam	3	0.075	0.184	0.184	0.415	0.415
Commercial Packaged Boilers	7	0.024	0.058	0.058	0.125	0.125
Large Oil-Fired Steam	3	0.030	0.089	0.089	0.174	0.174
Commercial Packaged Boilers	7	0.010	0.029	0.029	0.057	0.057
Total—All Classes	3	1.607	1.977	3.323	9.347	9.361
	7	0.451	0.558	0.606	1.997	1.966

* Parentheses indicate negative (−) values.

TABLE V.42—SUMMARY OF ANALYTICAL RESULTS FOR COMMERCIAL PACKAGED BOILER TSLS: MANUFACTURER AND CONSUMER IMPACTS

Category	TSL 1 *	TSL 2 *	TSL 3 *	TSL 4 *	TSL 5 *
Manufacturer Impacts					
Industry NPV (*million 2015$*) (No-new-standards case INPV = 277.6).	265.4 to 272.4	259.1 to 267.3	227.6 to 252.1	160.9 to 235.3	159.1 to 235.3.
Industry NPV (*% change*)	(4.4) to (1.9)	(6.7) to (3.7)	(18.0) to (9.2)	(42.0) to (15.2)	(42.7) to (15.2).

TABLE V.42—SUMMARY OF ANALYTICAL RESULTS FOR COMMERCIAL PACKAGED BOILER TSLS: MANUFACTURER AND CONSUMER IMPACTS—Continued

Category	TSL 1 *	TSL 2 *	TSL 3 *	TSL 4 *	TSL 5 *
Consumer Average LCC Savings (2015$)					
Small Gas-Fired Hot Water Commercial Packaged Boilers.	$212	$212	($2,267)	($2,267)	$945.
Large Gas-Fired Hot Water Commercial Packaged Boilers.	$1,307	$2,037	$2,037	$16,952	$16,952.
Small Oil-Fired Hot Water Commercial Packaged Boilers.	$14,421	$14,421	$14,421	$22,934	$22,934.
Large Oil-Fired Hot Water Commercial Packaged Boilers.	$10,193	$31,379	$31,379	$41,902	$23,643.
Small Gas-Fired Steam Commercial Packaged Boilers.	$720	$1,002	$1,002	$1,341	$1,341.
Large Gas-Fired Steam Commercial Packaged Boilers.	$7,959	$11,188	$11,188	$20,291	$20,291.
Small Oil-Fired Steam Commercial Packaged Boilers	$2,409	$5,839	$5,839	$12,779	$12,779.
Large Oil-Fired Steam Commercial Packaged Boilers	$12,563	$36,832	$36,832	$70,909	$70,909.
Consumer Simple PBP (years)					
Small Gas-Fired Hot Water Commercial Packaged Boilers.	10.1	10.1	17.4	17.4	15.4.
Large Gas-Fired Hot Water Commercial Packaged Boilers.	5.4	7.0	7.0	11.2	11.2.
Small Oil-Fired Hot Water Commercial Packaged Boilers.	4.1	4.1	4.1	8.5	8.5.
Large Oil-Fired Hot Water Commercial Packaged Boilers.	4.2	4.8	4.8	5.2	12.4.
Small Gas-Fired Steam Commercial Packaged Boilers.	9.5	10.1	10.1	11.3	11.3.
Large Gas-Fired Steam Commercial Packaged Boilers.	3.8	4.2	4.2	4.4	4.4.
Small Oil-Fired Steam Commercial Packaged Boilers	3.8	4.0	4.0	4.9	4.9.
Large Oil-Fired Steam Commercial Packaged Boilers	2.4	2.7	2.7	3.0	3.0.
% of Consumers that Experience Net Cost					
Small Gas-Fired Hot Water Commercial Packaged Boilers.	14%	14%	35%	35%	52%.
Large Gas-Fired Hot Water Commercial Packaged Boilers.	4%	6%	6%	33%	33%.
Small Oil-Fired Hot Water Commercial Packaged Boilers.	14%	14%	14%	42%	42%.
Large Oil-Fired Hot Water Commercial Packaged Boilers.	1%	7%	7%	10%	57%.
Small Gas-Fired Steam Commercial Packaged Boilers.	27%	41%	41%	54%	54%.
Large Gas-Fired Steam Commercial Packaged Boilers.	11%	15%	15%	21%	21%.
Small Oil-Fired Steam Commercial Packaged Boilers	2%	8%	8%	14%	14%.
Large Oil-Fired Steam Commercial Packaged Boilers	0%	1%	1%	3%	3%.

* Parentheses indicate negative (−) values.

DOE first considered TSL 5, which represents the max-tech level for all the equipment classes and offers the potential for the highest cumulative energy savings through the analysis period from 2020 through 2049. The estimated energy savings from TSL 5 are 2.11 quads of energy. TSL 5 has an estimated NPV of consumer benefit of $1.966 billion using a 7-percent discount rate, and $9.36 billion using a 3-percent discount rate.

The cumulative emissions reductions at TSL 5 are 119 million metric tons of CO_2, 7.52 thousand tons of SO_2, 300 thousand tons of NO_X, 1,293 thousand tons of CH_4, 0.49 thousand ton of N_2O, and an emissions increase of 0.0008 ton of Hg. The estimated monetary value of the CO_2 emissions reductions at TSL 5 ranges from $708 million to $10,441 million.

At TSL 5, the average LCC savings range from $945 to $70,909 depending on equipment class. The fraction of consumers incurring a net cost ranges from 3 percent for the large oil-fired steam CPB equipment class to 57 percent for the large oil-fired hot water CPB equipment class.

At TSL 5, the projected change in INPV ranges from a decrease of $118.5 million to a decrease of $42.3 million, which corresponds to a change in INPV of −42.7 percent to −15.2 percent, respectively. The industry is expected to incur $56.4 million in total conversion costs at this level. Approximately 98.6 percent of industry equipment listings require redesign to meet this standard level today. At this level, manufacturers stated they will require additional engineering expertise and production lines, or possibly source parts from other manufacturers.

Accordingly, the Secretary concludes that at TSL 5 for commercial packaged boilers, the benefits of energy savings, NPV of consumer benefits, emission reductions, and the estimated monetary value of the CO_2 emissions reductions will be outweighed by the negative LCC savings for consumers of small gas-fired hot water commercial packaged boilers, the large number of consumers of small gas-fired hot water commercial packaged boilers, large oil-fired hot water commercial packaged boilers, and small gas-fired steam commercial packaged boilers incurring a net cost, and the large negative change in INPV for manufacturers. Consequently, DOE has concluded that TSL 5 is not economically justified.

DOE then considered TSL 4, which corresponds to the efficiency level within each equipment class that provides the highest consumer NPV at a 7-percent discount rate over the analysis period from 2020 through 2049. The estimated energy savings from TSL 4 are 2.096 quad of energy. TSL 4 has an estimated NPV of consumer benefit of $2.0 billion using a 7-percent discount rate, and $9.35 billion using a 3-percent discount rate.

The cumulative emissions reductions at TSL 4 are 118 million metric tons of CO_2, 7.1 thousand tons of SO_2, 298 thousand tons of NO_X, 1,292 thousand tons of CH_4, 0.48 thousand ton of N_2O, and an emissions increase of 0.0008 ton of Hg. The estimated monetary value of the CO_2 emissions reductions at TSL 4 ranges from $703 million to $10,368 million.

At TSL 4, the average LCC savings range from −$2,267 to $70,909 depending on equipment class. The fraction of consumers incurring a net cost ranges from 3 percent for the large oil-fired steam CPB equipment class to 54 percent for the small gas-fired steam CPB equipment class.

At TSL 4, the projected change in INPV ranges from a decrease of $116.7 million to a decrease in $42.3 million, which corresponds to a change of −42.0 percent to −15.2 percent, respectively. The industry is expected to incur $55.2 million in total conversion costs at this level. Approximately 88.3 percent of industry equipment listings require redesign to meet this standard level today.

Accordingly, the Secretary concludes that at TSL 4 for commercial packaged boilers, the benefits of energy savings, NPV of consumer benefits, emission reductions, and the estimated monetary value of the CO_2 emissions reductions will be outweighed by the negative LCC savings for consumers of small gas-fired hot water commercial packaged boilers, the large percentage of small gas-fired steam and small gas-fired hot water CPB consumers incurring a net cost, and the reduction in INPV for manufacturers. Consequently, DOE has concluded that TSL 4 is not economically justified.

DOE then considered TSL 3, which corresponds to the intermediate level with both condensing and high efficiency non-condensing standard levels, depending on equipment class, and offers the potential for significant cumulative energy savings over the analysis period from 2020 through 2049. The estimated energy savings from TSL 3 are 0.80 quad of energy. TSL 3 has an estimated NPV of consumer benefit of $0.61 billion using a 7-percent discount rate, and $3.32 billion using a 3-percent discount rate.

The cumulative emissions reductions at TSL 3 are 45 million metric tons of CO_2, 2.74 thousand tons of SO_2, 115 thousand tons of NO_X, 493 thousand tons of CH_4, and 0.19 thousand ton of N_2O, and an emissions increase of 0.0014 ton of Hg. The estimated monetary value of the CO_2 emissions reductions at TSL 3 ranges from $272 million to $4,003 million.

At TSL 3, the average LCC savings range from −$2,267 to $36,832, depending on equipment class. The fraction of consumers incurring a net cost ranges from 1 percent for the large oil-fired steam CPB equipment class to 41 percent for the small gas-fired steam CPB equipment class.

At TSL 3, the projected INPV ranges from a decrease of $50.0 million to a decrease of $25.5 million, which corresponds to a change of −18.0 percent to −9.2 percent, respectively. The industry is expected to incur $40.5 million in total conversion costs at this level. Approximately 70.5 percent of industry equipment listings require redesign to meet this standard level today.

Accordingly, the Secretary concludes that at TSL 3 for commercial packaged boilers, the benefits of energy savings, NPV of consumer benefits, emission reductions, and the estimated monetary value of the CO_2 emissions reductions will be outweighed by the large negative average life-cycle-cost savings (*i.e.,* costs to the consumer) of the small gas-fired hot water CPB equipment class consumers and the large percentage of industry listings requiring redesign to meet this standard level today. Consequently, DOE has concluded that TSL 3 is not economically justified.

TSL 2 corresponds to the intermediate level with only non-condensing standard levels and offers the potential for significant cumulative energy savings over the analysis period from 2020 through 2049. The estimated energy savings from TSL 2 are 0.27 quad of energy. TSL 2 has an estimated NPV of consumer benefit of $0.56 billion using a 7-percent discount rate, and $1.98 billion using a 3-percent discount rate.

The cumulative emissions reductions at TSL 2 are 16 million metric tons of CO_2, 3.1 thousand tons of SO_2, 41 thousand tons of NO_X, 0.0003 ton of Hg, 139 thousand tons of CH_4, and 0.14 thousand ton of N_2O. The estimated monetary value of the CO_2 emissions reductions at TSL 2 ranges from $100 million to $1,468 million.

At TSL 2, the average LCC savings range from $212 to $36,832, depending on equipment class. The fraction of consumers incurring a net cost ranges from 1 percent for the large oil-fired steam CPB equipment class to 41 percent for the small gas-fired steam CPB equipment class.

At TSL 2, the projected INPV ranges from a decrease of $18.5 million to a decrease of $10.3 million, which corresponds to a change of −6.7 percent to −3.7 percent, respectively. The industry is expected to incur $21.2 million in total conversion costs at this level. Approximately 45.7 percent of industry equipment listings require redesign to meet this standard level today.

Accordingly, the Secretary concludes that at TSL 2 for commercial packaged boilers, the benefits of energy savings, NPV of consumer benefits, emission reductions, and the estimated monetary value of the CO_2 emissions reductions will outweigh the negative change in INPV for manufacturers. Consequently, DOE has concluded that TSL 2 is economically justified.

After carefully considering the analysis results and weighing the benefits and burdens of TSL 2, and based on clear and convincing evidence, setting the standards for commercial packaged boilers at TSL 2 represents a significant improvement in energy efficiency that is technologically feasible and economically justified, as defined under EPCA at 42 U.S.C. 6313(a). TSL 2 is technologically feasible because the technologies required to achieve these levels already exist in the current market and are available from multiple manufacturers. TSL 2 is economically justified because the benefits to the Nation in the form of energy savings, consumer NPV at 3-percent and 7-percent discount rates, and emissions reductions outweigh the costs associated with reduced INPV. This is the case for each of the low, primary and high economic cases examined, indicating even under the conservative estimations used in the low economic case the standards are still economically justified. Therefore, DOE adopts amended energy conservation standards for commercial packaged boilers at the levels established by TSL 2 and presented in Table V.43.

TABLE V.43—AMENDED ENERGY CONSERVATION STANDARDS FOR COMMERCIAL PACKAGED BOILERS (COMPLIANCE REQUIRED STARTING [DATE THREE YEARS AFTER PUBLICATION OF FINAL RULE])

Equipment	Energy conservation standards	
	Minimum thermal efficiency (%)	Minimum combustion efficiency (%)
Small Gas-Fired Hot Water Commercial Packaged Boilers	84	n/a
Large Gas-Fired Hot Water Commercial Packaged Boilers	n/a	85
Small Oil-Fired Hot Water Commercial Packaged Boilers	87	n/a
Large Oil-Fired Hot Water Commercial Packaged Boilers	n/a	88
Small Gas-Fired Steam Commercial Packaged Boilers	81	n/a
Large Gas-Fired Steam Commercial Packaged Boilers	82	n/a
Small Oil-Fired Steam Commercial Packaged Boilers	84	n/a
Large Oil-Fired Steam Commercial Packaged Boilers	85	n/a

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

The benefits and costs of the adopted standards can also be expressed in terms of annualized values. The annualized net benefit is the sum of (1) the annualized national economic value (expressed in 2015$) of the benefits from consumer operation of equipment that meets the adopted standards (consisting primarily of operating cost savings from using less energy, minus increases in equipment purchase and installation costs), and (2) the annualized monetary value of the CO_2 and NO_X emission reductions.[96]

Table V.44 shows the annualized values for commercial packaged boilers under TSL 2, expressed in 2015$. The results under the primary estimate are as follows. Using a 7-percent discount rate for benefits and costs other than CO_2 reductions (for which DOE used a 3-percent discount rate along with the average SCC series corresponding to a value of $40.6/t in 2015 (2015$)), the estimated cost of the adopted standards for CPB equipment is $35 million per year in increased equipment costs, while the estimated benefits are $90 million per year in reduced equipment operating costs, $27 million per year in CO_2 reductions, and $3.5 million per year in reduced NO_X emissions. In this case, the net benefit amounts to $85 million per year.

Using a 3-percent discount rate for all benefits and costs and the average SCC series corresponding to a value of $40.6/t in 2015 (in 2015$), the estimated cost of the adopted standards for commercial packaged boilers is $34 million per year in increased equipment costs, while the estimated annual benefits are $144 million in reduced operating costs, $27 million in CO_2 reductions, and $5.5 million in reduced NO_X emissions. In this case, the net benefit would amount to $143 million per year.

TABLE V.44—SELECTED CATEGORIES OF ANNUALIZED BENEFITS AND COSTS OF ADOPTED STANDARDS (TSL 2) FOR COMMERCIAL PACKAGED BOILERS *

	Discount rate	Primary estimate	Low net benefits estimate	High net benefits estimate
		(million 2015$/year)		
Benefits				
Consumer Operating Cost Savings *	7%	90	80	98.
	3%	144	128	160.
CO_2 Reduction Monetized Value (using mean SCC at 5% discount rate) ***.	5%	8	7	8.
CO_2 Reduction Monetized Value (using mean SCC at 3% discount rate) ***.	3%	27	24	29.
CO_2 Reduction Monetized Value (using mean SCC at 2.5% discount rate) ***.	2.5%	40	36	43.
CO_2 Reduction Monetized Value (using 95th percentile SCC at 3% discount rate) ***.	3%	82	74	89.
NO_X Reduction Value †	7%	3	3	9.
	3%	5	5	12.
Total Benefits ‡	7% plus CO_2 range	101 to 175	90 to 158	115 to 196.
	7%	120	108	136.
	3% plus CO_2 range	157 to 231	140 to 208	180 to 261.
	3%	177	158	201.

[96] 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 (2020, 2030, *etc.*), 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.44—SELECTED CATEGORIES OF ANNUALIZED BENEFITS AND COSTS OF ADOPTED STANDARDS (TSL 2) FOR COMMERCIAL PACKAGED BOILERS *—Continued

	Discount rate	Primary estimate	Low net benefits estimate	High net benefits estimate
		(million 2015$/year)		
Costs				
Consumer Incremental	7%	35	31	37.
Equipment Costs	3%	34	31	37.
Net Benefits				
Total ‡	7% plus CO_2 range	66 to 140	59 to 127	78 to 158.
	7%	85	77	99.
	3% plus CO_2 range	123 to 198	109 to 177	144 to 224.
	3%	143	127	165.

* This table presents the annualized costs and benefits associated with commercial packaged boilers shipped in 2020–2049. These results include benefits to consumers that accrue after 2049 from the equipment purchased in 2020–2049. 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 Benefits, and High Benefits Estimates utilize projections of building stock and energy prices from the *AEO2016* No-CPP case, a Low Economic Growth case, and a High Economic Growth case, respectively. In addition, DOE used a constant equipment price assumption as the default price projection; the cost to manufacture a given unit of higher efficiency neither increases nor decreases over time. The equipment price projection is described in section IV.F.1 of this document and chapter 8 of the NOPR technical support document (TSD). In addition, DOE used estimates for equipment efficiency distribution in its analysis based on national data supplied by industry. Purchases of higher efficiency equipment are a result of many different factors unique to each consumer including boiler heating loads, installation costs, site environmental consideration, and others. For each consumer, all other factors being the same, it would be anticipated that higher efficiency purchases in the baseline would correlate positively with higher energy prices. To the extent that this occurs, it would be expected to result in some lowering of the consumer operating cost savings from those calculated in this rule.

** The CO_2 reduction benefits are calculated using 4 different sets of SCC values. The first three use the average SCC calculated using 5-percent, 3-percent, and 2.5-percent discount rates, respectively. The fourth represents the 95th percentile of the SCC distribution calculated using a 3-percent 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 associated with electricity savings 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 *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 national benefit-per-ton estimates 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-percent and 7-percent cases are presented using only the average SCC with 3-percent discount rate.

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 (Oct. 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 this standards 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 commercial packaged boilers that are not captured by the users of such equipment. 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 qualify 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 the regulatory action in this document is a significant regulatory action under 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 chapter 17 of the technical support document for this rulemaking.[97]

DOE has also reviewed this regulation pursuant to Executive Order 13563. 76 FR 3281 (Jan. 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, the 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 concludes that this final rule is consistent with these principles, including the requirement that, to the extent permitted by law, benefits justify costs.

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) requires preparation of an initial regulatory flexibility analysis (IRFA) and a final regulatory flexibility analysis (FRFA) for any rule that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by 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 domestic small entities are properly considered during the rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of the General Counsel's website (*http://energy.gov/gc/office-general-counsel*). DOE published an IRFA in a notice of proposed rule published on March 24, 2016. 81 FR 15836. The Department requested comment on the IRFA and has prepared the following FRFA:

1. Need for, Objectives of, and Legal Basis for, the Rule

A statement of the need for, objectives of, and legal basis for, the rule is stated in section II.A and not repeated here.

2. Significant Issues Raised In Response to the IRFA

As part of the IRFA, DOE requested comment on financial, sales, and market share data from small manufacturers. In response to the request for comment, ABMA stated that it believes that the proposed standards included in the March 2016 NOPR, if adopted, will have an adverse effect on the financial well-being of all boiler manufacturing companies, with a proportionally greater impact on the smaller companies, operating in what is a very competitive marketplace. (ABMA, No. 64 at p. 3) However, ABMA did not provide any additional data regarding the finances, sales, or market share of small manufacturers that would allow DOE to refine its analysis. Lochinvar recommended DOE consult with AHRI on whether or not small manufacturers are accurately covered by its directory or other available sources. (Lochinvar, No. 70 at p. 6) DOE used AHRI's equipment directory and discussions with the manufacturers of the equipment as a resources to compile its small manufacturer list for the IRFA. Additionally, DOE asked all participants at the NOPR public meeting, including AHRI, for additional information on small manufacturers. Raypak noted that the 11 small manufacturers that are not part of AHRI or ABMA comprise 25 percent of the total marketplace. (Raypak, No. 72 at p. 3)

During the NOPR stage DOE used equipment listings from AHRI, information from the ABMA trade association website, company websites, and market research tools to identify small manufacturers. For the final rule analysis, DOE did not rely on AHRI data for the quantitative analysis behind this FRFA. Rather, DOE based its analysis on listings in the Compliance Certification Database,[98] which is the database that houses certified values submitted by manufacturers of covered equipment subject to Federal energy conservation standards. The equipment information in the Compliance Certification Database represents the entire market of covered equipment that is legally sold in the United States.

AHRI commented that utility data on rebate programs would be useful for the Regulatory Impact Analysis (RIA). (AHRI, Public Meeting Transcript, No. 61 at p. 215) PG&E commented that they could provide data on the effectiveness of utility rebate programs. (PG&E, Public Meeting Transcript, No. 61 at p. 215) Raypak noted that rebates on high efficiency boilers might encourage people to use them even in applications where such boilers are not operating at the high efficiency. (Raypak, Public Meeting Transcript, No. 61 at pp. 216–217)

DOE notes that it does consider rebate programs as an alternative to amended standards in its RIA. While it did not receive data on the effectiveness of utility rebates programs, rebates are still considered in this final rule among other alternatives evaluated. More information regarding the RIA may be found in chapter 17 of the final rule TSD. DOE also notes that the method of evaluating the impact of these non-regulatory alternatives considers that certain purchases of high efficiency/condensing boilers may not operate at, or near, their rated efficiencies.

3. Description and Estimate of the Number of Small Entities Affected

a. Methodology for Estimating the Number of Small Entities

For manufacturers of CPB equipment, 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 the rule. (See 13 CFR part 121.) The size standards are listed by North American Industry Classification System (NAICS) code and industry description and are

[97] See *https://www.regulations.gov/document?D=EERE-2013-BT-STD-0030-0044.*

[98] DOE Compliance Certification Database. *https://www.regulations.doe.gov/certification-data/#q=Product_Group_s%3A*.*

available at *https://www.sba.gov/sites/default/files/files/Size_Standards_Table.pdf.* Manufacturing of commercial packaged boilers is classified under NAICS 333414, ''Heating Equipment (except Warm Air Furnaces) Manufacturing.'' The SBA sets a threshold of 500 employees or fewer for an entity to be considered as a small business for this category.

To identify and estimate the total number of companies that could be small business manufacturers of equipment covered by this rulemaking, DOE conducted a market survey using publicly available information to identify potential small manufacturers. DOE's research involved its Compliance Certification Database, the AHRI Directory,[99] individual company and trade association websites, and market research tools (*e.g.,* Hoovers reports) to create a list of companies that manufacture or sell equipment covered by this rulemaking. DOE also asked stakeholders and industry representatives if they were aware of any other small manufacturers during manufacturer interviews and at DOE public meetings. DOE screened out companies that do not offer equipment covered by this rulemaking, do not meet the definition of a ''small business,'' or do not manufacture the covered equipment in the United States.

DOE identified 45 manufacturers of CPBs affected by this rulemaking. Of these, DOE identified 21 as small manufacturers that met the screening requirements.

DOE attempted to contact all the small business manufacturers of CPB equipment it had identified. Five of the 21 identified small businesses agreed to take part in an MIA interview. DOE also obtained information about small business impacts while interviewing large manufacturers.

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

The Compliance Certification Database, which provided quantitative data for the basis of this FRFA, contained equipment information for only 8 small manufacturers of CPBs in the market. The equipment distribution in the Compliance Certification Database is representative of the all CPB equipment legally sold in the United States and is the basis for the quantitative analysis of small businesses.

At higher trial standard levels, an increasing number of small manufacturer have no models that are able to meet the evaluated levels. Table VI.1 shows the number of small business manufacturers that have equipment on the market today that could meet the trial standard levels. Table VI.1 illustrates that as the standard level increases, smaller manufacturers, as a group, may have a harder time meeting the energy conservation standard.

TABLE VI.1—NUMBER OF SMALL MANUFACTURERS WITH COMPLIANT MODEL LISTINGS

Standard level	Number of small manufacturers
No-New STD	8
TSL 1	8
TSL 2	8
TSL 3	8
TSL 4	7
TSL 5	2

Additionally, DOE performed a more detail examination of impacts by equipment class. Table VI.2 shows the number of manufacturers in each equipment class able to meet trial standard levels with existing equipment offerings.

TABLE VI.2—NUMBER OF SMALL MANUFACTURERS WITH LISTINGS COMPLIANT AT THE ANALYZED STANDARD LEVELS

Standard level	Number of small business manufacturers with compliant equipment							
	SGHW	LGHW	SOHW	LOHW	SGST	LGST	SOST	LOST
No-New STD	8	4	3	3	4	1	3	2
TSL 1	8	2	1	1	2	1	3	2
TSL 2	8	2	1	1	2	1	3	2
TSL 3	7	2	1	1	2	1	3	2
TSL 4	7	0	0	1	1	0	0	0
TSL 5	0	0	0	1	1	0	0	0

At TSL 5, there are multiple equipment classes where no small manufacturers currently offer equipment that meets the efficiency level. Specifically, no small manufacturers have designs that could meet TSL in the small gas hot water, large gas hot water, small oil hot water, large gas steam, small oil steam, or large oil steam equipment classes. Similarly at TSL 4, small manufacturers do not currently have product offerings meeting the levels for most equipment classes. At TSL 3, TSL 2, and TSL 1, the number of small manufacturers that currently have compliant listings is reduced, but there are small manufacturers with existing equipment offerings meeting the efficiency level for every equipment class analyzed.

To estimate the maximum potential costs to the industry, DOE's conversion cost model assumes manufacturers will choose to redesign all non-compliant models. Manufacturers, including small manufacturers, with no equipment compliant with the amended standard would redesign all models to offer a full suite of equipment. DOE used model counts to disaggregate conversion costs for the small manufacturers in the Compliance Certification Database. Small manufacturers accounted for 21 percent of models. At the adopted standard, small manufacturers in the Compliance Certification Database would have conversion costs totaling $4.5 million. This averages out to $0.56 million in conversion costs per small manufacturer. Using publicly available information from Hoovers, Manta, and Glassdoor, DOE estimated revenues for small manufacturers listed in the Compliance Certification Database. The average annual revenue was $29.6 million. Based on this information, DOE estimated conversion costs to be 0.63 percent of revenue over the three-year conversion period.

For gas-fired commercial packaged boilers, DOE's engineering analysis concludes that no proprietary technology is required to meet today's amended standard level. Manufacturers would likely need to adopt one or a combination of different technology options: (1) Heat exchanger

[99] See *www.ahridirectory.org/ahriDirectory/pages/home.aspx.*

improvements (including upgrading mechanical draft or condensing heat exchangers); (2) improvements in burner technology; or (3) using oxygen trim systems.

DOE notes that the market for oil-fired commercial packaged boilers is shrinking. Some manufacturers, both small and large, may choose not to invest in equipment redesign given the small market size and projected decline in shipments. For manufacturers that do stay in the oil-fired market, DOE's analysis indicates that there are no proprietary technologies required to meet TSL 2. Manufacturers would likely need to adopt one or a combination of different technology options: (1) Heat exchanger improvements (including upgrading to mechanical draft heat exchangers); (2) improvements in burner technology; or (3) using oxygen trim systems.

5. Significant Alternatives to the Rule

The discussion above analyzes impacts on small businesses that would result from the adopted standards. In addition to considering other TSLs in this rulemaking, DOE considered several policy alternatives in lieu of standards that could potentially result in energy savings while reducing burdens on small businesses. DOE considered the following policy alternatives: (1) No change in standard; (2) commercial consumer rebates; (3) commercial consumer tax credits; (4) voluntary energy efficiency targets; and (5) early replacement. While these alternatives may mitigate to some varying extent the economic impacts on small entities compared to the standards, DOE determined that the energy savings of these alternatives are significantly smaller than those that would be expected to result from the adopted standard levels. Accordingly, DOE is declining to adopt any of these alternatives and is adopting the standards set forth in this rulemaking. (See chapter 17 of the final rule TSD for further detail on the policy alternatives DOE considered.)

In reviewing alternatives to the final rule, DOE examined energy conservation standards set at other trial standard levels. At levels above TSL 2, the impacts to small manufacturers would be more severe. While TSL 1 would reduce the impacts on small business manufacturers, it would come at the expense of a reduction in energy savings. DOE concludes that establishing standards at TSL 2 balances the benefits of the energy savings at TSL 2 with the potential burdens placed on commercial packaged boiler manufacturers, including small business manufacturers.

Additional compliance flexibilities may be available through other means. EPCA provides that a manufacturer whose annual gross revenue from all of its operations does not exceed $8 million may apply for an exemption from all or part of an energy conservation standard for a period not longer than 24 months after the effective date of a final rule establishing the standard. 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 10 CFR part 1003 for additional details.

C. Review Under the Paperwork Reduction Act

Manufacturers of commercial packaged boilers must certify to DOE that their equipment comply with any applicable energy conservation standards. In certifying compliance, manufacturers must test their equipment according to the DOE test procedures for commercial packaged boilers, including any amendments adopted for those test procedures. DOE has established regulations for the certification and recordkeeping requirements for all covered consumer equipment and commercial equipment, including commercial packaged boilers. 76 FR 12422 (March 7, 2011). 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. DOE requested OMB approval of an extension of this information collection for three years, specifically including the collection of information proposed in the present rulemaking, and estimated that the annual number of burden hours under this extension is 30 hours per company. In response to DOE's request, OMB approved DOE's information collection requirements covered under OMB control number 1910–1400 through November 30, 2017. 80 FR 5099 (January 30, 2015).

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 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 rule fits within the category of actions because it is a rulemaking that establishes energy conservation standards for consumer equipment 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 rule. DOE's CX determination for this rule is available at *http://energy.gov/nepa/categorical-exclusion-cx-determinations-cx.*

E. Review Under Executive Order 13132

Executive Order 13132, ''Federalism,'' 64 FR 43255 (Aug. 10, 1999), imposes certain requirements on Federal agencies formulating and implementing policies or regulations that preempt State law or that have Federalism implications. The Executive Order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and to carefully assess the necessity for such actions. The Executive Order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have Federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. DOE has examined this rule and has determined that it would not have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the equipment that is the subject of this final rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in

EPCA. (42 U.S.C. 6297) 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, and (3) provide a clear legal standard for affected conduct rather than a general standard and promote simplification and burden reduction. 61 FR 4729 (Feb. 7, 1996). 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 final 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 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 commercial packaged boilers 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 commercial packaged boilers, 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 final rule. (2 U.S.C. 1532(c)) The content requirements of section 202(b) of UMRA relevant to a private sector mandate substantially overlap the economic analysis requirements that apply under section 325(o) of EPCA and Executive Order 12866. The **SUPPLEMENTARY INFORMATION** section of the final rule and 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. As required by EPCA in 42 U.S.C. 6313(a), this final rule establishes amended energy conservation standards for commercial packaged boilers that are designed to achieve a significant 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 final rule.

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

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

I. Review Under Executive Order 12630

DOE has determined, under Executive Order 12630, ''Governmental Actions and Interference with Constitutionally Protected Property Rights,'' 53 FR 8859 (Mar. 15, 1988), that this regulation 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 guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (Feb. 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). DOE has reviewed this 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 significant energy action. A ''significant energy action'' is defined as any action by an agency that promulgates or is expected to lead to promulgation of a final rule, and that (1) is a significant regulatory action under Executive Order 12866, or any successor order, and (2) is likely to have a significant adverse effect on the supply, distribution, or use of energy, or (3) is designated by the Administrator of OIRA as a significant energy action. For any significant energy action, the agency must give a detailed statement of any adverse effects on energy supply, distribution, or use should the proposal be implemented, and of reasonable alternatives to the action and their expected benefits on energy supply, distribution, and use.

DOE has concluded that this regulatory action, which sets forth amended energy conservation standards for commercial packaged boilers, 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 the final rule.

L. Review Under the Information Quality Bulletin for Peer Review

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

In response to OMB's Bulletin, DOE conducted formal peer reviews of the energy conservation standards development process and the analyses that are typically used and prepared a report describing that peer review.[100] 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. DOJ has determined that the peer-reviewed analytical process continues to reflect current practice, and the Department followed that process for developing energy conservation standards in the case of the present rulemaking.

M. Congressional Notification

As required by 5 U.S.C. 801, DOE will report to Congress on the promulgation of this rule prior to its effective date. The report will state that it has been determined that the rule is a ''major rule'' as defined by 5 U.S.C. 804(2).

VII. Approval of the Office of the Secretary

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

List of Subject in 10 CFR Part 431

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

Issued in Washington, DC, on December 28, 2016.

David J. Friedman,

Acting Assistant Secretary, Energy Efficiency and Renewable Energy.

Note: DOE is publishing this document concerning commercial packaged boilers to comply with an order from the U.S. District Court for the Northern District of California in the consolidated cases of *Natural Resources Defense Council, et al.* v. *Perry and People of the State of California et al.* v. *Perry,* Case No. 17–cv–03404–VC, as affirmed by the U.S. Court of Appeals for the Ninth Circuit in the consolidated cases Nos. 18–15380 and 18–15475. DOE reaffirmed the original signature and date in the Energy Conservation Standards implementation of the court order published elsewhere in this issue of the **Federal Register**. This document is substantively identical to the signed document. DOE had previously posted to its website. In response to an error correction request, DOE revised two tables in the document that inadvertently listed the lower bound of several equipment classes as >300,000 Btu/h, instead of ≥300,000 Btu/h. The document has also been edited and formatted in conformance with the publication requirements for the **Federal Register** and CFR to ensure the document can be given legal effect.

Editorial Note: This document was received for publication by the Office of the Federal Register on December 3, 2019.

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

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

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

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

■ 2. Section 431.87 is revised to read as follows:

§ 431.87 Energy and water conservation standards and their effective dates.

(a) Each commercial packaged boiler listed in Table 1 to § 431.87 and manufactured on or after March 2, 2012 and prior to January 10, 2023, must meet the applicable energy conservation standard levels as follows:

TABLE 1 TO § 431.87—COMMERCIAL PACKAGED BOILER ENERGY CONSERVATIONS STANDARDS

Equipment	Subcategory	Size category (input)	Efficiency level—effective date: March 2, 2012 *
Hot Water Commercial Packaged Boilers	Gas-fired	≥300,000 Btu/h and ≤2,500,000 Btu/h	80.0% E_T.
Hot Water Commercial Packaged Boilers	Gas-fired	>2,500,000 Btu/h	82.0% E_C.
Hot Water Commercial Packaged Boilers	Oil-fired	≥300,000 Btu/h and ≤2,500,000 Btu/h	82.0% E_T.
Hot Water Commercial Packaged Boilers	Oil-fired	>2,500,000 Btu/h	84.0% E_C.
Steam Commercial Packaged Boilers	Gas-fired—all, except natural draft	≥300,000 Btu/h and ≤2,500,000 Btu/h	79.0% E_T.
Steam Commercial Packaged Boilers	Gas-fired—all, except natural draft	>2,500,000 Btu/h	79.0% E_T.
Steam Commercial Packaged Boilers	Gas-fired—natural draft	≥300,000 Btu/h and ≤2,500,000 Btu/h	77.0% E_T.
Steam Commercial Packaged Boilers	Gas-fired—natural draft	>2,500,000 Btu/h	77.0% E_T.
Steam Commercial Packaged Boilers	Oil-fired	≥300,000 Btu/h and ≤2,500,000 Btu/h	81.0% E_T.
Steam Commercial Packaged Boilers	Oil-fired	>2,500,000 Btu/h	81.0% E_T.

* Where E_T means ''thermal efficiency'' and E_C means ''combustion efficiency'' as defined in 10 CFR 431.82.

[100] The 2007 ''Energy Conservation Standards Rulemaking Peer Review Report'' is available at the following website: *http://energy.gov/eere/buildings/downloads/energy-conservation-standards-rulemaking-peer-review-report-0.*

(b) Each commercial packaged boiler listed in Table 2 to § 431.87 and manufactured on or after January 10, 2023, must meet the applicable energy conservation standard levels as follows:

TABLE 2 TO § 431.87—COMMERCIAL PACKAGED BOILER ENERGY CONSERVATIONS STANDARDS

Equipment	Size category (rated input)	Energy conservation standard
Small Gas-Fired Hot Water Commercial Packaged Boilers	≥300,000 Btu/h and ≤2,500,000 Btu/h	84.0% E_T.
Large Gas-Fired Hot Water Commercial Packaged Boilers	>2,500,000 Btu/h and ≤10,000,000 Btu/h	85.0% E_C.
Very Large Gas-Fired Hot Water Commercial Packaged Boilers.	>10,000,000 Btu/h	82.0% E_C.
Small Oil-Fired Hot Water Commercial Packaged Boilers	≥300,000 Btu/h and ≤2,500,000 Btu/h	87.0% E_T.
Large Oil-Fired Hot Water Commercial Packaged Boilers	>2,500,000 Btu/h and ≤10,000,000 Btu/h	88.0% E_C.
Very Large Oil-Fired Hot Water Commercial Packaged Boilers.	>10,000,000 Btu/h	84.0% E_C.
Small Gas-Fired Steam Commercial Packaged Boilers	≥300,000 Btu/h and ≤2,500,000 Btu/h	81.0% E_T.
Large Gas-Fired Steam Commercial Packaged Boilers	>2,500,000 Btu/h and ≤10,000,000 Btu/h	82.0% E_T.
Very Large Gas-Fired Steam Commercial Packaged Boilers **.	>10,000,000 Btu/h	79.0% E_T.
Small Oil-Fired Steam Commercial Packaged Boilers	≥300,000 Btu/h and ≤2,500,000 Btu/h	84.0% E_T.
Large Oil-Fired Steam Commercial Packaged Boilers	>2,500,000 Btu/h and ≤10,000,000 Btu/h	85.0% E_T.
Very Large Oil-Fired Steam Commercial Packaged Boilers	>10,000,000 Btu/h	81.0% E_T.

* Where E_T means "thermal efficiency" and E_C means "combustion efficiency" as defined in 10 CFR 431.82.

** Prior to March 2, 2022, for natural draft very large gas-fired steam commercial packaged boilers, a minimum thermal efficiency level of 77 percent is permitted and meets Federal commercial packaged boiler energy conservation standards.

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