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: Notice of proposed rulemaking and announcement of public meeting.

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. EPCA also requires the U.S. Department of Energy (DOE) to periodically determine whether more stringent standards would be technologically feasible and economically justified, and would save a significant amount of energy. DOE has tentatively concluded that more stringent standards are technologically feasible and economically justified, and would result in significant additional conservation of energy. Therefore, DOE proposes amended energy conservation standards for commercial packaged boilers. This document also announces a public meeting to receive comment on the proposed standards and associated analyses and results.

DATES: *Meeting:* DOE will hold a public meeting on Thursday, April 21, 2016, from 9:30 a.m. to 3 p.m., in Washington, DC. The meeting will also be broadcast as a webinar. See section VII, Public Participation, for webinar registration information, participant instructions, and information about the capabilities available to webinar participants.

Comments: DOE will accept comments, data, and information regarding this notice of proposed rulemaking (NOPR) before and after the public meeting, but no later than May 23, 2016. See section VII, Public Participation, for details.

Comments regarding the likely competitive impact of the proposed standard should be sent to the Department of Justice contact listed in the **ADDRESSES** section before April 25, 2016.

ADDRESSES: The public meeting will be held at the U.S. Department of Energy, Forrestal Building, Room 1E–245, 1000 Independence Avenue SW., Washington, DC 20585. To register for the webinar and receive call-in information, please use this link: *https://attendee.gotowebinar.com/register/6872804566336170753*.

Instructions: Any comments submitted must identify the NOPR on Energy Conservation Standards for Commercial Packaged Boilers, and provide docket number EERE–2013–BT–STD–0030 and/or regulatory information number (RIN) number 1904–AD01. Comments may be submitted using any of the following methods:

1. *Federal eRulemaking Portal: www.regulations.gov*. Follow the instructions for submitting comments.
2. *Email: PkgdBoilers2013STD0030@ee.doe.gov*. Include the docket number EERE–2013–BT–STD–0030 and/or RIN 1904–AD01 in the subject line of the message. Submit electronic comments in WordPerfect, Microsoft Word, PDF, or ASCII file format, and avoid the use of special characters or any form of encryption.
3. *Postal Mail:* Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Office, Mailstop EE–5B, 1000 Independence Avenue SW., Washington, DC 20585–0121. If possible, please submit all items on a CD, in which case it is not necessary to include printed copies.
4. *Hand Delivery/Courier:* Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Office, 950 L'Enfant Plaza SW., Room 6094, Washington, DC 20024. Telephone: (202) 586–2945. If possible, please submit all items on a compact disc (CD), in which case it is not necessary to include printed copies.

Written comments regarding the burden-hour estimates or other aspects of the collection-of-information requirements contained in this proposed rule may be submitted to Office of Energy Efficiency and Renewable Energy through the methods listed above and by email to *Chad_S_Whiteman@omb.eop.gov*.

No telefacsimilies (faxes) will be accepted. For detailed instructions on submitting comments and additional information on the rulemaking process, see section VII of this document (Public Participation).

EPCA requires the Attorney General to provide DOE a written determination of whether the proposed standard is likely to lessen competition. The U.S. Department of Justice Antitrust Division invites input from market participants and other interested persons with views on the likely competitive impact of the proposed standard. Interested persons may contact the Division at *energy.standards@usdoj.gov* before April 25, 2016. Please indicate in the ''subject'' line of your email the title and Docket Number of this proposed rule.

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

A link to the docket Web page can be found at *http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx?ruleid=79*. This Web page contains a link to the docket for this document on the *www.regulations.gov* site. The *www.regulations.gov* Web page contains simple instructions on how to access all documents, including public comments, in the docket. See section VII of this document for further information on how to submit comments through *www.regulations.gov*.

FOR FURTHER INFORMATION CONTACT: Mr. James Raba, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office, EE–5B, 1000 Independence Avenue SW., Washington, DC 20585–0121. Telephone: (202) 586–8654. Email: *Jim.Raba@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*.

For further information on how to submit a comment, review other public comments and the docket, or participate in the public meeting, contact Ms. Brenda Edwards at (202) 586–2945 or by email: *Brenda.Edwards@ee.doe.gov*.

SUPPLEMENTARY INFORMATION:

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I. Synopsis of the Proposed Rule

Title III, Part C [1] of the Energy Policy and Conservation Act of 1975 (42 U.S.C. 6291, *et seq.;* ''EPCA''), Public Law 94–163 (42 U.S.C. 6311–6317, as codified), added by Public Law 95–619, Title IV, section 441(a), establishes the Energy Conservation Program for Certain Industrial Equipment.[2] These include commercial packaged boilers (''CPB''), the subject of this document. (42 U.S.C. 6311(1)(J)) Commercial packaged boilers are also covered under 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.'' [3]

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 NOPR including proposed amended standards. (42 U.S.C. 6313(a)(6)(C)(i)) EPCA further requires that any new or amended energy conservation standards that DOE prescribes for covered equipment shall be designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. (42 U.S.C. 6313(a)(6)(A)(ii)(II)) Furthermore, the new or amended standard must result in a significant additional conservation of energy. *Id.* Under the applicable statutory provisions, DOE must determine that there is clear and convincing evidence supporting the adoption of more stringent energy conservation standards than the ASHRAE level. *Id.* Once complete, this

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

[2] 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).

[3] ASHRAE Standard 90.1–2013 (*i.e.,* the most recent version of ASHRAE Standard 90.1) did not amend the efficiency levels for commercial packaged boilers. Thus, DOE is undertaking this rulemaking under the 6-year review requirement in 42 U.S.C. 6313(a)(6)(C), as opposed to the statutory provision regarding ASHRAE equipment (42 U.S.C. 6313(a)(6)(A). For more information on DOE's review of ASHRAE Standard 90.1–2013, see: *http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx?ruleid=108.*

rulemaking will satisfy DOE's statutory obligation under 42 U.S.C. 6313(a)(6)(C).

Pursuant to these and other statutory requirements discussed in this document, DOE initiated this rulemaking to evaluate CPB energy conservation standards and to determine whether new or amended standards are warranted. DOE has examined the existing CPB standards and has tentatively concluded that modifying and expanding the existing 10 CPB equipment classes to 12 equipment classes is warranted. As discussed in detail in section IV.A.2 of this document, DOE proposes to: (1) Discontinue the use of draft type as a criteria 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 would consolidate the 4 existing draft-specific equipment classes into 2 non-draft-specific equipment classes. Further, the proposed change to distinguish very large CPB as separate equipment classes would result in an additional 4 equipment classes. As a result, the total number of equipment classes would increase from 10 to 12. DOE has tentatively concluded that there is clear and convincing evidence to support more stringent standards for 8 of the 12 equipment classes proposed in this NOPR, which includes all classes except for the newly proposed very large CPB classes. The proposed standards, which prescribe minimum thermal efficiencies (E_T) or combustion efficiencies (E_C), are shown in Table I.1. These proposed standards, if adopted, would apply to the applicable equipment classes listed in Table I.1 and manufactured in, or imported into, the United States on and after the date 3 years after the publication of the final rule.

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

Equipment	Size category (input)	Proposed energy conservation standard *	Compliance date †
Small Gas-Fired Hot Water Commercial Packaged Boilers.	>300,000 Btu/h and ≤2,500,000 Btu/h	85.0% E_T	[date 3 years after publication of final rule].
Large Gas-Fired Hot Water Commercial Packaged Boilers.	>2,500,000 Btu/h and ≤10,000,000 Btu/h	85.0% E_C	[date 3 years after publication of final rule].
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	[date 3 years after publication of final rule].
Large Oil-Fired Hot Water Commercial Packaged Boilers.	>2,500,000 Btu/h and ≤10,000,000 Btu/h	88.0% E_C	[date 3 years after publication of final rule].
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	[date 3 years after publication of final rule].
Large Gas-Fired Steam Commercial Packaged Boilers.	>2,500,000 Btu/h and ≤10,000,000 Btu/h	82.0% E_T	[date 3 years after publication of final rule].
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	[date 3 years after publication of final rule].
Large Oil-Fired Steam Commercial Packaged Boilers.	>2,500,000 Btu/h and ≤10,000,000 Btu/h	85.0% E_T	[date 3 years after publication of final rule].
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 proposes to retain the existing standards for such equipment, which had a compliance date of March 2, 2012, as shown.

A. Benefits and Costs to Consumers

Table I.2 presents DOE's evaluation of the economic impacts of the proposed 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).[4] 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 NOPR.

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

Equipment class	Average LCC savings *(2014$)*	Simple payback period *(years)*
Small Gas-Fired Hot Water	$521	9.6

[4] The average LCC savings 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 NOPR 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 PROPOSED ENERGY CONSERVATION STANDARDS ON CONSUMERS OF COMMERCIAL PACKAGED BOILERS—Continued

Equipment class	Average LCC savings *(2014$)*	Simple pay-back period *(years)*
Large Gas-Fired Hot Water	3,647	11.0
Small Oil-Fired Hot Water	7,799	5.7
Large Oil-Fired Hot Water	30,834	4.7
Small Gas-Fired Steam	2,782	7.4
Large Gas-Fired Steam	16,802	4.7
Small Oil-Fired Steam	4,256	5.3
Large Oil-Fired Steam	36,128	2.8

DOE's analysis of the impacts of the proposed standards on consumers is described in section IV.F of this document and in chapter 8 of the NOPR TSD.

B. Impact on Manufacturers

The industry net present value (INPV) is the sum of the discounted cash flows to the industry from the base year through the end of the analysis period (2014 to 2048). Using a real discount rate of 9.5 percent, DOE estimates that the INPV for manufacturers of commercial packaged boilers is $180.1 million in 2014$. Under the proposed standards, DOE expects that INPV may reduce by $23.8 to $13.1 million, which is approximately 13.2 to 7.3 percent respectively. Under today's proposed standard, DOE expects the industry to incur $27.5 million in conversion costs.

DOE's analysis of the impacts of the proposed standards on manufacturers is described in section IV.J of this document.

C. National Benefits and Costs [5]

DOE's analyses indicate that the proposed 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 (2019–2048), relative to the case without amended standards (referred to as the ''no-new-standards case''), amount to 0.39 quadrillion Btu (quads).[6] This represents a savings of 0.8 percent relative to the energy use of this equipment in the no-new-standards case.[7]

The cumulative net present value (NPV) of total consumer costs and savings of the proposed standards for commercial packaged boilers ranges from $0.414 billion (at a 7-percent discount rate) to $1.687 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 2019–2048.

In addition, the proposed CPB standards would have 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 22 million metric tons (Mt) [8] of carbon dioxide (CO_2), 233 thousand tons of methane (CH_4), 2.1 thousand tons of sulfur dioxide (SO_2), 162 thousand tons of nitrogen oxides (NO_X), 0.1 thousand tons of nitrous oxide (N_2O), and 0.0003 tons of mercury (Hg).[9] The cumulative reduction in CO_2 emissions through 2030 amounts to 2.86 Mt, which is equivalent to the emissions resulting from the annual electricity use of 0.393 million homes.

The value of the CO_2 reductions is calculated using a range of values per metric ton of CO_2 (otherwise known as the Social Cost of Carbon, or SCC) developed by a recent Federal interagency process.[10] The derivation of the SCC values is discussed in section IV.L of this document. Using discount rates appropriate for each set of SCC values (see Table I.3), DOE estimates the present monetary value of the CO_2 emissions reduction is between $0.14 billion and $2.0 billion, with a value of $0.66 billion using the central SCC case represented by $40.0 per metric ton in 2015.[11] DOE also estimates the present monetary value of the NO_X emissions reduction is $0.16 billion at a 7-percent discount rate and $0.45 billion at a 3-percent discount rate.[12] More detailed results can be found in chapter 14 of the NOPR TSD.

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

[5] All monetary values in this section are expressed in 2014 dollars and, where appropriate, are discounted to 2015.

[6] 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.1 of this document.

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

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

[9] DOE calculated emissions reductions relative to the no-new-standards case, which reflects key assumptions in the *Annual Energy Outlook 2015* (*AEO2015*) Reference case. *AEO2015* generally represents current legislation and environmental regulations for which implementing regulations were available as of October 31, 2014.

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

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

[12] DOE estimated the monetized value of NO_Xemissions reductions using benefits per ton estimates from the Regulatory Impact Analysis titled, ''Proposed Carbon Pollution Guidelines for Existing Power Plants and Emission Standards for Modified and Reconstructed Power Plants,'' published in June 2014 by EPA's Office of Air Quality Planning Standards. (Available at *www3.epa.gov/ttnecas1/regdata/RIAs/111dproposalRIAfinal10602.pdf.*) See section IV.L.2 for further discussion. Note that the agency is presenting a national benefit-per-ton estimate for particulate matter 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. Because of the sensitivity of the benefit-per-ton estimate to the geographical considerations of sources and receptors of emissions by assessing the regional approach taken by EPA's Regulatory Impact Analysis of the Clean Power Plan Final Rule. Note the DOE is currently investigating valuation of avoided SO_2 and H_g emissions.

TABLE I.3—SUMMARY OF NATIONAL ECONOMIC BENEFITS AND COSTS OF PROPOSED ENERGY CONSERVATION STANDARDS FOR COMMERCIAL PACKAGED BOILERS (TSL 2 *)

Category	Present value (million 2014$)	Discount rate (%)
Benefits		
Operating Cost Savings	925	7
	2,550	3
CO_2 Reduction (using mean SCC at 5% discount rate) **	136	5
CO_2 Reduction (using mean SCC at 3% discount rate) **	655	3
CO_2 Reduction (using mean SCC at 2.5% discount rate) **	1,054	2.5
CO_2 Reduction (using 95th percentile SCC at 3% discount rate) **	1,998	3
NO_X Reduction †	158	7
	447	3
Total Benefits ††	1,738	7
	3,653	3
Costs		
Incremental Installed Costs	512	7
	863	3
Total Net Benefits		
Including CO_2 and NO_X Reduction Monetized Value ††	1,227	7
	2,789	3

* This table presents the costs and benefits associated with commercial packaged boilers shipped in 2019 − 2048. These results include benefits to consumers that accrue after 2048 from the equipment purchased in 2019 − 2048. The incremental installed costs include incremental equipment cost as well as installation costs. The CO_2 reduction benefits are global benefits due to actions that occur nationally.

** The interagency group selected four sets of SCC values for use in regulatory analyses. Three sets of values are based on the average SCC from the integrated assessment models, at discount rates of 5, 3, and 2.5 percent. For example, for 2015 emissions, these values are $12.2/metric ton, $40.0/metric ton, and $62.3/metric ton, in 2014$, respectively. The fourth set ($117 per metric ton in 2014$ for 2015 emissions), which represents the 95th percentile of the SCC distribution calculated using SCC estimate across all three models at 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.

† The $/ton values used for NO_X are described in section IV.L. DOE estimated the monetized value of NO_X emissions reductions using benefit per ton estimates from the Regulatory Impact Analysis titled, "Proposed Carbon Pollution Guidelines for Existing Power Plants and Emission Standards for Modified and Reconstructed Power Plants," published in June 2014 by EPA's Office of Air Quality Planning and Standards. (Available at *www3.epa.gov/ttnecas1/regdata/RIAs/111dproposalRIAfinal0602.pdf.*) See section IV.L.2 for further discussion. Note that the agency is presenting a national benefit-per-ton estimate for particulate matter emitted from the Electric 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. Because of the sensitivity of the benefit-per-ton estimate to the geographical considerations of sources and receptors of emissions, DOE intends to investigate refinements to the agency's current approach of one national estimate by assessing the regional approach taken by EPA's Regulatory Impact Analysis for the Clean Power Plan Final Rule.

†† 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 this NOPR's proposed energy conservation standards, for covered commercial packaged boilers sold in 2019–2048, 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 proposed standards (consisting primarily of reduced operating costs minus increases in product purchase price and installation costs); and (2) the annualized value of the benefits of CO_2 and NO_X emission reductions.[13]

The national operating savings are domestic private U.S. consumer monetary savings that occur as a result of purchasing these equipment. The national operating cost savings is measured for the lifetime of commercial packaged boilers shipped in 2019–2048.

The CO_2 reduction is a benefit that accrues globally due to decreased domestic energy consumption that is expected to result from this proposed rule. Because CO_2 emissions have a very long residence time in the atmosphere,[14] 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 proposed standards are shown in Table I.4. The results under the primary estimate are as follows. Using a 7-percent discount rate for benefits and costs other than CO_2 reduction, for which DOE used a 3-percent discount rate along with the average SCC series that has a value of $40.0 per metric ton in 2015, the cost of the standards proposed in this rulemaking is $51 million per year in increased equipment costs, while the benefits are $91 million per year in reduced equipment operating costs, $37 million in CO_2 reductions, and $16 million in reduced NO_X emissions. In

[13] To convert the time-series of costs and benefits into annualized values, DOE calculated a present value in 2015, 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 2015. 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.

[14] 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).

this case, the net benefit amounts to $93 million per year. Using a 3-percent discount rate for all benefits and costs and the average SCC series that has a value of $40.0 per metric ton in 2015, the estimated cost of the CPB standards proposed in this rulemaking is $48 million per year in increased equipment costs, while the benefits are $142 million per year in reduced operating costs, $37 million in CO_2 reductions, and $25 million in reduced NO_X emissions. In this case, the net benefit amounts to $156 million per year.

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

	Discount rate	*Million 2014$/year*		
		Primary estimate *	Low net benefits estimate *	High net benefits estimate *
Benefits				
Consumer Operating Cost Savings *	7%	91	84	101.
	3%	142	129	160.
CO_2 Reduction (using mean SCC at 5% discount rate) ***	5%	10	10	11.
CO_2 Reduction (using mean SCC at 3% discount rate) ***	3%	37	34	39.
CO_2 Reduction (using mean SCC at 2.5% discount rate) ***	2.5%	54	51	58.
CO_2 Reduction (using 95th percentile SCC at 3% discount rate) ***.	3%	111	104	119.
NO_X Reduction †	7%	16	15	37.
	3%	25	23	59.
Total Benefits ††	7% plus CO_2 range	117 to 218	108 to 203	149 to 258.
	7%	143	133	177.
	3% plus CO_2 range	177 to 278	162 to 256	230 to 338.
	3%	204	186	258.
Costs				
Consumer Incremental Equipment Costs	7%	51	54	47.
	3%	48	52	45.
Net Benefits				
Total ††	7% plus CO_2 range	67 to 168	54 to 149	102 to 210.
	7%	93	79	130.
	3% plus CO_2 range	129 to 230	110 to 205	185 to 293.
	3%	156	135	213.

* This table presents the annualized costs and benefits associated with commercial packaged boilers shipped in 2019 − 2048. These results include benefits to consumers that accrue after 2048 from the equipment purchased in 2019 − 2048. 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 *AEO2015* Reference case, Low Economic Growth case, and 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).

** The interagency group selected four sets of SCC values for use in regulatory analyses. Three sets of values are based on the average SCC from the integrated assessment models, at discount rates of 5, 3, and 2.5 percent. For example, for 2015 emissions, these values are $12.2/metric ton, $40.0/metric ton, and $62.3/metric ton, in 2014$, respectively. The fourth set ($117 per metric ton in 2014$ for 2015 emissions), which represents the 95th percentile of the SCC distribution calculated using SCC estimate across all three models at 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 for more details.

† The $/ton values used for NO_X are described in section IV.L. DOE estimated the monetized value of NO_X emissions reductions using benefit per ton estimates from the Regulatory Impact Analysis titled, ''Proposed Carbon Pollution Guidelines for Existing Power Plants and Emission Standards for Modified and Reconstructed Power Plants,'' published in June 2014 by EPA's Office of Air Quality Planning and Standards. (Available at *www3.epa.gov/ttnecas1/regdata/RIAs/111dproposalRIAfinal0602.pdf.*) See section IV.L.2 for further discussion. Note that the agency is presenting a national benefit-per-ton estimate for particulate matter emitted from the Electric 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. Because of the sensitivity of the benefit-per-ton estimate to the geographical considerations of sources and receptors of emissions, DOE intends to investigate refinements to the agency's current approach of one national estimate by assessing the regional approach taken by EPA's Regulatory Impact Analysis for the Clean Power Plan Final Rule.

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

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

D. Conclusion

Based on clear and convincing evidence, DOE has tentatively concluded that the proposed standards represent the maximum improvement in energy efficiency that is technologically feasible and economically justified, and would result in the significant conservation of energy. DOE further notes that equipment achieving these standard levels is already commercially available for at least some, if not most, equipment classes covered by this proposal.[15] Based on the analyses described above, DOE has tentatively concluded that the benefits of the proposed standards to the Nation (energy savings, positive NPV of consumer benefits, consumer LCC savings, and emission reductions) would outweigh the burdens (loss of INPV for manufacturers and LCC increases for some consumers).

DOE also considered more stringent energy efficiency levels as potential standards, and is considering them in this rulemaking. However, DOE has tentatively concluded that the potential burdens of the more stringent energy efficiency levels would outweigh the projected benefits. Based on consideration of the public comments that DOE receives in response to this document and related information collected and analyzed during the course of this rulemaking effort, DOE may adopt energy efficiency levels presented in this document that are either higher or lower than the proposed standards, or some combination of level(s) that incorporate the proposed standards in part.

II. Introduction

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

A. Authority

Title III, Part C [16] of the Energy Policy and Conservation Act of 1975 (''EPCA'' or ''the Act''), Public Law 94–163 (42 U.S.C. 6311–6317, as codified), added by Public Law 95–619, Title IV, section 441(a), sets forth a variety of provisions designed to improve energy efficiency.[17] It established the ''Energy Conservation Program for Certain Industrial Equipment,'' which includes commercial packaged boilers that are the subject of this rulemaking. The energy conservation standards for commercial packaged boilers are codified in DOE's regulations under subpart E of Title 10 of the Code of Federal Regulations (CFR), Part 431.

The 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'').[18] EPCA directs DOE to consider amending the existing Federal energy conservation standard for each type of covered ASHRAE equipment whenever ASHRAE amends the efficiency levels in Standard 90.1. (42 U.S.C. 6313(a)(6)(A)) 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 clear and convincing evidence supports a determination that adoption of a more stringent level would produce significant additional energy savings and would be technologically feasible and economically justified. (42 U.S.C. 6313(a)(6)(A)(ii)) If DOE decides to adopt as a national standard the efficiency levels specified in the amended ASHRAE Standard 90.1, DOE must establish such standard not later than 18 months after publication of the amended industry standard. (42 U.S.C. 6313(a)(6)(A)(ii)(I)) However, if DOE determines that a more stringent standard is justified, then it must establish such more stringent standard not later than 30 months after publication of the amended ASHRAE Standard 90.1. (42 U.S.C. 6313(a)(6)(B)(i))

In the event that ASHRAE does not act to amend Standard 90.1, EPCA provides an alternative statutory mechanism for initiating such review. More specifically, EPCA requires that every six years, the Secretary of Energy (Secretary) shall consider amending the energy conservation standards for covered commercial equipment and shall publish either a notice of determination that those standards do not need to be amended, or a notice of proposed rulemaking for more stringent energy efficiency standards. (42 U.S.C. 6313(a)(6)(C))

Pursuant to EPCA, DOE's energy conservation program for covered equipment consists essentially of four parts: (1) Testing, (2) labeling, (3) the establishment of Federal energy conservation standards, and (4) compliance certification and enforcement procedures. Subject to certain criteria and conditions, DOE has authority, as discussed above, to adopt amended energy conservation standards for commercial packaged boilers. In addition, DOE is required to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating cost of covered equipment. (42 U.S.C. 6314(a)(2)) Manufacturers of covered equipment must use the prescribed DOE test procedure as the basis for certifying to DOE that their equipment comply with the applicable energy conservation standards adopted under EPCA and when making representations to the public regarding the energy use or efficiency of such equipment. (42 U.S.C. 6314(d)(1)) Similarly, DOE must use these test procedures to determine whether the equipment comply with standards adopted pursuant to EPCA. The DOE test procedures for commercial packaged boilers currently appear at 10 CFR 431.86.

When setting standards for the ASHRAE equipment addressed by this document, EPCA, as amended, prescribes certain statutory criteria for DOE to consider. See generally 42 U.S.C. 6313(a)(6)(A)–(D). Any amended standard for covered equipment more stringent than the level contained in ASHRAE Standard 90.1 must be designed to achieve significant improvement in energy efficiency that is technologically feasible and economically justified. (42 U.S.C. 6313(a)(6)(A)(ii)(II) and (C)(i)) Furthermore, DOE may not adopt a more stringent standard that would not result in the significant additional conservation of energy. *Id.* In deciding whether a proposed standard is economically justified, DOE must determine whether the benefits of the standard exceed its burdens. DOE must make this determination after receiving comments on the proposed standard, and by considering, to the maximum extent practicable, the following seven factors:

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

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

[16] For editorial reasons, upon codification in the United States Code (U.S.C.), Part C was re-designated Part A–1.

[17] 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).

[18] For more information, see *www.ashrae.org.*

(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))

Subject to certain criteria and conditions, DOE is required to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating cost of covered equipment. (42 U.S.C. 6314) Specifically, EPCA requires that if a test procedure referenced in ASHRAE Standard 90.1 is updated, DOE must update its test procedure to be consistent with the amended test procedure in ASHRAE Standard 90.1, unless DOE determines that the amended test procedure is not reasonably designed to produce test results that reflect the energy efficiency, energy use, or estimated operating costs of the ASHRAE equipment during a representative average use cycle. In addition, DOE must determine that the amended test procedure is not unduly burdensome to conduct. (42 U.S.C. 6314(a)(2) and (4)) Manufacturers of covered equipment must use the prescribed DOE test procedure as the basis for certifying to DOE that their equipment complies with the applicable energy conservation standards adopted under EPCA and when making representations to the public regarding the energy use or efficiency of such equipment. (42 U.S.C. 6314(d)) Similarly, DOE must use these test procedures to determine whether the equipment complies with standards adopted pursuant to EPCA. The DOE test procedure for commercial packaged boilers currently appear at 10 CFR 431.86.

EPCA, as codified, also contains what is known as an ''anti-backsliding'' provision, which prevents the Secretary from prescribing any amended standard that either increases the maximum allowable energy use or decreases the minimum required energy efficiency of a covered product. (42 U.S.C. 6313(a)(6)(B)(iii)(I) and (C)(i)) Furthermore, the Secretary may not prescribe an amended or new standard if interested persons have established by a preponderance of the evidence that the standard is likely to result in the unavailability in the United States 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) and (C)(i))

Further, EPCA, as codified, establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the energy (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. For this rulemaking, DOE considered the criteria for rebuttable presumption as part of its analysis.

Additionally, when a type or class of covered equipment has two or more subcategories, DOE often specifies more than one standard level. DOE generally will adopt a different standard level than that which applies generally to such type or class of products for any group of covered products that have the same function or intended use if DOE determines that products within such group (A) consume a different kind of energy from that consumed by other covered products within such type (or class), or (B) have a capacity or other performance-related feature that other products within such type (or class) do not have and which justifies a higher or lower standard. In determining whether a performance-related feature justifies a different standard for a group of products, DOE generally considers such factors as the utility to the consumer of the feature and other factors DOE deems appropriate. In a rule prescribing such a standard, DOE includes an explanation of the basis on which such higher or lower level was established. DOE considered these criteria for this rulemaking.

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 and ASHRAE Standard 90.1–2013), DOE is analyzing amended standards consistent with the procedures defined under 42 U.S.C. 6313(a)(6)(C). Specifically, pursuant to 42 U.S.C. 6313(a)(6)(C)(i)(II), DOE must use the procedures established under subparagraph (B) when issuing a NOPR.

After carefully reviewing all commercial packaged boiler equipment classes, DOE has tentatively concluded that there is clear and convincing evidence that the proposed amended standards for eight of the twelve proposed commercial packaged boiler equipment classes (*i.e.,* all commercial packaged boilers with fuel input rate ≤10,000 kBtu/h) would result in significant additional conservation of energy and would be technologically feasible and economically justified, as mandated by 42 U.S.C. 6313(a)(6).

For the remaining four equipment classes, (*i.e.,* all commercial packaged boilers with fuel input rate >10,000 kBtu/h) DOE proposes to maintain the existing standards because there is not sufficient data to provide clear and convincing evidence that more stringent standards would be technologically feasible and economically justified, and would result in significant additional energy savings.

B. Background

1. Current Standards

DOE 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). Compliance with the amended standards 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 will be 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.

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 *
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.

* 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 six 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, so as a result, DOE is required to act to publish one of the above two documents within 6 years. Once completed, this rulemaking will satisfy DOE's statutory obligation under 42 U.S.C. 6313(a)(6)(C). DOE must publish a final rule not later than two years after this NOPR is issued. (42 U.S.C. 6313(a)(6)(C)(iii)(I))

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: *http://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. 79 FR 69066. The preliminary analysis technical support document (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 TSD. The preliminary TSD is available at: *http://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. Parties providing comments are shown in Table II.3. DOE considered the comments and feedback for the updating the analysis in preparation of this document. Relevant comments and DOE's responses are provided in section III and section IV of this document.

TABLE II.3—PARTIES THAT PROVIDED COMMENTS ON THE PRELIMINARY ANALYSIS TSD

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, National Resource Defense Council.	ACEEE, ASAP & NRDC	Written	EA
American Council for Energy Efficient Economy	ACEEE	Public Meeting	EA
Lochinvar, LLC	Lochinvar	Public Meeting, Written	M
Raypak, Inc	Raypak	Public Meeting, Written	M
PVI Industries	PVI	Public Meeting	M
Plumbing, Heating and Cooling Contractors	PHCC	Public Meeting	C
Appliance Standards Awareness Project	ASAP	Public Meeting	EA
Pacific Gas & Electric, Southern California Edison	PGE & SCE	Written	U

* TA: Trade Association; EA: Efficiency/Environmental Advocate; M: Manufacturer; C: Contractor; U: Utility.

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.[19] 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.

Lastly, DOE is also currently conducting a separate test procedure rulemaking to consider an amended test procedure for commercial packaged boilers. On February 20, 2014, DOE published 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 February 22, 2016, DOE issued a NOPR, which proposed to update the test procedure for determining the efficiency of commercial packaged boilers (February 2016 test procedure NOPR).[20] Through the proposed test procedure, DOE has sought to addresses some of the issues raised by DOE in the RFI and by interested parties in their comments. Section III.B of this document briefly discusses the changes proposed to the current test procedure and the potential impact on the energy conservation standards.[21] The analyses conducted for this NOPR reflect the changes proposed in the February 2016 test procedure NOPR.

III. General Discussion

A. Compliance Dates

In 42 U.S.C. 6313(a), EPCA prescribes a number of compliance dates for any resulting amended standards for commercial packaged boilers. These compliance dates vary depending on 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 that follows explains the potential 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 for any equipment for which more than 6 years has elapsed since the issuance of the most recent final rule. (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)). For commercial packaged boilers, the final rule is scheduled to be published in 2016 and the current standards went into effect in 2012. Thus, the date 3 years after the publication of a final rule (2019) would be later than the date 6 years after the effective date of the current standard (2018) for this round of rulemaking. As a result, compliance with any amended energy conservation standards promulgated in the final rule would be required beginning on the date that is 3 years after the publication of the final rule.

[19] Comments with regards to the coverage determination of natural draft CPB from both the 2013 NOPD and the preliminary analysis TSD are discussed in detail in the 2015 withdrawal notice (80 FR 51487).

[20] A link to the February 2016 test procedure NOPR issued by DOE can be found at: *http://energy.gov/eere/buildings/downloads/issuance-2016-02-22-energy-conservation-program-certain-commercial-and.*

[21] For detailed discussion on the test procedure including the comments and DOE's response please see the docket no. EERE–2014–BT–TP–0006. The docket can also be accessed using the following link: *http://www.regulations.gov/#!docketDetail;D=EERE-2014-BT-TP-0006.*

B. Test Procedure

The current test procedure for commercial packaged boilers is found at 10 CFR 431.86, and incorporates by reference the Hydronics Institute (HI) BTS–2000 (Rev 06.07) testing standard, *Method to Determine Efficiency of Commercial Space Heating Boilers.* As stated previously, on February 22, 2016, DOE issued a notice of proposed rulemaking that proposes several amendments to the CPB test procedure. The changes that are proposed in the new test procedure include: (1) Clarify 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) provide an optional field test for commercial packaged boilers with fuel input rate greater than 5,000,000 Btu/h, (3) provide a conversion method to calculate thermal efficiency based on combustion efficiency testing for steam commercial packaged boilers with fuel input rate greater than 5,000,000 Btu/h, (4) modify the inlet and outlet water temperatures during tests of hot water commercial packaged boilers, (5) establish limits on the ambient temperature and relative humidity conditions during testing, (6) modify setup and instrumentation requirements to remove ambiguity, and (7) standardize terminology and provisions for ''fuel input rate.'' [22]

In the comments received on the preliminary analysis TSD for the energy conservation standards rulemaking, DOE received several comments that are specifically related to the current test procedure for commercial packaged boilers. Comments related to the technical aspects of the test procedure development were considered and addressed in the test procedure NOPR.

In addition, DOE received several comments related to the timing of the test procedure and energy conservation standard. AHRI stated that it appreciates DOE's effort to finalize the test procedure revisions in advance of the standards revisions and that it is critical that the revised test procedures be finalized so that the analysis for the revised standard is based properly on the test procedures that will be applied to products to establish their compliance with the revised efficiency standard. AHRI also stated that there must be sufficient time between the completion of the revised test procedure and the NOPR for the efficiency standard to allow all parties to assess the effect of test procedure revisions on potential increased efficiency standards, and encouraged DOE to continue its efforts to minimize the burden. (AHRI, No. 37 at p. 2) [23] Raypak stated that it is concerned about the lack of a finalized efficiency test procedure, and argued that this will adversely affect the capability of DOE to properly evaluate potential efficiency standard changes. (Raypak, No. 35 at p. 1) At the preliminary analysis public meeting, AHRI commented regarding the need to finalize both the test procedure and the coverage determination prior to the NOPR for the energy conservation standards rulemaking. (AHRI, Public Meeting Transcript, No. 39 at p. 16 and pp. 209–211) In the meeting, ACEEE acknowledged the challenges in compliance, certification, and enforcement for large commercial packaged boilers and asked whether DOE is likely to have regulation without enforcement or whether the Department is planning ahead now for enforcement of large (*e.g.,* 10 million Btu/h) commercial packaged boilers. (ACEEE, Public Meeting Transcript, No. 39 at p. 21)

As noted previously, the test procedure NOPR for commercial packaged boilers was issued by DOE on February 22, 2016. Although the test procedure has not yet been finalized, DOE believes the proposed test method updates give enough insight as to the changes under consideration that amended standard levels can reasonably be considered in this rulemaking. DOE conducted analyses for this NOPR based on the amended test procedure proposed in the February 2016 test procedure NOPR. However, DOE notes its final rule analyses will be based on DOE's most recently adopted CPB test procedure available at the time of the analyses. EPCA requires that, at least once every 7 years, the Secretary of Energy shall evaluate each type of covered equipment, including packaged boilers, to determine whether amended test procedures would more accurately or fully comply with the requirements for the test procedures to be reasonably designed to produce test results which reflect energy efficiency, energy use, and estimated operating costs during a representative average use cycle; and would not be unduly burdensome to conduct. (42 U.S.C. 6314(a)(1)–(2)) DOE adopted its latest amendments to its CPB test procedure in a final rule published on July 22, 2009. 74 FR 36312. Pursuant to EPCA's provision at 42 U.S.C. 6314(a)(1)–(2), DOE is conducting a concurrent test procedure rulemaking to evaluate its current CPB test procedure.

Regarding the effect of the amended test procedure on efficiency ratings, DOE notes that it tested several commercial packaged boilers with both the previous and the proposed test procedure to observe the variation in efficiency ratings as a result of the amended test procedure. As explained in the February 2016 test procedure NOPR, based on the results of this testing, DOE has tentatively determined that the proposed amendments, in aggregate, would not result in an overall measurable impact on ratings.

C. Technological Feasibility

1. General

In each energy conservation standards rulemaking, DOE conducts a screening analysis based on information gathered on all current technology options and prototype designs that could improve the efficiency of the products or equipment that are the subject of the rulemaking. As the first step in such an analysis, DOE 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 products 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 product utility or availability; and (3) adverse impacts on health or safety. 10 CFR part 430, subpart C, appendix A, section 4(a)(4)(ii) through (iv). Additionally, DOE notes that these screening criteria do not directly address the proprietary status of design options. DOE only

[22] In this notice and the NOPR TSD, DOE uses ''fuel input rate,'' to refer to the maximum rate at which a commercial packaged boiler uses energy, in order to be consistent with Test Procedure definition and language. The industry also uses terms such as input capacity, input ratings, capacity, and rating, and any such instances should be considered synonymous with fuel input rate.

[23] A notation in this form provides a reference for information that is in the docket of DOE's rulemaking to develop energy conservation standards for commercial packaged boilers (Docket No. EERE–2013–BT–STD–0030, which is maintained at *http://www.regulations.gov/#!docketDetail;D=EERE-2013-BT-STD-0030*). This particular notation refers to a comment: (1) Submitted by AHRI; (2) appearing in document number 0035; and (3) appearing on page 3 of that document.

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 believes the proposed standards for the equipment covered in this rulemaking would not mandate the use of any proprietary technologies, and that all manufacturers would be able to achieve the proposed levels through the use of non-proprietary designs. Section IV.B of this document discusses the results of the screening analysis for commercial packaged boilers, particularly the designs DOE considered, those it screened out, and those that are the basis for the TSLs in this rulemaking. For further details on the screening analysis for this rulemaking, see chapter 4 of the NOPR TSD.

2. Maximum Technologically Feasible Levels

When DOE proposes to adopt an amended standard for a type or class of covered product, it must determine the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible for such equipment. Accordingly, in the engineering analysis, 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 available on the market or in working prototypes. 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 NOPR TSD.

D. Energy Savings

1. Determination of Savings

For each TSL, DOE projected energy savings from the commercial packaged boilers that are the subject of this rulemaking purchased in the 30-year period that begins in the year of compliance with amended standards (2019–2048).[24] 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 in the absence of amended efficiency standards, and it considers market forces and policies that may affect future demand for more-efficient equipment.

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 energy savings in site energy, which is the energy directly consumed by equipment at the locations where they are used. For electricity, DOE calculates national energy savings in terms of primary energy savings, which is the savings in the energy that is used to generate and transmit the site electricity. For electricity and natural gas and oil, DOE also calculates full-fuel-cycle (FFC) energy savings. As discussed in DOE's statement of policy and notice of policy amendment, 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 efficiency standards. 76 FR 51281 (Aug. 18, 2011), as amended at 77 FR 49701 (Aug. 17, 2012).

To calculate primary energy savings, DOE derives annual conversion factors from the model used to prepare the Energy Information Administration's (EIA's) most recent *Annual Energy Outlook.* For FFC energy savings, 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, see section IV.H.2 of this document.

2. Significance of Savings

To amend standards for commercial packaged boilers, DOE must determine with clear and convincing evidence 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), opined that Congress intended ''significant'' energy savings in the context of EPCA to be savings that were not ''genuinely trivial.'' DOE has tentatively concluded the energy savings for the proposed standards (presented in section V.B.3.a 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) and (C)(i)) 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 commercial consumers of the products subject to the standard. (42 U.S.C. 6313(a)(6)(B)(I) and (C)(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.

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

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) and (C)(i)) 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 consumer discount rates. 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 a more-efficient product through lower operating costs. DOE calculates the PBP by dividing the change in purchase cost due to a more stringent standard by the change in annual operating cost for the year that standards are assumed to take effect.

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 NOPR TSD, DOE uses spreadsheet models to project national energy savings.

d. Lessening of Utility or Performance of Equipment

In determining whether a proposed 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) and (C)(i)) Based on data available to DOE, the standards proposed in this document would not reduce the utility or performance of the equipment under consideration in this rulemaking.

e. Impact of Any Lessening of Competition

EPCA directs DOE to consider the impact of any lessening of competition, as determined in writing by the Attorney General of the United States that is likely to result from a proposed standard. (42 U.S.C. 6313(a)(6)(B)(ii)(V) and (C)(i)) DOE will transmit a copy of this proposed rule to the Attorney General with a request that the Department of Justice (DOJ) provide its determination on this issue. DOE will publish and respond to the Attorney General's determination in the final 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)(VII) and (C)(i)) The proposed 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 proposed standards also are likely to result in environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases 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

EPCA allows the Secretary of Energy, in determining whether a standard is economically justified, to consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6313(a)(6)(B)(ii)(VII) and (C)(i)) 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 proposed 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 IV.F.11 of this document.

IV. Methodology and Discussion of Related Comments

DOE used three analytical tools to estimate the impact of the proposed standards. The first tool is a spreadsheet that calculates LCCs and PBPs of potential new energy conservation standards. The second tool is a spreadsheet that calculates national energy savings and net present value resulting from potential amended energy conservation standards.[25] The third spreadsheet tool, the Government

[25] The shipments model was developed as a Microsoft Excel spreadsheet, which is integrated into the spreadsheet for the NIA. The ''shipment forecast'' and ''historical shipments'' worksheets of the NIA model present the scope of the shipment analysis and the total shipments in units for the commercial packaged boilers in scope.

Regulatory Impact Model (GRIM), helped DOE to assess manufacturer impacts of potential standards. These tools are available on the DOE Web site for this rulemaking: *http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx?ruleid=79.*

Additionally, DOE estimated the impacts of energy conservation standards for commercial packaged boilers on utilities and the environment. DOE used a version of EIA's National Energy Modeling System (NEMS) for the utility and environmental analyses. The NEMS model simulates the energy sector of the U.S. economy. EIA uses NEMS to prepare its *Annual Energy Outlook (AEO),* a widely known energy forecast for the United States. The version of NEMS used for appliance standards analysis is called NEMS–BT and is based on the *AEO* version with minor modifications.[26] The NEMS–BT model offers a sophisticated picture of the effect of standards, because it accounts for the interactions between the various energy supply and demand sectors and the economy as a whole.

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. The analysis carried out under this chapter is broadly divided 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 and on data submitted by manufacturers and other interested parties. Issues addressed include CPB characteristics, market share and equipment classes; existing regulatory and non-regulatory efficiency improvement initiatives; overview of historical equipment shipments and lifetimes and trends in the equipment markets. The purpose of the technology assessment is to investigate technologies that will improve the energy efficiency of commercial packaged boilers, and 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 NOPR 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.

In this NOPR, DOE also 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 person who: (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 definitions.

Through extensive search of publicly available information, including ABMA's and AHRI's Web sites, DOE identified 45 CPB manufacturers that meet this definition. The complete list of manufacturers can be found in chapter 3 of the NOPR TSD.

DOE requests comment on the number and names of manufacturers that qualify as CPB manufacturers according to the list of manufacturers in chapter 3 of the NOPR TSD.

2. Scope of Coverage and Equipment Classes

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 its regulations, DOE clarifies the term ''packaged boiler'' to exclude a boiler that is ''custom designed and field constructed,'' and it further provides 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. 10 CFR 431.82.

DOE's regulations also define the term ''commercial packaged boiler'' as ''a type of packaged low pressure boiler that is industrial equipment with a capacity (rated maximum input) of 300,000 Btu per hour (Btu/h) or more which, to any significant extent, is distributed in commerce (1) for heating or space conditioning applications in buildings; or (2) for service water heating in buildings but does not meet the definition of 'hot water supply boiler' in [10 CFR part 431].'' A ''packaged low pressure boiler'' means, ''a packaged boiler that is (1) a steam boiler designed to operate below a steam pressure of 15 psig; or (2) a hot water boiler designed to operate at or below a water pressure of 160 psig and a temperature of 250°F or (3) a boiler that is designed to be capable of supplying either steam or hot water, and designed to operate under the conditions in paragraphs (1) and (2) of this definition.'' 10 CFR 431.82.

As noted above, the current definition of ''packaged boiler'' refers to a boiler that is shipped complete with heating equipment, mechanical draft equipment, and automatic controls. The definition does not explicitly include natural draft equipment. However, as discussed in the August 2015 withdrawal notice, DOE interprets the definitions in the statute to include natural draft commercial packaged boilers. After considering written comments on the August 2013 NOPD and comments on the preliminary analysis TSD related to the coverage of natural draft equipment, DOE concluded that natural draft commercial packaged boilers are and have been covered equipment subject to DOE's energy conservation standards. Therefore, DOE concluded it was unnecessary to publish a determination to clarify its statutory authority to cover natural draft commercial packaged boilers. Accordingly, DOE has included natural draft commercial packaged boilers under the scope of the rulemaking.

In the preliminary analysis, DOE specifically sought public comment on its tentative decision not to set an upper limit to the fuel input rate for commercial packaged boilers. This issue was first raised in the Framework document (Item 2–4 at page 12), where DOE requested feedback on whether there were any size related issues that may render energy conservation

[26] The EIA allows the use of the name ''NEMS'' to describe only an *AEO* version of the model without any modification to code or data. Because the present analysis entails some minor code modifications and runs the model under various policy scenarios that deviate from *AEO* assumptions, the name ''NEMS–BT'' refers to the model as used here. For more information on NEMS, refer to The National Energy Modeling System: An Overview, DOE/EIA–0581 (98) (Feb.1998), available at: *http://tonto.eia.doe.gov/FTPROOT/forecasting/058198.pdf.*

standards infeasible for very large commercial packaged boilers. DOE received several comments in response to the Framework document that included suggestions of input capacities at which the scope of the standards rulemaking could be capped. AHRI recommended that the scope of the rulemaking should be capped at 5,000 kBtu/h. (AHRI, No.17 at pp. 1–2) ABMA, Burnham Holdings, and Cleaver Brooks suggested that the scope should be capped at 2,500 kBtu/h, citing high testing costs and practicability concerns. (ABMA, No. 14 at pp. 2–3; Cleaver-Brooks, No. 12 at p. 1; Burnham, No. 15 at p. 2) HTP recommended three commercial packaged boiler classifications: ''small,'' with fuel input rates ≥300 kBtu/h to <2,500 kBtu/h; ''medium,'' with fuel input rates ≥2,500 kBtu/h and <5,000 kBtu/h; and ''large,'' with fuel input rates ≥5,000 kBtu/h. (HTP, No. 18 at pp. 1–2) DOE provided responses to all these comments in chapter 2 of the preliminary analysis TSD. In its response, DOE acknowledged the difficulty of testing and rating very large commercial packaged boilers. However, DOE pointed out that defining a fuel input rate upper limit above which standards will not apply could violate EPCA's anti-backsliding provision. As a result, in the preliminary analysis TSD, DOE analyzed all equipment classes for commercial packaged boilers that fit EPCA's definition and have a fuel input rate of 300 kBtu/h or more with no upper limit. DOE also requested further public comment from interested parties on its tentative decision to not set an upper limit.

Several interested parties and stakeholders commented on this issue in response to the preliminary analysis TSD. Lochinvar commented in support of DOE's decision, stating that the inclusion of commercial packaged boilers with very large fuel input rate is needed to ensure a level playing field and accurate product ratings. Lochinvar further commented that many concerns regarding the test burden are addressed by the revised Alternative Efficiency Determination Methods (AEDM) rules. (Lochinvar, No. 34 at p. 1) ABMA stated that DOE's decision not to set an upper limit on input capacity for commercial packaged boilers is causing significant concern among their member boiler manufacturers. ABMA reported that boilers can approach capacities as high as 80,000 kBtu/h with the testing cost approaching one million dollars, which imposes a prohibitively high financial burden on companies manufacturing large institutional sized space heating boilers. ABMA also argued that their member manufacturers have been offering efficiency guarantees since the late 1970s on the large space heating commercial and institutional packaged boilers and have been capable of meeting current efficiency requirements since 1970. Further, ABMA stated that there exists significant difference between smaller boilers that are built in large quantities to a standard specification and large custom engineered boilers manufactured to specifications for a particular installation. ABMA recommended that DOE cap the efficiency certification requirements for commercial packaged boilers at 2,500 kBtu/h. (ABMA, No. 33 at pp. 1–2) AHRI stated that the commercial boilers that have input rates in the high millions of Btu/h are very different products and that many factors that are considered in DOE's analysis and the associated conclusions cannot be extrapolated up to characterize very large commercial packaged boilers. (AHRI, No. 37 at p. 1) AHRI also stated that when going from 3,000 kBtu/h to tens of millions of Btu/h, a whole different price structure should be employed and there may be an upper limit at which the price structure changes completely. (AHRI, Public Meeting Transcript, No. 39 at p. 45) During the public meeting, ABMA also expressed concern on how DOE would extrapolate prices for an 80 million Btu/h boiler using a 3 million Btu/h boiler as the representative unit. (ABMA, Public Meeting Transcript, No. 39 at pp. 64–65)

DOE considered the comments received from interested parties. Comments regarding testing large commercial packaged boilers were addressed separately in the ongoing test procedure rulemaking (discussed further in section III.B of this document). DOE also acknowledges other issues with regards to the compliance burden of very large commercial packaged boilers, particularly those that are engineered-to-order. Some stakeholders suggested capping the scope of the energy conservation standards as an option to resolve this issue. However, as discussed previously, setting an upper limit to the scope of DOE's energy conservation standards for commercial packaged boilers could violate EPCA's anti-backsliding provision. Therefore, DOE has not set an upper limit for fuel input rate above which the standards will not be applicable. However, as discussed in further detail below, DOE proposes a separate equipment class for ''very large'' commercial packaged boilers with input capacities greater than 10 million Btu/h.

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 levels for each.[27] 10 CFR 431.87. These equipment classes are based on (1) size (fuel input rate), (2) heating media (hot water or steam), and (3) type of fuel used (oil or gas).[28] The gas-fired steam commercial packaged boilers are further classified according to draft type (thereby creating two additional equipment classes). Table IV.1 shows equipment classes that are set forth in the current regulations at 10 CFR 431.87.

TABLE IV.1—CPB EQUIPMENT CLASSES SET FORTH IN THE CURRENT REGULATIONS AT 10 CFR 431.87

Equipment type	Subcategory	Size category (input)	Equipment class	Energy efficiency metric
Hot Water Commercial Packaged Boilers.	Gas-fired	≥300,000 Btu/h and ≤2,500,000 Btu/h.	Small Gas Hot Water	Thermal Efficiency.

[27] These standard levels were adopted in the July 2009 final rule.

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

TABLE IV.1—CPB EQUIPMENT CLASSES SET FORTH IN THE CURRENT REGULATIONS AT 10 CFR 431.87—Continued

Equipment type	Subcategory	Size category (input)	Equipment class	Energy efficiency metric
Hot Water Commercial Packaged Boilers.	Gas-fired	>2,500,000 Btu/h	Large Gas Hot Water	Combustion Efficiency.
Hot Water Commercial Packaged Boilers.	Oil-fired	≥300,000 Btu/h and ≤2,500,000 Btu/h.	Small Oil Hot Water	Thermal Efficiency.
Hot Water Commercial Packaged Boilers.	Oil-fired	>2,500,000 Btu/h	Large Oil Hot Water	Combustion Efficiency.
Steam Commercial Packaged Boilers.	Gas-fired—all except natural draft.	≥300,000 Btu/h and ≤2,500,000 Btu/h.	Small Gas Mechanical Draft Steam.	Thermal Efficiency.
Steam Commercial Packaged Boilers.	Gas-fired—all except natural draft.	>2,500,000 Btu/h	Large Gas Mechanical Draft Steam.	Thermal Efficiency.
Steam Commercial Packaged Boilers.	Gas-fired—natural draft	≥300,000 Btu/h and ≤2,500,000 Btu/h.	Small Gas Natural Draft Steam.	Thermal Efficiency.
Steam Commercial Packaged Boilers.	Gas-fired—natural draft	>2,500,000 Btu/h	Large Gas Natural Draft Steam.	Thermal Efficiency.
Steam Commercial Packaged Boilers.	Oil-fired	≥300,000 Btu/h and ≤2,500,000 Btu/h.	Small Oil Steam	Thermal Efficiency.
Steam Commercial Packaged Boilers.	Oil-fired	>2,500,000 Btu/h	Large Oil Steam	Thermal Efficiency.

In the preliminary analysis, DOE divided commercial packaged boilers into 16 equipment classes, based on size, fuel, heating medium, and type of draft. DOE sought public comment on its tentative decision to classify commercial packaged boilers into 16 equipment classes.

In response to the request, ACEEE, ASAP, and NRDC recommended that DOE adopt a single equipment class for natural draft and mechanical draft commercial packaged boilers, citing that natural draft commercial packaged boilers are inherently less efficient and that this will ensure maximum energy efficiency improvement. The commenters also stated that they are unaware of any distinct utility that is offered by natural draft commercial packaged boilers that is different from mechanical draft commercial packaged boilers. (ACEEE, ASAP, and NRDC, No. 36 at p. 2) PG&E and SCE noted that natural draft commercial packaged boilers have much lower part-load efficiency and are rapidly becoming obsolete due to changes in consumer buying behavior. The commenters argued against the separation of the equipment classes, specifically hot water commercial packaged boilers and stated that both mechanical draft and natural draft systems have the same utility and, therefore, should be considered in the same equipment class. (PG&E and SCE, No. 38 at p. 3) Raypak recommended DOE to revert back to the 10 equipment classes that are set forth in the current energy conservation standards at 10 CFR 431.87. (Raypak, No. 35 at p. 2) Raypak noted that non-condensing boilers are still a significant part of the market and offer several advantages such as simple operation and maintenance, higher design water temperature, lower costs, and higher lifetimes, and encouraged DOE to maintain the natural draft boiler equipment classes. Raypak further encouraged DOE not to amend energy conservation standards to a level that would not support natural draft commercial packaged boilers. (Raypak, No. 35 at pp. 6–7) Lochinvar encouraged DOE to maintain the 10 equipment classes that are set forth in the current energy conservation standards at 10 CFR 431.87 and stated that the division of the classes will lead to different minimum ratings for natural draft and mechanical draft boilers and competitive inequality. Lochinvar also cited commercial water heaters as an example, stating that commercial water heaters are available with mechanical and natural draft systems, but the energy conservation standards are applicable to all types of equipment irrespective of the draft type (Lochinvar, No. 34 at p. 1) AHRI argued that natural draft commercial packaged boilers are covered equipment subject to DOE's efficiency standards, but this does not extend to creating separate equipment classes for such products in the efficiency standards. AHRI further stated that the current 10 equipment classes set forth in 10 CFR 431.87 are appropriate. (AHRI, No. 37 at p. 2) AHRI also commented during the preliminary analysis public meeting that the 16 equipment classes used in the preliminary analysis were a good starting point, but that the classes can be squeezed together. (AHRI, Public Meeting Transcript, No. 39 at p. 26) ASAP questioned DOE's rationale for adopting separate equipment classes for mechanical and natural draft commercial packaged boilers. (ASAP, Public Meeting Transcript, No. 39 at p. 39)

DOE agrees with comments stating that both natural draft and mechanical draft commercial packaged boilers provide the same utility. Based on DOE's understanding, there appears to be no distinct performance related utility that is provided by natural draft commercial packaged boilers that justifies a separate equipment class for such equipment. Consequently, there appears to be no justification to maintain separate equipment classes for natural draft commercial packaged boilers. Therefore, in this document, DOE proposes to consolidate CPB equipment classes that are currently divided by draft type.[29] Specifically, DOE proposes 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.

In addition, based on the concerns expressed by interested parties regarding the complexities of regulating very large commercial packaged boilers discussed earlier in this section, DOE has tentatively decided to propose

[29] Because DOE has not proposed amended standards for commercial packaged boilers with input ratings 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.

separate equipment classes for commercial packaged boilers with fuel input rates above 10,000 kBtu/h. In order to determine the fuel input rate at which to separate the proposed large CPB equipment classes (*i.e.,* equipment classes with a fuel input rate >2,500 kBtu/h) and the proposed new equipment class for ''very large'' commercial packaged boilers, DOE performed a calculation to estimate the energy savings potential for very large CPB equipment classes at various minimum fuel input rate thresholds. DOE estimated the potential for energy savings for commercial packaged boilers with fuel input rates above 10,000 kBtu/h to be between 0.014 and 0.025 quads based on the range of TSLs considered in the NOPR, by assigning the same efficiency level to the very large equipment classes as was considered for the corresponding large equipment classes. Further, DOE examined the price data collected for the engineering analysis and noticed a smooth linear trend in prices as they vary with fuel input rate, from 300 kBtu/h up to approximately 9,500 kBtu/h. The smooth trend created by the data appears to indicate that commercial packaged boilers below 10,000 kBtu/h do not have a separate price structure; this linear price trend is discussed further in the engineering analysis, section IV.C of this document. Despite extensive efforts, DOE was unable to obtain pricing data for commercial packaged boilers with fuel input rate above 10,000 kBtu/h. Based on these assessments, including the lack of available data, DOE is proposing to classify commercial packaged boiler with fuel input rate above 10,000 kBtu/h as very large equipment classes. As commercial packaged boilers with fuel input rate above 10,000 kBtu/h are currently covered equipment, the existing standards at 10 CFR 431.87 are still applicable. DOE proposes to maintain the existing standards for commercial packaged boilers with fuel input rate above 10,000 kBtu/h (referred to as very large commercial package boilers in this notice) because there is not sufficient data to provide clear and convincing evidence that more stringent standards would be technologically feasible and economically justified, and would result in significant additional energy savings.

DOE requests data on manufacturer selling prices, shipments and conversion costs of very large commercial packaged boilers with fuel input rate above 10,000 kBtu/h that can be used to supplement the analyses of such equipment in this rulemaking.

See section VII.E for a list of issues on which DOE seeks comment.

DOE also believes that creating separate equipment classes for very large commercial packaged boilers would reduce the overall compliance burden of manufacturers.

In summary, DOE proposes the following changes to the equipment classes: (1) Separating the equipment classes for commercial packaged boilers that have a fuel input rate 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 draft specific. Thus, in total, DOE proposes 12 equipment classes [30] for this NOPR. These classes are categorized based on three performance parameters: (1) Size; (2) heating medium; and (3) fuel type. Table IV.2 shows all of the proposed CPB equipment classes, including the eight equipment classes for which DOE proposes amended standards and four equipment classes for which DOE did not propose to amend standards. In subsequent sections of this document, DOE uses the designated name of equipment classes given in the first column of Table IV.2 to explain various aspects of the rulemaking analyses.

TABLE IV.2—PROPOSED EQUIPMENT CLASSES FOR COMMERCIAL PACKAGED BOILERS

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

* The existing small, gas-fired, steam, natural draft equipment classes and small, gas-fired steam, all except natural draft equipment classes are proposed to be consolidated into a single small gas-fired, steam equipment class. Similarly, the existing large, gas-fired, steam, natural draft equipment classes and large, gas-fired steam, all except natural draft equipment classes are proposed to be consolidated into a single large, gas-fired, steam equipment class.

** DOE proposes to establish separate equipment classes for CPB with fuel input rate above 10,000kBtu/h.

In addition to the two issues discussed previously in this section, DOE received several comments in response to the preliminary analysis related to standby mode and off mode energy consumption. In chapter 2 of the preliminary analysis TSD, DOE reported that standby mode and off mode energy consumption is a negligible proportion of the total energy consumption of the commercial packaged boiler (about 0.02 percent of total energy used). Consequently, DOE decided in the preliminary analysis not to analyze standards for commercial packaged boilers to regulate their standby mode and off mode energy consumption. AHRI, Raypak, and Lochinvar supported DOE's preliminary findings on the standby mode and off mode energy consumption and discouraged DOE from pursuing the development of standards for these modes of operation. (AHRI, No. 37 at p. 2; Raypak, No. 35 at p. 2; Lochinvar, No. 34 at p. 2) Lochinvar stated that the data on standby mode and off mode is very

[30] 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 a total of 12 equipment classes.

limited because its measurement is not required and based on measurements conducted on their commercial hot water boilers, the standby mode power consumption was found to be 0.007 percent of the total power consumed by the boiler. (Lochinvar, No. 34 at p. 2) ABMA urged DOE not to consider standby and off cycles or the energy consumed in different operational modes, stating that there are multiple variables related to system design, set-up, and operation for a one-size fits all rule. (ABMA, No. 33 at p. 2) No interested parties commented in support of standby mode and off mode standards, and DOE did not receive any new standby loss or off mode energy consumption data that would cause DOE to reverse its previous tentative conclusion. Therefore, DOE has not conducted any further analysis of potential standby mode and off mode energy conservation standards for commercial packaged boilers.

3. 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 believes are technologically feasible.

As a starting point, DOE typically uses information relating to existing and past technology options 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 technologically feasible design options for the considered equipment through consultation with manufacturers, including manufacturers of components and systems, and from trade publications and technical papers.

In the preliminary analysis, DOE presented a list of technologies for improving the efficiency of commercial packaged boilers. Based on comments received in response to the preliminary analysis (discussed in detail in section IV.B of this document), DOE retained all the technology options that were identified in the preliminary analysis. However, for ''pulse combustion burners,'' DOE is now considering the technology as a path to achieve condensing operation and categorizing it as a condensing boiler design. Additionally, in research for the NOPR, DOE identified a new technology option: oxygen trim system. The technology options that DOE identified for this NOPR analysis are listed in Table IV.3:

TABLE IV.3—TECHNOLOGY OPTIONS THAT IMPROVE COMBUSTION EFFICIENCY OR THERMAL EFFICIENCY THAT ARE CONSIDERED IN THE MARKET AND TECHNOLOGY ASSESSMENT

Jacket Insulation.
Heat Exchanger Improvements (Including Condensing Heat Exchanger).
Burner Derating.
Improved Burner Technology.
Combustion Air Preheaters.
Economizers.
Blowdown Waste Heat Recovery.
Oxygen Trim Systems.
Integrated, High-Efficiency Steam Boilers.

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 products 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 products 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 product utility or equipment availability:* If DOE determines a technology would have a significant adverse impact on the utility of the product to significant subgroups of consumers, or would result in the unavailability of any covered product type with performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as products generally available in the United States at the time, 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))

Additionally, DOE notes that these screening criteria do not directly address the propriety 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).

In the preliminary analysis TSD, DOE applied the screening criteria to the technology options that were considered in the market and technology assessment and sought comments and feedback on the technology options that passed the screening analysis.

DOE received several general comments on the options that passed the screening analysis in the preliminary analysis TSD chapter. Lochinvar agreed with technology options that passed the screening test, noting that the options identified are technologically feasible. (Lochinvar, No. 34 at p. 2) AHRI and Raypak agreed with the technology options that successfully passed the screening analysis, with the exception of pulse combustion (as discussed in further detail later in this section). (AHRI, No. 37 at p. 3; Raypak No. 35 at p. 2)

ACEEE commented that the deficiencies in the current test procedure have led to the exclusion of modulating gas burners as an efficiency improving technology. (ACEEE, Public Meeting Transcript, No. 39 at p. 29)

Regarding modulating boilers, DOE notes that in the equipment database it found several CPB models at baseline and near baseline efficiency levels that utilize a modulating burner. As noted by ACEEE, the test procedure currently does not provide an efficiency advantage for modulating burners. DOE notes that the February 2016 test procedure NOPR also does not provide an efficiency benefit for the inclusion of a modulating burner for reasons explained further in that notice. As a result, DOE did not consider modulating burners as a technology option for improving the efficiency of commercial packaged boilers for this NOPR.

The technology options that were identified in the market and technology assessment are presented immediately below, along with whether or not the technology was ultimately considered further in the analysis.

Jacket Insulation

Optimizing jacket insulation thickness reduces the heat loss from commercial packaged boiler to the outside air. However, most manufacturers already use this technology option and the potential benefits of using this option are a minimal increase in thermal efficiency. Consequently, DOE did not consider this technology option further.

Heat Exchanger Improvements (Including Condensing Heat Exchanger)

DOE considered several heat exchanger improvement options that can increase thermal and combustion efficiencies of commercial packaged boilers. These options include incorporation of baffles and turbulators; improved fin designs such as micro-fins and louvered fins; improved tube designs such as corrugated tubes and internally rifled tubes; and addition of a condensing heat exchanger. In response to these technology options, Lochinvar commented that options such as increased heat exchanger surface area, baffles and creative pin/fin arrangements are all viable options for natural draft boilers and have been implemented by manufacturers for decades. Lochinvar also stated that DOE needs to consider that design changes are complex and often involve significant redesign to achieve efficiency targets without sacrificing safety and reliability. (Lochinvar, No. 34 at p. 2) Raypak commented that consideration of any additional restrictions of the heat exchanger must be balanced with the need to ensure safe operation and venting. (Raypak No. 35 at p. 2) AHRI commented that DOE must avoid considering heat exchanger designs that are so restrictive that they adversely affect safe operation and venting of the boiler. (AHRI, No. 37 at p. 3)

DOE reviewed the comments and examined whether the extent of heat exchanger improvements considered are restrictive such that any of these options would potentially adversely impact safe operation and venting of the commercial packaged boiler. In considering improved heat exchanger designs, DOE focused on technology options that are currently being used by commercial packaged boilers available on the market, as a vast array of heat exchanger designs and efficiencies was observed. DOE examined product literature and operation manuals and is not aware of potential safety concerns for commercial packaged boilers with heat exchanger designs that achieve the efficiency levels analyzed in this NOPR. Where upgraded venting is required for potential condensate formation in the vent piping, DOE considered such cost in its analysis of installation costs (see section IV.F.2 of this document). Consequently, the technology option of heat exchanger improvements passed the screening analysis and is considered as a design option to improve CPB thermal or combustion efficiency.

Burner Derating

Burner derating increases the ratio of the heat transfer area to fuel input by reducing the burner input rating while maintaining the same heat exchanger, which can increase the thermal efficiency of commercial packaged boilers. In the preliminary analysis public meeting, AHRI commented that burner derating has already been used by the industry to achieve the current efficiency standards, so there is not much more potential for this option to further improve efficiency. (AHRI, Public Meeting Transcript, No. 39 at pp. 25–26)

As in the preliminary analysis, DOE proposes to screen out burner derating as it reduces the usable heat output, and would reduce utility. Therefore, DOE did not consider this technology option further in the analysis.

Improved Burner Technology

Burner technologies that were considered under this technology option include pulse combustion, premix burners and low pressure, air atomized oil burners. In the preliminary analysis TSD, all three burner technology options passed the screening analysis and were considered as options to improve thermal and combustion efficiency. In response to the inclusion of the three burner technologies, AHRI and Raypak commented that they do not consider pulse combustion as a technology option. Raypak stated that it views pulse combustion more as a fundamental aspect of the boiler design comparable to whether the boiler is water tube or fire tube. (Raypak No. 35 at p. 2) AHRI also stated pulse combustion is one way to create a boiler that condenses. (AHRI, No. 37 at p. 3)

After considering the comments discussed above, DOE has re-classified pulse combustion as a type of condensing boiler technology, rather than a design option that would be applied to a less efficient boiler to make it more efficient. In the screening analysis of the NOPR TSD, DOE included pulse combustion under heat exchanger improvement technology options and premix burners and low pressure air atomized oil burners under improved burner technology options. All three technology options passed the screening analysis.

Combustion Air Preheaters

Combustion air pre heaters use a gas to gas heat exchanger to transfer heat from the flue gases to the incoming combustion air. Although this option can increase the operating efficiency of a commercial packaged boiler in the field, this efficiency is not measured by the current test procedure, because the current test procedure requires inlet air to be within ± 5°F of the room ambient temperature. Therefore, DOE did not consider this technology option further in its analysis.

Economizers

Economizers are gas to water heat exchangers that are used to transfer residual heat in the flue gases to the inlet water to the commercial packaged boiler. Unlike a condensing commercial packaged boiler that operates on the same principle, economizers are used as an add-on to the existing commercial packaged boilers and improve efficiency by pre heating the incoming water before it enters the primary heat exchanger. Although this technology option has the potential to improve efficiency by reducing the fuel input required to heat the water, the improvement in efficiency is not measured by the current test procedure, because the current test procedure requires the inlet water to have a set temperature before it enters the primary heat exchanger of the commercial packaged boiler. Therefore, DOE did not consider economizers as a technology option for improving commercial packaged boiler efficiency ratings.

Blowdown Waste Heat Recovery

Some large commercial steam boilers require a blowdown operation to remove dissolved solids and salts that are left behind after the boiling process. These solids are usually dissolved in water that is hot and can be utilized to pre heat incoming water before it enters the primary heat exchanger of the commercial packaged boiler. Although this option can improve operating efficiency, measurement of the improvement in efficiency can only occur is there is sufficient deposit left behind in the boiler after continuous boiler operation. The current DOE test procedure is a laboratory based test that uses a commercial packaged boiler that is not previously installed or commissioned. During the test, the commercial packaged boiler will not be able to extract the waste heat from a blowdown operation. Therefore, DOE did not consider blowdown waste heat recovery further in the analysis.

Oxygen Trim Systems

DOE added this technology option in the market and technology assessment chapter at the NOPR stage of the rulemaking. An oxygen ''trim'' system is a control strategy that can be used to minimize excess combustion air and optimize the air-to-fuel ratio. These systems can increase efficiencies by 1 to 2 percentage points. This option passed the screening analysis.

For this NOPR the following technology options were found to have an impact on the rated efficiency metric and passed the screening analysis to be considered further in the downstream analyses: (1) Heat exchanger improvements (including condensing heat exchanger), (2) improvement in burner technology, and (3) oxygen trim systems.

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. In the market assessment DOE compiled a set of data containing the rated performance information and various characteristics of all CPB equipment available on the market. In the engineering analysis DOE refers to this as the ''equipment database''. The equipment database contains all commercial packaged boilers that are listed in AHRI's Directory of Certified Product Performance [31] and commercial packaged boilers that are manufactured by members of ABMA. 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 fuel input rate (representative fuel input rate) 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 NOPR TSD), DOE determines customer 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 NOPR TSD).

In the preliminary analysis, as noted previously, DOE classified commercial packaged boilers into sixteen equipment classes and analyzed each class separately. DOE received CPB price information for several mechanical draft equipment classes that was sufficient to develop a price-efficiency trend. However, DOE was unable to collect sufficient pricing data to develop a price-efficiency trend for the condensing efficiency levels, and the large mechanical draft steam and all natural draft equipment classes, and instead relied on alternate methodologies.

In the preliminary analysis for the classes that had sufficient price data, DOE calculated the incremental increase in price at each efficiency level analyzed for each manufacturer at the representative fuel input rate, and then took an average of these price at each efficiency level to get the final price efficiency curve for all equipment classes. For the other equipment classes that did not have adequate pricing information, DOE used alternate methods of calculating incremental prices. These methods include extrapolation of price efficiency curves or actual pricing data to other equipment classes. DOE requested comments and feedback from interested parties on various aspects of the engineering analysis performed for the preliminary analysis, and specifically on the methodology and results. In response, DOE received several comments, which are discussed further in the following applicable sections.

For the NOPR, as discussed in section IV.C.2 of this document, DOE was able to obtain more pricing information than it had for the preliminary analysis. As a result, DOE updated its approach for several equipment classes to include a direct analysis of that class using only pricing data obtained for that class. DOE also improved its methodology to account for the difference in equipment price as a function of capacity.

In the NOPR analysis, for each price obtained, DOE first calculated the ratio of the price of the commercial packaged boiler with respect to its fuel input rate to obtain all prices on a per unit fuel input rate basis (dollars per kBtu/h). DOE then used its equipment database to determine and apply appropriate weights to individual prices (on a per fuel input rate basis) based on the distribution of input capacities on the market. The weight given to each CPB price per fuel input rate represents the number of commercial packaged boilers of that fuel input rate available in the market. Thus, price per fuel input rate of models that are similar in capacity to higher numbers of models on the market were weighted more heavily than price per fuel input rate of models at a fuel input rate for which relatively few models are available. DOE applied these weights to calculate the weighted average price per fuel input rate and the weighted average fuel input rate for each efficiency level analyzed.

Next, DOE scaled the weighted average price (on a per fuel input rate basis) at each efficiency level from the weighted average fuel input rate (at

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

[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.

which the price was calculated in the previous step) to the representative fuel input rate for a given equipment class. To do this, DOE plotted the price per input as a function of fuel input rate and applied a non-linear regression model that best represented the trend. In these plots, it is apparent that for lower input capacities the price on a per input basis is higher, and as the fuel input rate increases, the price per input decreases. In addition, the rate of change of the price on a per-unit input basis with respect to fuel input rate also decreases considerably as the fuel input rate increases. The result is a scatter plot that appears to resemble a decreasing exponential curve. DOE applied the regression equation to determine the weighted average price per input at the representative fuel input rate.

DOE performed a regression analysis on the weighted average price per input results at the representative fuel input rate and the efficiency levels 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 fuel input rate for all efficiency levels that were analyzed in each equipment class. DOE then multiplied the predicted weighted average price per input at the representative fuel input rate by the representative fuel input rate 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. Further details on the methodology and results are provided in the chapter 5 of the NOPR TSD.

DOE requests feedback on the methodology used to analyze all equipment classes and the results obtained. In particular DOE is interested in comments on whether the results are appropriate and representative of the current market prices for such type of equipment.

See section VII.E for a list of issues on which DOE seeks comment.

a. Overall Methodology and Extrapolation of Prices

DOE received several comments from interested parties in response to DOE's preliminary analyses on the overall methodology that was used to develop the price-efficiency relationships.

ACEEE, ASAP, and NRDC noted that in other rulemakings, DOE typically constructs cost estimates by conducting teardowns and generating a Bill of Materials (BOMs); however, for the current rulemaking, DOE has not conducted any teardowns for commercial packaged boilers. The commenters stated that in contractor-installed systems such as commercial packaged boilers, prices are highly variable and may be based on factors other than efficiency (*e.g.* labor costs). (ACEEE, ASAP, and NRDC, No. 36 at p. 2) ASAP asked if DOE looked at the incremental costs, as opposed to incremental prices and that in looking at the incremental prices, the actual costs to improve efficiency are overestimated. (ASAP, Public Meeting Transcript No. 39 at p. 60)

As discussed previously, DOE has decided to use the efficiency-level approach to conduct the engineering analysis. In this approach DOE collects prices at various efficiency levels and estimates the incremental price for higher efficiency models as an average or weighted average of the commercial packaged boilers available on the market. Although DOE commonly uses a reverse-engineering approach, DOE decided not to use this approach for commercial packaged boilers due to practical concerns involved in tearing down commercial packaged boilers, especially those belonging to large equipment classes. Commercial packaged boilers exhibit a large variety of designs depending on a number of factors including, size, efficiency, fuel used, heating medium, draft type, heat exchanger design/material, and whether it is fire-tube or water-tube. In the analysis for this rulemaking, DOE collected pricing information for 584 commercial packaged boilers, which covered a range of different types of CPB equipment. Tearing down enough units to perform a reverse-engineering analysis would be extremely time intensive given the large number of CPB designs at each efficiency level and within each equipment class, and the physical size of some commercial packaged boilers. In addition, there are several practical issues involved with tearing down large commercial packaged boilers, given the size and weight of this equipment, which can require upgraded infrastructure for handling the equipment. In view of these issues, DOE felt that a pricing survey to collect information on actual CPB prices at various efficiency levels for each equipment class is a more practical methodology for conducting the engineering analysis for commercial packaged boilers.

ACEEE, ASAP, and NRDC also encouraged DOE to ensure that the estimates of incremental prices only include the incremental price associated with the technology options required to meet a given efficiency level, and not the cost of auxiliary options that are often associated with premium products but are not associated with efficiency. (ACEEE, ASAP, and NRDC, No. 36 at pp. 3–4)

DOE shares the commenters' concerns regarding the incremental price options being influence by auxiliary options that are not associated with energy efficiency. To the extent possible, DOE normalized optional features when gathering pricing by specifying the same options for all CPB prices collected. For example, DOE noticed that in several CPB series, prices of burner systems are listed separately and the price of the burner system that is selected is added to the basic model trade price for the total price for the commercial packaged boiler. For such cases, DOE chose the same type of burner 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. DOE believes this approach helped to minimize the effects of optional auxiliary components.

At the preliminary analysis public meeting ACEEE argued that the level field for comparing purchase options would be output capacity, and as a result it is time to migrate to output capacities, rather than input capacities, that are comparable across classes. (ACEEE, Public Meeting Transcript No. 39 at p. 44) DOE notes that in EPCA, commercial packaged boilers are defined as having ''capacity (rated maximum input)'' greater than or equal to 300 kBtu/h, and CPB equipment classes are currently divided based on fuel input rate. DOE notes that in adopting the existing equipment class divisions based on fuel input rate, DOE followed the approach in ASHRAE Standard 90.1 for dividing equipment based on fuel input rate. Moreover, while DOE agrees many purchasers would consider output capacity when purchasing a replacement commercial packaged boiler, DOE believes there is also a contingent of CPB purchasers that may only look at the fuel input rate for comparison purposes when choosing a new commercial packaged boiler, as both ratings are featured prominently in product literature. Therefore, DOE believes it appropriate to continue to use rated fuel input rate as the performance parameter for carrying out the analyses.

b. Large CPB Analysis and Representative Fuel Input Rate

Another topic on which DOE received comments and feedback is related to large CPB pricing and its representative fuel input rate for analysis. AHRI commented that most of the analysis appears to be based on information for models with input rates of 5,000,000 Btu/h or less, and commercial packaged boilers that have input rates in the high millions of Btu per hour are very different products. AHRI stated that many factors that have been considered in the engineering analysis and the associated conclusions cannot be simply extrapolated up to characterize the particular factor as it applies to those very large commercial packaged boiler. (AHRI, No. 37 at p. 1) AHRI also commented that DOE should not assume a linear relationship between boiler size and component costs and encouraged DOE to review the data it has collected so far on the relationship and extrapolation between input rate and price, or obtain additional data for the analysis. (AHRI, No. 37 at p. 3 and p. 5) Raypak stated that DOE should not assume a linear relationship between commercial packaged boiler size and component costs and that as a commercial packaged boiler gets larger in input the cost of gas burner and blower components rises exponentially. (Raypak, No. 35 at pp. 2–4) Raypak also provided comments during the preliminary analysis public meeting stating that made-to-order units will be priced higher due to the engineering work necessary to create a custom boiler. (Raypak, Public Meeting Transcript, No. 39 at p. 49)

ABMA provided written comments on the methodology used for analyzing large commercial packaged boilers. In particular, ABMA expressed concern over the large commercial packaged boilers representative fuel input rate being 3,000 kBtu/h. ABMA argued that the representative fuel input rate of 3,000 kBtu/h is one of the smallest size boilers manufactured by ABMA member manufacturers and that it does not accurately represent the large boiler market. (ABMA, No. 33 at p. 2) ABMA advocated capping the scope of the analysis to 2.5 million Btu/h. (ABMA, No. 33 at p. 2; ABMA, Public Meeting Transcript, No. 39 at p. 65)

PGE & SCE commented that the comparison of small and large sized custom made boilers is not linear and DOE should look at methods for estimating very large equipment other than simply extrapolation. Further, PGE and SCE stated their concern that the methods used to estimate energy use, equipment classes and prices for medium sized commercial boilers are not appropriate for extrapolation to large commercial custom engineered boilers. (PGE & SCE, No. 38 at p. 3)

As discussed in section IV.A.2, DOE has proposed to establish separate equipment classes for very large commercial packaged boilers with input capacities of greater than10,000 kBtu/h, and DOE is not considering amended standards for the proposed very large equipment classes in this rulemaking. Instead, DOE's current energy conservation standards that are set forth at 10 CFR 431.87 for commercial packaged boilers with a fuel input rate greater than 2,500 kBtu/h would continue to apply to all commercial packaged boilers that have a fuel input rate above 10,000 kBtu/h. DOE believes this addresses many concerns that the analysis does not apply to very large commercial packaged boilers. As discussed previously, DOE noticed a smooth increase in prices (devoid of any inflection) from the low fuel input rate commercial packaged boilers (*i.e.,* near 300 kBtu/h) to the maximum fuel input rate commercial packaged boiler for which prices are available (~9,500 kBtu/h). DOE did not observe any sudden change in the price structure within this range of fuel input rate and, based on this observation, believes its analysis would be applicable for input capacities ranging from 300 kBtu/h to 10,000 kBtu/h.

DOE chose the representative fuel input rate in the preliminary analysis as 3,000 kBtu/h by considering CPB models offered in the market and information received during manufacturer interviews. Several commenters suggested that a fuel input rate of 3,000 kBtu/h would not be appropriate for representing very large commercial packaged boilers. However, as discussed above, for this NOPR DOE proposes to consider commercial packaged boilers with fuel input rate above 10,000 kBtu/h separately from the commercial packaged boilers in the large (*i.e.,* > 2,500 and ≤ 10,000 kBtu/h) equipment class (which would be represented by the 3,000 kBtu/h fuel input rate). Further, the analysis of prices included data points for prices of commercial packaged boilers with input capacities up to 9,500 kBtu/h, and DOE did not observe any step change in the price-efficiency trend up to that point. DOE did not receive any new data that would justify choosing a different representative fuel input rate for large equipment classes, and therefore has maintained the 3,000 kBtu/h representative fuel input rate for this NOPR analysis.

In the preliminary analysis, DOE used the price of two small commercial packaged boilers at 1,500 kBtu/h as a proxy for the price of one large 3,000 kBtu/h commercial packaged boiler, because DOE did not have sufficient price data in certain large CPB equipment classes to accurately establish the relationship between boiler size and price. In response to the preliminary analysis, DOE received comments from ACEEE, ASAP, and NRDC, questioning the accuracy of this approach. ACEEE, ASAP, and NRDC encouraged DOE to collect additional data to validate its assumption that the price of two 1,500 kBtu/h boilers is an accurate proxy for the price of a 3,000 kBtu/h boiler. The commenters elaborated that a large boiler will have only one burner, one heat exchanger, one shell, and one set of controls, possibly reducing prices for large boilers in comparison to two smaller boilers; however, there are far fewer 3,000 kBtu/h boilers sold than 1,500 kBtu/h boilers, so the allocation of design, testing, certification and other common costs will be much higher. (ACEEE, ASAP, and NRDC, No. 36 at pp. 2–3) The commenters also argued that DOE's methodology related to slope and inflection points of the efficiency curves for small gas-fired mechanical draft hot water boilers raises questions about the overall accuracy of the analysis. (ACEEE, ASAP, and NRDC, No. 36 at p. 3)

For the NOPR analysis, as discussed in section IV.C.2, DOE was able to collect an additional 258 CPB prices. Despite the additional data, there were still certain efficiency levels for large CPB equipment classes where DOE lacked enough data to perform a robust analysis. Generally these were levels where there are few models available on the market to begin with. In these cases, DOE again leveraged the pricing collected for the small CPB equipment classes to estimate the price of a large commercial packaged boiler. However, in the NOPR analysis, to address the concerns expressed by stakeholders, DOE used a modified approach to calculate the price of a large commercial packaged boiler based on two or more smaller sized boilers. In this approach, DOE first combined the price data of each small and large equipment classes that have the same characteristics (*e.g.,* small oil fired hot water and large oil fired hot water classes). DOE then performed a regression analysis of the entire dataset to find an equation that represents the relationship between equipment price and fuel input rate 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. DOE used this modified approach for three equipment classes: (1) Large, oil-fired, hot water; (2) large, oil-fired, steam and (3) large, gas-fired, steam. The detailed methodology for the engineering analysis including the plots that show the variation of CPB price with fuel input rate are included in chapter 5 of the NOPR TSD. The new methodology adopted by DOE addresses the concerns expressed by stakeholders in their comments as it considers pricing data across a range of input capacities to estimate the change in price as input increases.

2. Data Collection and Categorization

As part of the engineering analysis, DOE collected CPB prices from manufacturers, wholesalers, distributors and contractors. In the preliminary analysis, DOE collected pricing data, but as discussed previously was able to conduct a direct analysis of only six equipment classes: (1) Small, gas-fired, mechanical draft hot water; (2) large, gas-fired, mechanical draft hot water; (3) small, oil-fired, mechanical draft, hot water; (4) large, oil-fired, mechanical draft, hot water; (5) small, gas-fired, mechanical draft, steam; and (6) small, oil-fired, mechanical draft, steam. For the remaining classes, DOE did not have enough data to analyze the equipment directly, and consequently relied upon extrapolation of results from the equipment classes with adequate pricing information. In response to the preliminary analysis, DOE received several comments urging DOE to collect additional data for the NOPR stage.

ACEEE, ASAP, and NRDC commented that the limited amount of price data available for classes other than small, gas-fired, mechanical draft boilers forces DOE to rely on very uncertain extrapolations. The commenters encouraged DOE to collect additional price data to supplement its analysis, as they are concerned that the price-efficiency curves in the preliminary TSD were developed using a limited data set that may yield inaccurate results. Further the commenters also expressed concern that the analysis does not contain any information about the number of individuals surveyed, number of useful results, etc. (ACEEE, ASAP, and NRDC, No. 36 at p. 2) ACEEE, ASAP, and NRDC encouraged DOE to collect additional price data through interviews with and surveys of those who write specifications (consulting engineers and others) and those who bid on projects (mechanical contractors). The commenters also suggested DOE could obtain data on CPB purchases by the Federal government. Finally, ACEEE, ASAP, and NRDC stated that DOE should ensure that the data reflects the prices that consumers are actually paying as opposed to the ''list'' price that are widely discounted in actual bids (ACEEE, ASAP, and NRDC, No. 36 at p. 3) AHRI and Raypak encouraged DOE to contact additional contractors and others involved in selling and installing commercial packaged boilers to obtain more prices for natural draft models. (AHRI, No. 37 at p. 3; Raypak, No. 35 at p. 2) PGE and SCE recommended that DOE pursue other options for obtaining sales and price figures for commercial boilers that will generate more accurate results, and suggested the use of use market surveys or working with industry to gain insight into costs for larger boiler equipment. PGE and SCE also recommended that DOE explore California's Database of Energy Efficiency Resources for incremental costs of commercial boilers. (PGE & SCE, No. 38 at p. 3) ACEEE commented during the public meeting that the Building Services Research and Information Association (BSRIA) is a resource that has done cost comparisons, including condensing boilers, and various commercial sizes. ACEEE also suggested reviewing the comments from the transcripts of negotiated rulemaking of 2013 on certification, compliance, and enforcement (CCE) where many CPB manufacturers were represented. (ACEEE, Public Meeting Transcript No. 39 at p. 54)

DOE explored the suggestions provided by stakeholders, and found that the most reliable and complete price information was obtained directly from manufacturers, contractors, and distributors. DOE was able to collect a significant number of additional CPB prices in the NOPR stage, which were used to conduct a direct analysis of each equipment class. This eliminated the need to extrapolate price results between two different equipment classes, addressing the concerns of ACEEE, ASAP, and NRDC.

DOE agrees with ACEEE, ASAP, and NRDC that the list price is different from the actual manufacturer selling price and that this should be accounted for in the analysis. DOE accounted for this in both the preliminary analysis and in this NOPR analysis. A distributor or wholesaler is usually the first consumer in the distribution chain and typically receives a discount compared to the list price when purchasing equipment from the manufacturer. This discount varies by manufacturer 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 given from the list pricing, and applied the average 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 the NOPR analysis, DOE used prices collected in the preliminary analysis stage with additional CPB prices that were collected in the NOPR stage.[33] In total, DOE was able to obtain prices for a variety of commercial packaged boilers. These commercial packaged boilers included mechanical draft, natural (or atmospheric) draft, condensing boilers and non-condensing boilers. And their input capacities ranged from 300 kBtu/h to 9,500 kBtu/h. In aggregate, DOE used 584 CPB prices for its analysis. The 584 prices include 326 CPB prices that were used in the preliminary analysis stage and 258 that were collected in the NOPR stage of the rulemaking. The Table IV.4 shows the number of CPB prices that DOE used in the engineering analysis in each equipment class.

TABLE IV.4—NUMBER OF PRICES COLLECTED FOR ENGINEERING ANALYSIS

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

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. A baseline unit is one that meets, but does not exceed, the required existing energy conservation standard, as applicable, and provides basic consumer utility. A CPB model that has a rated efficiency equal to its applicable

[33] For the prices used from the preliminary analysis stage, DOE first confirmed the models were still active and then updated the price to account for inflation.

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, life-cycle cost (LCC) analysis, payback period (PBP) analysis and national impacts analysis (NIA). For the engineering analysis, DOE used the current energy conservation standards that are set forth in CFR 431.87 as baseline efficiency levels.

As discussed previously in section IV.A.2 of this document, DOE has proposed to modify the equipment classes for commercial packaged boilers for this analysis. If the proposed equipment classes are ultimately adopted in the final rule, then the equipment classes that are set forth in the current regulations would be consolidated such that the current draft-specific classes (*i.e.,* those identified as being ''natural draft'' and ''all except natural draft'') would be merged into non-draft-specific classes. For the remaining equipment classes, DOE retained the current standards in 10 CFR 431.87 as the baseline efficiency levels in the engineering analysis. For the four draft-specific classes, DOE used the natural draft equipment class efficiency standard as the baseline efficiency level. The baseline efficiency levels for each equipment class are presented in Table IV.5.

TABLE IV.5—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 equipment database compiled during the market assessment to identify intermediate and max-tech efficiency levels for analysis. The efficiency levels for each equipment class that DOE considered in the NOPR TSD are presented in Table IV.6

TABLE IV.6—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.

TABLE IV.6—BASELINE, INTERMEDIATE AND MAX TECH EFFICIENCY LEVELS ANALYZED IN THE ENGINEERING ANALYSIS—Continued

Equipment class	Efficiency* (%)	Efficiency level identifier
	79	EL–2.
	80	EL–3.
	81	EL–4.
	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 Large Gas Hot Water and Large Oil Hot Water, for which the efficiency levels are in terms of combustion efficiency.

In the preliminary analysis, DOE selected several efficiency levels for consideration in the analysis, many of which were retained in this NOPR. In response to the preliminary analysis, ACEEE, ASAP, and NRDC encouraged DOE to evaluate at the least one additional condensing level for the small, oil-fired, mechanical draft, hot water and the large, oil-fired, mechanical draft, hot water equipment classes at a level that could be considered ''baseline'' condensing equipment (*i.e.,* efficiency levels at or just above 90%). (ACEEE, ASAP, and NRDC, No. 36 at p. 4) During the preliminary analysis public meeting, AHRI also noted the absence of an interim point for some classes, particularly referring to the small oil mechanical draft hot water class. However, in continuation, AHRI also noted that making a condensing oil boiler has many challenges. (AHRI, Public Meeting Transcript, No. 39 at p. 41) In the public meeting ACEEE also commented that the inclusion of low-level condensing product in the analysis will illustrate the challenges faced in marketing such a product, at a cost-effective price and encouraged DOE to explore additional intermediate levels for this reason. (ACEEE, Public Meeting Transcript, No. 39 at p. 43) DOE notes that in the preliminary analysis for small oil fired mechanical draft hot water equipment class there was an eleven percentage point jump between the efficiency level just below max-tech and max tech. Similarly, for the large oil-fired mechanical draft hot water equipment class, there was a 9 percentage point jump.

DOE considered these comments carefully and examined whether there is a need to add interim condensing efficiency levels between max-tech and the level below max tech in the oil-fired hot water CPB equipment classes. While selecting intermediate efficiency levels for this rulemaking, DOE examined the distribution of commercial packaged boilers available in the market at all efficiency levels.[34] DOE then, selected several intermediate efficiency levels that have a substantial representation of commercial packaged boilers in the market. In the case of oil-fired hot water equipment classes, the large equipment class has three commercial packaged boilers and the small equipment class has one commercial packaged boiler that achieve efficiencies that require condensing operation. The one small condensing boiler has a thermal efficiency of 96.8% while the three large condensing boilers have combustion efficiencies of 95.8%, 96.9% and 97%. Based on this assessment, there appears to be no oil-fired hot water condensing boilers in the market with efficiency less than 95% that could potentially serve as a baseline for condensing efficiency levels. In addition, DOE also agrees with the commenters that there are significant challenges involved in designing and operating oil-fired condensing boilers.

Given the absence of such boilers available in the market and the challenges and uncertainties inherent to analyzing a product that does not exist, DOE has decided not to analyze additional interim condensing efficiency levels below max-tech for the oil-fired hot water equipment classes. DOE believes the consideration of the max-tech levels in these classes, which include condensing technology, are adequate for determining the cost-effectiveness of condensing designs.

[34] The efficiency levels refer to combustion efficiency for large hot water equipment classes and thermal efficiency for all other equipment classes.

DOE notes that for the small gas-fired hot water equipment class, efficiency levels of 93 percent and 95 percent were included in the analysis and represent interim condensing efficiency levels. Similarly, for the large gas-fired hot water equipment class, DOE has analyzed 94 percent as an interim condensing efficiency level below the max-tech. For these classes, the availability of commercial packaged boilers at these efficiency levels in the dataset in sufficiently large numbers justifies DOE's selection of intermediate efficiency levels.

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 preliminary analysis TSD. Lochinvar commented that the variation in manufacturing cost and the markup at each stage of distribution makes an accurate projection of incremental costs difficult, but that the methodology seems sound. Lochinvar also stated that the projected cost to the consumer appears to be a little high (5-10%) across the board and suggested a modest underestimation of markup as a reason. (Lochinvar, No. 34 at p. 2) ACEEE, ASAP, and NRDC commented that DOE's results for condensing efficiency levels of small gas mechanical draft hot water equipment class appear to be inconsistent with DOE's statements that there is generally a step change in price from a non-condensing boiler to a condensing boiler. (ACEEE, ASAP, and NRDC, No. 36 at p. 3).

DOE appreciates Lochinvar's comments comparing the results to their own pricing, but also notes that the analysis performed covered a wide variety of manufacturers and CPB models. Thus, DOE does not believe that a 5- to 10-percent variation from Lochinvar's results would be unexpected, as each individual manufacturer will set its prices differently.

DOE also examined the issue regarding the step change in prices of condensing boilers. More specifically, DOE investigated why there exists a relatively flatter trend in the incremental prices when going from non-condensing efficiency levels to condensing efficiency levels given the step change in technology from non-condensing to condensing. From the pricing data collected for small gas-fired hot water commercial packaged boilers, it is evident that the price of a commercial packaged boiler generally increases as it approaches the highest non-condensing efficiency levels, then displays a relatively flat trend to achieve lower condensing levels. The prices then increase as the efficiency approaches the mid-condensing efficiency levels, suggesting that achieving lower condensing levels is only slightly more costly than achieving the highest non-condensing levels.

There could be several reasons for this trend. First, commercial packaged boilers achieving efficiencies at the highest end of the non-condensing range sometimes incorporate designs that anticipate formation of condensate under certain conditions, such as high-grade stainless steel vent connectors, which will increase the cost and price of the commercial packaged boiler. DOE also notes from the market and technology assessment that only about 5 percent of all the small gas hot water boilers have a thermal efficiency that is greater than 86 percent and less than 90 percent. The comparatively lower production volumes of these commercial packaged boilers could also contribute to the higher prices. In this NOPR, DOE is analyzing the efficiency levels 93% and 95% for the small gas hot water equipment class. These efficiency levels represent the mid-level condensing levels that are a step higher than the other non-condensing and low condensing efficiency levels. As explained in section IV.A.2 of this document, these levels were chosen due to the high number of models already available on the market at these efficiencies. The price-efficiency curves for all equipment classes including small gas hot water are shown in chapter 5 of the NOPR TSD. Table IV.7 shows the incremental manufacturer selling price results for all eight equipment classes along with the baseline prices.

TABLE IV.7—MANUFACTURER SELLING PRICE–EFFICIENCY RESULTS

Equipment class	Efficiency level (%)	Incremental MSP	Baseline MSP
Small Gas Hot Water	Baseline—80	$0	$6,928
	81	472	
	82	977	
	84	2,759	
	85	3,561	
	93	10,027	
	95	10,494	
	Max Tech—99	13,966	
Large Gas Hot Water	Baseline—82	0	21,244
	83	2,534	
	84	5,370	
	85	8,544	
	94	32,796	
	Max Tech—97	36,904	
Small Oil Hot Water	Baseline—82	0	8,404
	83	634	
	84	1,315	
	85	2,048	
	87	3,683	
	88	4,594	
	Max Tech—97	17,687	
Large Oil Hot Water	Baseline—84	0	18,915
	86	4,785	
	88	10,781	
	89	14,326	
	Max Tech—97	49,923	
Small Gas Steam	Baseline—77	0	6,659
	78	540	
	79	1,124	
	80	1,756	
	81	2,439	
	Max Tech—83	3,975	
Large Gas Steam	Baseline—77	0	19,122
	78	1,097	
	79	2,256	
	80	3,483	
	81	4,779	
	82	6,150	
	Max Tech—84	9,132	
Small Oil Steam	Baseline—81	0	7,294
	83	1,722	
	84	2,730	

TABLE IV.7—MANUFACTURER SELLING PRICE–EFFICIENCY RESULTS—Continued

Equipment class	Efficiency level (%)	Incremental MSP	Baseline MSP
	Max Tech—86	5,097	
Large Oil Steam	Baseline—81	0	18,702
	83	3,017	
	85	6,521	
	Max Tech—87	10,590	

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 the preliminary analyses, 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 (assumed as 17.5% of sales in the preliminary analysis; other distribution channels previously discussed make up the remaining 82.5% market share). 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 product class and details may be found in chapter 6 of the TSD. In these instances, installation is typically accomplished by site personnel. These distribution channels are depicted as follows:

- Manufacturer → Commercial 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 [35] 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 [36] to develop mechanical contractor markups, and (3) U.S. Census Bureau's 2007 Economic Census data [37] 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.[38] 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.

During the preliminary analysis public meeting and in written comments responding to DOE's preliminary analyses, DOE received feedback regarding distribution channels and market share of equipment through different channels. Lochinvar, Plumbing-Heating-Cooling Contractors National Association (PHCC), and Raypak commented that DOE's considered distribution channels seem accurate. Lochinvar estimates that commercial sales for all CPB sizes are primarily (80% or more) through manufacturer's representatives. (Lochinvar, No. 34 at p. 2) PHCC noted that boilers below 4,000,000 Btu/h are likely to have wholesaler presence, but anything larger would most likely be sold through a manufacturer's representative. (PHCC, Public Meeting Transcript, No. 39 at p. 79) Raypak stated that, due to complexity of installation of commercial packaged boilers, sales are done primarily through a manufacturer's representative that provides additional equipment and expertise needed, and that wholesalers do not really apply to commercial packaged boilers. (Raypak, Public Meeting Transcript, No. 39 at p. 81)

DOE received contradictory comments from stakeholders regarding the presence of wholesalers in the distribution chain for commercial packaged boilers. However, for the NOPR analysis, consistent with the preliminary analysis, the impact on markups from sales through wholesalers and sales through manufacturer's representatives are assumed to be equal. As a result, the distinction would not result in any impact on the overall markups. For its NOPR analysis DOE retained the distribution channels, and the assumed share of equipment

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

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

[37] Census Bureau, 2007 Economic Census Data (2007) (Available at: *http://www.census.gov/econ/*)

[38] Sales Tax Clearinghouse Inc., State Sales Tax Rates Along with Combined Average City and County Rates, 2013 (Available at: *http://thestc.com/STrates.stm*).

through these channels, as established in the preliminary analysis.

In addition, DOE received comments on the value of the markups, the applicability of the markups to small businesses, and tax exemption for commercial packaged boilers used for manufacturing purposes. Lochinvar suggested that DOE's markups in the preliminary analysis were 5–10% higher than they expected, resulting in overestimation of consumer price of the same order. (Lochinvar, No. 34 at pp. 2–3) PVI Industries, LLC (PVI) noted that the markups established from publicly traded companies are not reflective of smaller manufacturers that may not benefit from higher volume sales and economies of scale. (PVI, Public Meeting Transcript, No. 39 at p. 82) PHCC noted that, in some states, a tax exemption may exist for commercial packaged boilers if they are used for manufacturing purposes, citing Indiana and Michigan as states where such tax exemptions exist. (PHCC, Public Meeting Transcript, No. 39 at p. 77)

Based on these comments, DOE reexamined the markups and encountered errors in its preliminary analysis calculations resulting in overly high markups. DOE has corrected this issue in the NOPR markups analysis. With respect to adequately representing markups for small businesses that may not benefit from high volume sales, and thus certain economies of scale, DOE is not generally privy to financial data for non-publically traded firms and cannot assess the likely impact, or magnitude of impact, on overall markups of smaller firms with reduced sales. With respect to tax exemptions that may exist for commercial packaged boilers used for manufacturing purposes, this rulemaking does not cover process boilers that are not used for space heating. In addition, based on the information available to DOE, DOE did not identify any tax exemptions available for the commercial packaged boilers covered in this rulemaking. As such, DOE did not consider tax exemptions in its NOPR analyses for this rulemaking.

Chapter 6 of the NOPR TSD provides further detail on the estimation of markups.

DOE requests information or insight that can better inform its markups analysis.

See section VII.E for a list of issues on which DOE seeks comment.

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)). In contrast to the CPB test procedure under title 10 of the Code of Federal Regulations part 431, which uses fixed operating conditions in a laboratory setting, the energy use analysis for commercial packaged boilers seeks to estimate the range of energy consumption of the equipment in the field. 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 annual energy consumption of commercial packaged boilers is used in subsequent analyses, including the LCC and PBP analysis and the national impact analysis.

In its preliminary analyses, 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 Energy Information Administration's (EIA) 2003 Commercial Building Energy Consumption Survey [39] (CBECS 2003) and EIA's 2009 Residential Energy Consumption Survey (RECS 2009), respectively. In their written comments in response to DOE's preliminary analyses, Raypak and AHRI expressed concern regarding the use of 2003 CBECS data, noting that it would not properly reflect the energy use of commercial packaged boilers being installed in 2019 and beyond, and urged DOE to await the release of CBECS 2012. (Raypak, No. 35 at p. 1; AHRI, No. 37 at p. 2)

DOE acknowledges there is benefit to the use of more recent CBECS data. However, EIA, so far, has released only a single microdata file (''Building Characteristics Public Use Microdata,'' June 25, 2015) covering the ''building characteristics'' portion of the 2012 CBECS survey sample results.[40] In its NOPR analysis, DOE used this data for updating the equipment class distributions in the analysis period, the shipment analysis, and the national impact analysis. To use the CBECS sample data for the LCC analysis, DOE requires the microdata file covering consumption and expenditure data. Since CBECS 2003 is the latest survey, with complete microdata available for the purpose of DOE's energy use analysis, DOE continued to use CBECS 2003 in the LCC analysis.

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 when 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 the preliminary analyses, DOE analyzed CPB annual energy use based on the building sample, equipment efficiency characteristics, and equipment performance at part-load conditions.

In the preliminary analyses, in determining building heat load, DOE adjusted the building heat load to reflect the expectation that buildings in 2019 would have a somewhat different building heat load than buildings in the CBECS 2003 and RECS 2009 building sample. The adjustment involved multiplying the calculated BHL for each CBECS 2003 or RECS 2009 building by the building shell efficiency index from *AEO2014.* This factor differs for commercial and residential buildings as well as new construction and replacement buildings. Additionally, DOE also adjusted the building heat load reported in CBECS 2003 and RECS 2009 for each building using the ratio of the historical National Oceanic and Atmospheric Administration (NOAA) average heating degree day data for the specific region each CBECS or RECS building sampled is in to the 2003 or 2009 heating degree days value, respectively, for the same region, to reflect the heating load under historical average climate conditions.

DOE requests feedback on the methodology and assumptions used for the building heat load adjustment.

See section VII.E for a list of issues on which DOE seeks comment.

For its preliminary analyses, 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

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

[40] U.S. Energy Information Administration (EIA). *2012 Commercial Building Energy Consumption Survey (CBECS) Data.* 2012. Available at *http://www.eia.gov/consumption/commercial/data/2012/index.cfm?view=microdata.*

RWT is applied to all commercial packaged boilers in the new construction market, 25 percent of replacement boilers in buildings built after 1990, and 5 percent of replacement boilers in buildings built before 1990. DOE assumed that all other 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 NOPR 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 on the preliminary analysis regarding the energy modeling approach. Regarding DOE's approach to converting combustion efficiency to thermal efficiency, Lochinvar suggested that, in order to avoid confusion, DOE should not convert one to the other. (Lochinvar, No. 34 at p. 7) Relative to adjusting rated thermal efficiency of commercial packaged boilers using return water temperature, Lochinvar urged DOE not to attempt correcting the efficiency of hot water commercial packaged boilers based on expected return water temperature conditions, noting that certain aspects of the BTS–2000 test procedure are being overlooked, such as the use of a recirculating loop used in some instances allowing for higher return water temperature into the boiler. Lochinvar also noted that efficiency curves over a wide range of return water temperatures used to derive conversion factors in the analysis are not based on BTS–2000 methodology, and using data created without a consistent test procedure is certain to introduce errors. (Lochinvar, No. 34 at p. 3) Similarly, AHRI expressed concerns regarding DOE's decision to try to adjust rated thermal efficiency and annual energy consumption estimates of commercial packaged boilers to account for differences in return and supply water temperatures, noting the lack of field data and the use of outdoor reset in many installations, a field condition variable that adjusts return water temperature based on building heating load and ambient air temperature. AHRI furthered stated that such efficiency adjustment would be an estimate not supported by adequate field data. (AHRI, No. 37 at p. 4) Raypak noted that return water temperature is unique to every boiler application, building design, and engineering plans for building operation. Raypak stated that there is no representative profile of return water temperature in the field. (Raypak, No. 35 at p. 3)

AHRI commented that, given the trends toward multiple boilers, the energy use calculations in buildings where multiple boilers are installed should be considered in DOE's energy use analysis. (AHRI, Public Meeting Transcript, No. 39 at pp. 95–96) DOE's analysis of non-condensing boilers considers cycling loss curves that reflect staging with multiple boilers, where multiple boilers exist, reducing the cycling adjustment factor based on the modulation capability of multiple-boiler systems. For condensing boilers, the part-load curves do not consider effects of multiple boilers but instead consider impact on efficiency due to modulation.

With respect to the adjustments made to CPB efficiencies and annual energy use based on return water temperature conditions, DOE understands that field conditions may be variable but recognizes that one of the key drivers impacting CPB efficiency is return water temperature. In its analysis, DOE sought to estimate the energy use of equipment in the field and, as such, considered factors that may impact CPB efficiency, including return water temperature conditions. DOE's energy use analysis has been designed to reflect conditions in the field, considering the expectations for existing buildings and the potential in new construction, as well as the proposed testing conditions in DOE's concurrent test procedure rulemaking.[41]

Regarding DOE's approach to converting combustion efficiency to thermal efficiency, Lochinvar stated that DOE's conversion factor where every 1 percent increase in combustion efficiency equates to a 1.0867 percent increase in thermal efficiency could be misleading when reversing the conversion factor to prescribe new minimum combustion standards. Lochinvar believes such reversed conversions would require DOE to justify a greater energy savings for large commercial packaged boilers in order to justify an increase in combustion efficiency. Lochinvar suggested that, in order to avoid confusion, DOE should not convert one to the other. (Lochinvar, No. 34 at p. 7)

DOE disagrees that its method of converting combustion efficiency to thermal efficiency for applicable large commercial packaged boilers is misleading. As detailed in chapter 7 of the NOPR TSD, DOE calculated annual energy use of covered commercial packaged boilers based on the thermal efficiency of the equipment while accounting for cycling loss, part load operating conditions, and return water temperature. For equipment classes rated in combustion efficiency, DOE converted the combustion efficiency levels defined in the engineering analysis to thermal efficiency levels in order to appropriately characterize the energy use of the equipment. However, DOE did not reverse the conversion when establishing standard levels in combustion efficiency. Rather, DOE identified combustion efficiency levels through its engineering analysis by evaluating technologically feasible options. DOE then calculated energy use and associated operating cost savings through converting combustion efficiency to thermal efficiency when determining economic justification of each identified combustion efficiency level. As such, DOE disagrees with Lochinvar's point that the conversion from combustion efficiency to thermal efficiency is misleading or will create confusion. DOE did review the conversion factor that DOE developed in the preliminary analysis and adjusted it to ensure the NOPR analysis does not result in a conversion where the thermal efficiency value is higher than the combustion efficiency. DOE applied the same methodology to convert combustion efficiency to thermal efficiency to determine energy use of equipment rated in combustion efficiency in its energy analysis for the NOPR.

DOE also received comments related to system considerations that may impact return water temperature conditions, and the resulting impact on the expected performance of condensing units that replace non-condensing commercial packaged boilers. ABMA commented that unless the boiler sizing closely follows the seasonal load profile, and the control system is capable of selecting the correct boiler for the prevailing load, the efficiency savings will not be maximized. (ABMA, No. 33 at p. 3) Raypak similarly commented that DOE should be aware of the distribution system considerations for ensuring proper operation with lower boiler water temperatures, as needed for

[41] A link to the February 2016 test procedure NOPR issued by DOE can be found at: *http://energy.gov/eere/buildings/downloads/issuance-2016-02-22-energy-conservation-program-certain-commercial-and.*

a condensing system to yield the maximum energy savings, and that it is aware of many condensing boiler installations that have not realized the desired savings due to system considerations that prevent condensation from taking place. (Raypak, No. 35 at p. 4) Raypak and PVI commented that installing a high efficiency condensing commercial packaged boiler in a system that operates with return water temperatures that do not allow for high efficiency operation will yield little or no cost/energy savings. (Raypak, No. 35 at p. 4; PVI, Public Meeting Transcript, No. 39 at p. 183) PVI further noted that the analysis assumes that a high efficiency condensing commercial packaged boiler operates at high efficiency all the time but that, anecdotally, the vast majority of buildings in the United States today have return water temperatures of between 140 and 160 degrees that do not allow for condensing, and that a system redesign would be required to allow for condensing to take place. (PVI, Public Meeting Transcript, No. 39 at pp. 182–183) AHRI and Raypak stated that the costs associated with a system retrofit in such cases should be considered in the model. (Raypak, Public Meeting Transcript, No. 39 at p. 186; AHRI, Public Meeting Transcript, No. 39 at pp. 119–120) PHCC inquired as to the fraction of commercial packaged boilers that the preliminary analysis assumed are condensing boilers operating in condensing mode and noted that water temperature requirements for a system are more a function of system conditions than sizing of the boiler and that a minimum water temperature may be required to transfer heat from the emitter to the space being heated. (PHCC, Public Meeting Transcript, No. 39 at pp. 121 and 133) PHCC commented that in new installations, it is important to note that when using high-efficiency products, a system must be designed such that you obtain lower return water temperatures to operate in the effective part of the boiler efficiency curve. (PHCC, Public Meeting Transcript, No. 39 at p. 98) ACEEE, however, noted that field experience has demonstrated system conversions to high efficiency commercial packaged boilers to be feasible, despite assertions to the contrary based on designed-in system temperatures. (ACEEE, Public Meeting Transcript, No. 39 at pp. 183–184) ACEEE commented on the potential impact that oversizing practices in the field may have on system efficiencies, stating that it expects substantial oversizing for the actual peak draws that would be expected in a facility, and inquired as to how this may impact the amount of time a condensing boiler spends in condensing mode. (ACEEE, Public Meeting Transcript, No. 39 at pp. 93–94 and 132–133) ACEEE also commented that the DOE is focusing too much on the CPB costs and not enough on other system costs, recommending Vermont Efficiency Community as a source of information and interactions with design engineers to obtain a better understanding of design considerations and to obtain relevant case studies. (ACEEE, Public Meeting Transcript, No. 39 at p. 127) PVI also commented that interacting with the engineering community is essential to understanding what is involved in converting a system designed for high water temperature to use low water temperature. (PVI, Public Meeting Transcript, No. 39 at p. 126–127) AHRI and Lochinvar identified the Centre of Energy Efficiency at Minneapolis (MNCEE) as a possible source of useful information and suggested that DOE should contact them. (AHRI No. 37 at p. 4; Lochinvar No. 34 at p. 3) DOE reviewed relevant published literature from the MNCEE Web site, and after contacting them learned about an ongoing study on ''Condensing Boiler Optimization in Commercial Buildings.''

DOE acknowledges that there are system considerations that can negatively impact the performance of a condensing commercial packaged boiler, resulting in less than optimum CPB efficiency. The analysis considered the return water temperature's effect on condensing boiler efficiency and took into account climate zone data to account for expected differences in operation and performance between different climates. DOE's analysis developed a heating load-weighted average return water temperature for two scenarios. In one scenario, a low return water temperature is provided for commercial packaged boilers that are installed in a system that would allow for condensation to occur. In a second scenario, a high return water temperature is provided for commercial packaged boilers that are installed in a system that does not allow for condensation to occur. For buildings in new construction, DOE assumed that all buildings will be designed to allow for condensing boilers to condense for a significant part of the heating season and therefore used low return water temperatures for its analysis. For buildings built after 1990, DOE assumed that 25% of buildings will be capable of low return water temperatures to allow condensing during part of the heating season. For buildings built before 1990, DOE assumed that 5% of buildings will be capable of low return water temperatures to allow condensing during part of the heating season. For the remainder of buildings, DOE's analysis used the average high return water temperature scenario. DOE tentatively concluded that it has appropriately considered the building hot water and steam distribution systems to appropriately account for the performance impact on commercial packaged boilers resulting from return water temperature conditions in the field.

DOE received feedback from Lochinvar, AHRI, ABMA, and PHCC relative to the various control options for commercial packaged boilers, particularly those used in multiple-boiler installations. Some of these controls may include fixed thermostats, fixed lead/lag thermostats with rotation on lead, individual thermistors with modulation, individual modulation with rotating lead, and group modulation. Lochinvar notes that some of the control options may be integral or external to the CPB, a point also echoed by AHRI, which commented on the variety of control systems and that some (*e.g.,* building energy management systems) are independent of the control system provided on the boiler. PHCC further noted that contractors specializing in building management systems may be used to install and integrate such control systems. PHCC also noted that multiple-boiler staging may be accomplished with aftermarket products that are designed to communicate with boilers or between boilers, and that a contractor may perform the installation but a different control contractor may integrate the boiler control to a building management program. (Lochinvar, No. 34 at p. 4; AHRI, No. 37 at p. 4; PHCC, Public Meeting Transcript, No. 39 at pp. 99–101) AHRI noted that in CPB installations with mixed efficiency levels, the control system usually calls on the secondary (*i.e.,* less efficient) boiler to operate only in increased load situations. AHRI also noted that it would be useful to understand how many commercial boiler installations include a system control panel that adds sophistication to controlling the boiler and system. (AHRI, No. 37 at p. 4; AHRI, Public Meeting Transcript, No. 39 at p. 100) AHRI also notes that ASHRAE Standard 90 requires load-sensing controls for boiler-based heating systems. (AHRI, Public Meeting Transcript, No. 39 at pp. 32–33) ABMA noted that unless the boiler sizing closely follows the seasonal load profile, and the control system is capable of selecting the correct boiler for the prevailing load, the efficiency savings will not be maximized. In consideration of these comments, DOE notes that while the analysis does not specifically apply any individual controls for multiple-boiler situations, it does consider the impact on the efficiency of a boiler on a multiple-boiler installation (through providing for differing part load/cycling adjustment where staging of multiple-boilers is possible). The analysis does not consider multiple-boiler installations where commercial packaged boilers of different fuel input rate are used; nor does it consider hybrid systems that may use condensing and non-condensing boilers together and controlled in sequence as part of its no-new-standards case. For more information on this part of the analysis, refer to chapter 7 and appendix 7B of the TSD.

For the NOPR, DOE modified the energy use characterization conducted in the preliminary analysis to improve the modeling of equipment performance. The modifications that DOE performed included changes to the cycling loss factors for individual commercial packaged boilers, improved accounting for estimating performance of multiple-boiler installations, and improving the return water temperature efficiency adjustment factors.

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

2. Building Sample Selection and Sizing Methodology

In its energy analysis for this NOPR, DOE's estimation of the annual energy savings of commercial packaged boilers from higher efficiency equipment alternatives relies on building sample data from CBECS 2003, RECS 2009, and CBECS 2012.[42] CBECS 2003 includes energy consumption and building characteristic data for 5,215 commercial buildings representing 4.9 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 2003 and RECS 2009 building records used in the analysis met the following criteria. The CPB application

- 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/hr), and
- 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), fuel input rate (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 its NOPR 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. In absence of the newer sample data from CBECS 2012, DOE's new construction sample was based on the same selection algorithms as the replacement sample but included only buildings built after 1990, which DOE tentatively concluded would have building characteristics more similar to the new construction buildings in the start of the analysis period in 2019 (*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 uses a sizing methodology to determine the sizes of the commercial packaged boilers installed in the building. In the preliminary analysis, DOE used a rule-based sizing methodology (*i.e.,* predetermined number of commercial packaged boilers for a building with a given sizing heating load) with key threshold size parameters estimated from the AHRI directory model counts. In the NOPR analysis, DOE used a statistical sizing approach 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, 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 (MMBtu/h) 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 (MMBtu/hr) by an estimated number of boilers of equal capacity. To estimate the number of commercial packaged boilers in a given sample building, DOE established a CPB count distribution for a given sizing load range in a set of sample buildings from CBECS data of 1979 and 1983—the only two CBECS surveys where the CPB count data were available for the sample buildings. DOE assigned the number of commercial packaged boilers to all the qualified sample buildings of 2003 CBECS based on this distribution. The number of commercial packaged boilers in each sample building was multiplied by the respective building sample weights in CBECS to obtain an estimate of the overall CPB population and their respective capacities. The CPB size distributions obtained by this method were compared with the size distribution of the space heating boilers obtained in an EPA database[43] having size information of over 120,000 space heating boilers. The comparison from these two different datasets did not reveal any significant differences. Minor tweaks were made to the statistical assignment of the number of commercial packaged boilers so as to maximize the utility of the sampled buildings used for the NOPR analysis;

[42] EIA released only building characteristic micro-data tables for CBECS 2012 in June 2015. These buildings could not be used as sample buildings for this rulemaking because they did not have energy consumption details. However this partial set of data in CBECS 2012 was used to determine useful trends for developing the final sample distribution across various equipment classes during the analysis period.

[43] Environmental Protection Agency. *13 State Boiler Inspector Inventory Database with Projections (Area Sources).* EPA–HQ–OAR–2006–0790–0013 (April 2010) (Available at *http://www.epa.gov/ttnatw01/boiler/boilerpg.html*).

i.e., the number of commercial packaged boilers assigned to very large buildings in cold climates with large design sizing loads were high enough to ensure that the capacity of a single unit of the multiple-boiler installation was lower than 10 MMBtu/h, the maximum CPB size for the equipment classes analyzed. At the lower end of the heating load spectrum, the number of commercial packaged boilers assigned to the installation were matched to ensure that any commercial packaged boiler in the installation has a capacity higher than 300,000 Btu/h—the minimum size for a covered commercial packaged boiler.

DOE received several comments pertaining to its sizing methodology used in the preliminary analyses—*i.e.,* its use of a rule-based sizing methodology, oversize factors used in the aggregate sizing calculation, and number of commercial packaged boilers used to meet a given design load. Raypak commented that there is no such thing as typical CPB sizing practice and that engineers and architects are responsible for creating the buildings the way the owner wants it. (Raypak, No. 35 at p. 3) PHCC commented that the design heating load is not the only criterion for sizing, but ''connected load'' is an important determinant of the sizing practice, especially for steam systems. (PHCC, Public Meeting Transcript, No. 39 at p. 97) Sizes of individual commercial packaged boilers in any installation depend on the aggregate design condition heating load and the number of commercial packaged boilers in the installation. DOE recognizes that the number of commercial packaged boilers assigned to meet the system heating load of a given building and to create some degree of redundancy varies in current HVAC system design practice. DOE's approach to sizing is based on CPB counts distributions from previous CBECS surveys and statistics gathered from the EPA database of space heating boilers. This methodology does not use a set number of commercial packaged boilers for a given design heating load but assigns the number of commercial packaged boilers within a range of counts based on previous observations from CBECS surveys. Regarding PHCC's comment on impact of connected load on CPB sizing, since DOE is not aware of any currently available data on the heat distribution equipment in commercial buildings, it was unable to make reasonable assumptions that could be incorporated in its sizing methodology. DOE welcomes comments on improving this sizing methodology and any other data that may assist DOE to establish a correlation between a given building heating load and the number of commercial packaged boilers in the installation.

The CBECS 2003 and RECS 2009 weightings for each building sample indicate how frequently each commercial building or household unit occurs on the national level in 2003 and 2009, respectively. DOE used these weightings from CBECS 2003 and RECS 2009 buildings for estimation of individual equipment class sample weights. Appendix 7A of the NOPR TSD presents the variables included and their definitions, as well as further information about the derivation of the building samples, the adjustments to the CPB weights, and sampling fractions for each of the four samples: Commercial and residential, each divided between new construction and retrofit.

DOE received multiple comments regarding the sizing methodology and other assumptions used in estimation of the equipment sample weights. PHCC pointed out that in the retrofit situation, though there are contractors who just replace the boilers on ''like for like'' basis, most contractors look at the overall system load and then size the installation appropriately considering the design heating load, particularly when a higher efficiency system is being considered. (PHCC, Public Meeting Transcript, No. 39 at p. 98) AHRI noted that it is not unusual to have a backup boiler in installations of some building types, creating some redundancy, in particular where absence of heating is unacceptable. (AHRI, Public Meeting Transcript, No. 39 at p. 94–95) AHRI further observed that this has been a historical practice, and current design practice mostly provides for multiple-boiler installations. ACEEE commented that installations needing 100-percent backup may use a second large boiler, or some may opt for having various small boilers that together cover 130 or 120 percent of the peak load. (ACEEE, Public Meeting Transcript, No. 39 at pp. 101–103). DOE's use of data-driven boiler count distributions to estimate the number of boilers in a given installation obviates the need for assumptions on the percent of the sample buildings requiring redundancy in the boiler installation and the extent of redundancy. For example, DOE estimated that 30% of the sample buildings having design heating loads between 570,000 and 865,000 Btu/hr would have two commercial packaged boilers, the rest being single boiler installations. While the capacity of the single commercial packaged boiler is based on an oversize factor of 110%, in the two-boiler situation each commercial packaged boiler has half the capacity of the single large commercial packaged boiler. The two-boiler situation creates redundancy only to the extent of 55% of the design load but has no provision for 100% redundancy under design heating condition. In the NOPR analysis, the maximum number of commercial packaged boilers assigned to any sample building is eight, implying redundancy of 96% of the design heating load. PHCC commented that fully redundant boilers are less frequent now than it has been in the past. (PHCC, Public Meeting Transcript, No. 39 at pp. 103–104) PHCC further noted that reasonable degree of redundancy can be created even when only 100% of the design load is shared by multiple boilers in an installation. PHCC observed that presently building owners are unwilling to spend a significant amount of additional funds to ensure redundancy as there are acceptable and safe alternatives. (PHCC, Public Meeting Transcript, No. 39 at p. 104) DOE's NOPR analysis assumes an average oversize factor of 110%, which appear reasonable.

The issues of redundant, modular, and multiple-boiler use in a given installation are intertwined, and DOE received several comments in this area. AHRI, Lochinvar, and Raypak noted that ASHRAE Standard 90.1–2013 requires a 3:1 turndown ratio for boiler systems with an input rate of 1 MMBtu/hr or more (accomplished with a modulating boiler or multiple boilers) to provide some measure of load following. (AHRI, No. 37 at p. 4; Lochinvar, No. 34 at p. 4; Raypak, No. 35 at p. 3). Raypak commented that trends show that more buildings, new and existing, are being provided with multiple smaller boilers instead of a single large boiler, and that buildings such as hospitals, hotels, colleges, and prisons are examples where redundant equipment may be used, though not necessarily providing 100% coverage. ACEEE also commented that there is some shift away from larger boilers to multiple smaller boilers. (ACEEE No. 39 at p. 33)

DOE notes that one of the key drivers of the trend toward installation of multiple or modular commercial packaged boilers in any installation would be ASHRAE standard 90.1–2013,[44] which requires CPB systems with an input rate of 1 MMBtu/hour or more to have a turndown ratios of 3:1 or more. As this can be achieved either by staging of multiple smaller

[44] ANSI/ASHRAE/IESNA Standard 90.1–2013, Energy Standard for Buildings Except Low-Rise Residential Buildings, American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc., Atlanta, GA 30329.

commercial packaged boilers or having large commercial packed boilers with modular heat exchangers and turndown capability, greater usage of multiple boilers or modular boilers are mutually offsetting. In the NOPR analysis, DOE has considered that commercial packaged boilers at the high end of the efficiency spectrum do have built-in turndown capability. Further in its NOPR analysis, DOE assumed that all commercial packaged boilers installed in new buildings will be part of a system with at least 3:1 turndown ratio and calculated the adjusted thermal efficiency of commercial packaged boilers in such systems accordingly. DOE could not quantify a definitive impact of ASHRAE standard 90.1–2013 on future CPB sizing practices because the standard is yet to be incorporated in most state building codes. However it modified future sizing methodology in the analysis period (2019–2048) to have a minimum count of at least two commercial packaged boilers of the same size for design heating loads exceeding 1 MM Btu/hr for new constructions.

Raypak noted that DOE's assumption in the preliminary analysis that all multiple boilers are of the same size and type when installed in the same building is incorrect. Raypak stated that it is seeing more ''hybrid'' systems that include both condensing and non-condensing boilers on the same system, with some of these hybrid systems having the ability to monitor the return water temperature and initiate condensing boiler operation. (Raypak, No. 35 at p. 3) PHCC commented that use of one low-efficiency and one high-efficiency boiler in a new installation could be rare but may happen in retrofit scenarios. (PHCC, Public Meeting Transcript, No. 39 at p. 104) DOE agrees with PHCC that hybrid installations are possible in retrofit situations where new condensing boiler(s) operating in the ''base load mode'' combine with the pre-existing non-condensing boilers to meet the design load. In new construction, DOE's analysis can be limited only to single efficiency levels for all commercial packaged boilers as any mandated efficiency standards stipulate a single minimum efficiency level only. It is likely that operation in the hybrid configuration may improve the economics of the ''condensing boiler'' efficiency option in DOE's NOPR analysis because of higher utilization of the condensing boilers in the hybrid retrofitted systems vis-à-vis utilizations currently estimated in the sample buildings under a ''uniform configuration.'' However to quantify this impact, DOE needs to develop a reasonable baseline assumption regarding the current degree of adoption of the hybrid configuration practice in retrofit situations.

DOE requests information on what constitutes a reasonable baseline assumption about the current degree of adoption of hybrid boiler configurations in retrofit situations and on other related parameters such as percentage of total installed capacity typically assigned to the new condensing boilers, climate zones where it may be more prevalent and any other supporting documentation.

See section VII.E for a list of issues on which DOE seeks comment.

Building sampling methodology is detailed in NOPR TSD appendix 7A.

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. In the preliminary analysis, DOE assumed that if the CBECS data indicates that the CPB fuel is the same as the fuel used for water heating then in 50% of the sample buildings, the same commercial packaged boiler is also used for water heating. Several stakeholders commented on the reasonableness and validity of this assumption. AHRI stated that in the collective opinion of its members, the fraction of boilers used for both space heating and hot water in commercial building is far less than the 50% assumed in the preliminary analysis. (AHRI, No. 37 at p. 5) Raypak agreed with AHRI's comment and further pointed out that this practice, though common in Europe for condensing boilers in residential applications, is not commonly observed in commercial buildings in the United States. (Raypak, No. 35 at p. 4) Lochinvar expressed that possibly a greater percentage of residential boilers are used for both space and water heating than boilers in commercial buildings. ACEEE pointed out that using packaged boilers also for hot water heating is a wasteful practice because of the presence of long recirculating loops, which are restricted in the new building codes. (ACEEE, Public Meeting Transcript, No. 39 at p. 113) ACEEE further pointed out that the current system design practice is moving away from having dual-use installations in commercial buildings. DOE agrees with the previous comments and consequently limited the fraction of occurrence of dual-use boilers to 20% of the samples in the NOPR analysis compared to the previously considered level of 50%.

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.

DOE received several comments regarding energy use by pumps. AHRI noted that there has been significant progress on ASHRAE 90.1 in requiring or specifying more efficient mode of pumps for the circulating pumps and that there is a parallel rulemaking on commercial industrial pumps, and the impact of such rulemaking should be considered in this analysis and rulemaking as it relates to pumps used in commercial packaged boilers. (AHRI, Public Meeting Transcript, No. 39 at pp. 108–109 and 114) PHCC noted that the analysis should be clear as to whether pump power refers to a system pump, boiler pump, or both, and commented that small boilers are probably all provided with a system circulating pump, but, as systems get larger, the pumps may be field selected, and coming up with an average efficiency would be complicated given the various pump options available out there. (PHCC, Public Meeting Transcript, No. 39 at pp. 109–110 and 112–113) Similarly, Raypak noted that boiler pumps may not be included with the commercial packaged boiler but rather be a purchase decision made by the manufacturer's representative or contractor to meet the CPB flow and head requirements, and that care should be taken when taking this energy consumption into consideration. (Raypak, Public Meeting Transcript, No. 39 at pp. 115–116) ACEEE noted that care must be taken in the analysis to include only energy use for pumps integral to the operation of the boiler and not for those that are used for distribution to the system. (ACEEE, Public Meeting Transcript, No. 39 at p. 111)

With respect to the electricity use of pumps, DOE wishes to clarify that the current analysis 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 used for distributing water throughout a system since the circulating pumps are not part of the commercial packaged boiler itself and inclusion of its energy consumption would not be appropriate to the development of the standard.

In its NOPR analysis, DOE maintained the electricity use analysis method used for the preliminary analysis.

F. Life-Cycle Cost and Payback Period Analysis

The purpose of the LCC and PBP analysis is to analyze the effects of potential amended energy conservation standards on consumers of commercial packaged boilers by determining how a potential amended standard affects their operating expenses (usually decreased) and their total installed costs (usually increased).

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 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, product efficiency is chosen based on its probability. If the chosen product efficiency is greater than or equal to the efficiency of the standard level under consideration, the LCC and PBP calculation reveals that a consumer is not impacted by the standard level. By accounting for consumers that already purchase more-efficient products, DOE avoids overstating the potential benefits from increasing product efficiency.

EPCA establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the energy (and, as applicable, water) savings during the first year that the consumer will receive as a result of the standard, as calculated under the test procedure in place for that standard. 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 year that compliance with amended standards is required. The projected compliance date for amended standards is early 2019. Therefore, for purposes of its analysis, DOE used January 1, 2019 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 derives the consumer equipment cost for the baseline equipment by multiplying the baseline equipment manufacturer production cost and the baseline overall markup (including any applicable sales tax). For each efficiency level above the baseline, DOE derives the consumer equipment cost by adding baseline equipment consumer cost to the product of incremental manufacturer cost 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 tentatively determined that there is no clear historical price trend for CPB equipment and used costs established in the engineering analysis directly for determining 2019 equipment prices for the LCC and PBP analysis.

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 for replacements or the installation of a commercial packaged boiler in a new building, removal of the existing boiler, and any applicable permit fees. DOE estimates the installation costs at each considered efficiency level using a variety of sources, including RS Means 2015 facilities construction cost data, manufacturer literature, and information from expert consultants.[45] Appendix 8D of the NOPR TSD contains a detailed discussion of the development of installation costs.

DOE received feedback regarding installation costs for commercial packaged boilers, including comments related to installation locations within buildings, venting materials and sizes, and common venting. AHRI commented that boilers located within buildings are usually in the basement or penthouse, and in high-rise buildings, they are often located in intermediate floors, and that vertical vent termination is most common. (AHRI, No. 37 at p. 6) Raypak commented that there is no ''typical'' boiler installation, and that boilers may be located in basements, mechanical rooms, penthouses, or outdoors and, in high-rise buildings, boilers are often located in intermediate floors due to other system limitations. (Raypak, No. 35 at p. 6) PHCC also noted that likely places for boiler installations are boiler rooms, equipment rooms, basements of hotels, and powerhouses in hospitals. Venting in these installations could be through sidewalls, roofs, masonry, chimneys, or stainless steel vents. (PHCC, No. 39 at p. 138) Lochinvar noted that they do not have specific information but speculate that less than 10% of installations will require significant additional installation expenses, and that most likely this expense would occur for condensing boilers with long vent runs that require custom-designed common vent systems with modulating draft control systems. (Lochinvar, No. 34 at p. 5) ACEEE suggested getting in touch with ASHRAE technical committees to obtain more specific information on design practices, and engaging the engineering community, system designers, and contractors to get a better handle on installation costs. (ACEEE, No. 39 at pp. 105 and 128) PHCC suggested that information on this topic may be more succinctly gathered from a survey sent to contractors, engineers, and manufacturers. (PHCC, No. 39 at p. 135)

Regarding costs associated with venting, AHRI, Lochinvar, and Raypak noted that venting material selection is a function of system design, but generally vents 8 inches and larger are metal, 4 inches and smaller are PVC/CPVC/PP,[46] and that 6-inch vents may be either, with Raypak also noting that plastic vent materials that are ULC S636 certified are not readily available in larger sizes. (AHRI, No. 37 at p. 5; Lochinvar, No. 34 at p. 5; Raypak, No. 35 at p. 5) PHCC's comment agreed with the general trend identified as PHCC commented that plastic venting is more common in small-capacity installations, but stainless steel is more typical in larger boilers with an input of 1 MM Btu/h sizes and higher. (PHCC, No. 39 at p. 130) AHRI further noted that stainless steel is rarely used in existing CPB installations with efficiencies in the low 80 percent range. (AHRI, No. 37 at p. 6) However, Raypak noted that the same boiler, when designed to use a Category I vent in a vertical vent situation, may be required to use a Category III stainless steel vent if vented horizontally, but noted that manufacturers have limited knowledge of the final installation and whether a particular boiler will be vented horizontally or vertically.[47] (Raypak, No. 39 at p. 136 and No. 35 at p. 5) PHCC proposed that most of the time condensing boilers are direct vented but noted that they have no specific data to support that opinion. (PHCC, No. 39 at p. 130) Lochinvar commented that almost all condensing commercial packaged boilers have the option of direct venting, and that the majority of non-condensing commercial packaged boilers sold do not have the direct vent option. They further noted that there is a small fraction of near condensing commercial packaged boilers that require stainless steel venting, but almost all are designed for either non-condensing conventional venting or condensing with PVC or stainless steel venting, noting the selection of PVC versus stainless steel being based on size rather than efficiency. (Lochinvar, No. 34 at p. 5) Lochinvar commented that vent termination has historically been vertical, but that direct venting options have caused a trend toward side wall venting, and in some instances that has resulted in functional problems. The trend is currently reverting to vertical venting for all products, with side wall venting currently applied in less than 20% of cases and this percentage is declining. (Lochinvar, No. 34 at p. 5) Raypak stated that direct venting has nothing to do with boiler efficiency, and that many mechanical draft boilers and some natural draft boilers are designed to accommodate standard venting or direct venting, depending on the installation requirements. Raypak commented that stainless steel venting is rarely used in existing installations of commercial packaged boilers with efficiencies below condensing, and that stainless steel venting is much more costly than standard ''B-vent'' which is used for most non-condensing boilers vented in Category I venting configurations. Raypak also commented that venting configuration for outdoor installations is not addressed by the DOE analysis. (Raypak, No. 35 at p. 5) In the public meeting, AHRI commented that venting approaches may differ between small and large boilers, and that DOE's analysis focuses on fairly small boilers. AHRI offered to discuss this perspective with their members and provide additional information. (AHRI, No. 39 at p. 132)

With respect to common venting, Lochinvar commented that multiple-boiler installations are often commonly vented (10% and growing), but that common venting commercial packaged boilers with water heaters is rare, and they advise against mixing unlike product types when venting. (Lochinvar, No. 34 at p. 6) AHRI noted that the National Fuel Gas Code (NFGC) requires condensing boilers to be separately vented, and that it is customary to commonly vent non-condensing boilers, but that commercial water heaters are usually not commonly vented with commercial packaged boilers. (AHRI, No. 37 at p. 6) AHRI further elaborated on this point during the public meeting, stating that common venting may become problematic for the water heater when the boiler is not firing and the vent size is very large. (AHRI, No. 39 at p. 141) Raypak, in their comments submitted in response to the public meeting, also noted that the NFGC addresses common venting of non-condensing Category I equipment, but when it comes to common venting of condensing boilers or other category boilers, the NFGC calls for ''Engineered Vent Systems,'' resulting in additional costs for the design, including a Registered Professional Engineer's stamp (approving the venting system design), and equipment over and above the cost of the vent materials alone. (Raypak, No. 35 at p. 6) Similarly, PVI noted that non-condensing boilers are commonly vented together; condensing boilers are most commonly vented individually, but some (research) projects are investigating what it would

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

[46] Plastic polymers: Polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polypropylene (PP).

[47] DOE interprets the referenced Category III venting requirement to relate to the lack of flue gas buoyancy in horizontally vented equipment, and that venting designed to maintain a positive internal pressure is therefore utilized in these installations.

take to common vent condensing boilers. (PVI, No. 39 at p. 140) Raypak further notes that boilers designed for Category III, if vented horizontally, would use stainless steel to comply with categorization requirements for boilers. (Raypak, No. 35 at p. 6)

DOE acknowledges that the number of possible variations in venting arrangements is significant and has utilized this input in a logic sequence based upon probability distribution of venting conditions to provide representative venting costs for the range of products analyzed. See chapter 8 and appendix 8D of the NOPR TSD for details on DOE's analysis of installation costs including venting costs.

DOE seeks input on its characterization and development of representative installation costs, including venting costs, in new and replacement commercial package boiler installations, including data to support assumptions on vent sizing, vent length distributions, and vent materials.

See section VII.E for a list of issues on which DOE seeks comment.

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 NOPR 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.[48] The findings suggest that in general the rebound associated with lighting efficiency programs in the commercial and industrial sectors is very small. In a 1995 paper, Eto et al.[49] 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 customer 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,[50] 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 CPBs, *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 proposed rule.

EIA includes a rebound effect for several end-uses in the commercial sector, including heating and cooling, as well as improvements in building shell efficiency in its AEO reports.[51] The DOE analysis presented here does not include either the rebound effect for building shell efficiency or the rebound effect for equipment efficiency as is included in the AEO, and therefore cannot definitively assess what the impact of including the rebound effect would have on this analysis. For example, if the building shell efficiency improvements included in the AEO reduced heating and cooling load by 10 percent and the rebound effect on building shell efficiency was assumed to be 10 percent, the total impact would be to reduce heating and cooling loads by 9 percent. The DOE analysis presented here includes only the building shell improvements from the AEO but not the rebound effect on the building shell efficiency improvements. For illustrative purposes, DOE estimates that a rebound effect of 10 percent on CPB efficiency for heating improvements could reduce the energy savings by 0.04 quads (10 percent) over the analysis period. However, this ignores that the proposed rule would have saved more than 0.39 quads if the building shell efficiency rebound effect included in the AEO was also included in DOE's analysis.

DOE requests comment and seeks data on the assumption that a rebound effect is unlikely to occur for these commercial applications.

See section VII.E for a list of issues on which DOE seeks comment.

4. Energy Prices and Energy Price Trends

DOE derives 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 assigns an appropriate energy price to each commercial building and household in the sample, depending on its type (commercial or residential), and its location. DOE derives 2014 annual electricity prices from EIA Form 826 data.[52] DOE obtains 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 commercial consumers.[53] DOE collects 2013 average commercial fuel oil prices from EIA's State Energy Consumption, Price, and Expenditure Estimates (SEDS) and adjusts it using CPI inflation factors to reflect 2014 prices.[54]

To arrive at prices in future years, DOE multiplies the prices by the forecasts of annual average price changes in *AEO2015.* To estimate the trend after 2040, DOE uses the average rate of change during 2030–2040. Appendix 8C of the NOPR TSD includes more details on energy prices and trends.

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

[49] Eto et al. (1995). Where Did the Money Go? The Cost and Performance of the Largest Commercial Sector DSM Programs. LBL–3820. Lawrence Berkeley National Laboratory, Berkeley, CA.

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

[51] Energy Information Administration, Commercial Demand Module of the National Energy Modeling System: Model Documentation 2013, Washington, DC, November 2013, page 57. The building shell efficiency improvement index in the AEO accounts for reductions in heating and cooling load due to building code enhancements and other improvements that could reduce the buildings need for heating and cooling.

[52] 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/*).

[53] 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*).

[54] Source: CPI factors derived from U.S. Department of Labor, Bureau of Labor Statistics, Consumer Price Index (CPI) (Available at: *www.bls.gov/cpi/cpifiles/cpiai.txt*).

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.[55] 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.

DOE requested comments regarding the frequency and typical cost of maintenance of minimum- and high-efficiency commercial packaged boilers. ABMA commented that the maintenance costs shown in the analysis seem low and more along the lines of residential maintenance costs. (ABMA, Public Meeting Transcript, No. 39 at p. 65) Similarly, Raypak believes that DOE should not assume that there is a linear relationship between the size of the boiler and the cost of its components. (Raypak, No. 35 at p. 4) Additionally, Raypak commented that the frequency and cost of maintenance, major repairs, *etc.* presented in the analysis is representative of older technology boilers, but newer technology boilers have a higher cost of service/repair since they require a higher level of expertise from technicians and specialized equipment. Raypak also added that, although they do not have specific data, Raypak believes 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. However, Raypak noted there may be some general maintenance items such as checking for blockages in vent/air intake, looking at burner flame, and maintaining or adjusting water quality that may be accomplished by on-site staff. (Raypak, No. 35 at p. 5) AHRI similarly noted that the industry trend for boiler maintenance is toward using external contractors who specialize in servicing advance design boilers or boiler systems. (AHRI, No. 37 at p. 5) PHCC, on the contrary, noted that maintenance estimates seem adequate. (PHCC, Public Meeting Transcript, No. 39 at p. 146) PHCC also noted that hospitals, larger apartment buildings, and other sites with competent maintenance staff are likely to use on-site staff for general boiler maintenance but resort to external contractors for repair work. Large boiler installations are likely to use external contractors for maintenance and repairs. (PHCC, Public Meeting Transcript, No. 39 at p. 147)

Two stakeholders proposed that DOE implement additional data collection techniques. ACEEE encouraged DOE to look at international experience/comparisons relative to maintenance, maintenance contracts, incremental costs, and lifetime estimates, especially where it related to condensing technology where other regions have more history of condensing technology use. (ACEEE, Public Meeting Transcript, No. 39 at p. 209) PVI suggested that surveying boiler service companies regarding maintenance and frequency of repairs, as well as self-service versus external, may help provide some answers for the analysis. (PVI, No. 39 at p. 153) DOE appreciates the recommendations made by commenters. However, DOE considers the information it was able to collect and examine through publically available sources to be sufficient to perform the NOPR analyses.

With respect to adherence to a maintenance schedule on commercial packaged boilers, Lochinvar noted that CPB manufacturers recommend annual maintenance, but evidence supports that it is often neglected. (Lochinvar, No. 34 at p. 4) Raypak also noted the lack of maintenance requirements on boilers and the impact that lack of maintenance can have on boiler lifetime. (Raypak, Public Meeting Transcript, No. 39 at p. 208)

DOE appreciates the stakeholder comments received regarding CPB equipment maintenance frequency and costs. DOE notes that for the NOPR, DOE is not changing the maintenance cost calculation methodology used in the preliminary analysis as it risks oversimplifying the maintenance cost estimating methodology, which may result in costs that are not reflective of the recommended preventive maintenance tasks performed in the facilities and boiler plants, and not significantly different from one equipment class to another.

The cost estimates used in the analysis are specific to preventive maintenance tasks performed by the in-plant engineer/technician. DOE notes that RS Means is a representative, well-documented, and widely accepted data resource specifically developed for cost estimating purposes depicting typical preventive maintenance tasks and associated costs at different CPB capacities, which is the requirement for the purposes of the LCC analysis. Furthermore, the version of RS Means used for the LCC purposes specifically looked at facilities that used CPB plants and larger commercial packaged boilers to ensure that the costs used are appropriate.

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). In its preliminary analysis, 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 received comments regarding repair costs for commercial packaged boilers. AHRI commented that DOE should not assume a linear relationship between boiler size and component costs, and both AHRI and Raypak noted that repair costs shown in the analysis may be representative of historical models, but newer commercial models require more specialized equipment and technicians, resulting in an underestimation of repair costs in the analysis for higher efficiency equipment. (AHRI, No. 37 at p. 5; Raypak, No. 35 at p. 4) With respect to heat exchanger repairs, Raypak notes that a replacement heat exchanger would show up simply in replacement parts orders and a replacement boiler would show up as a boiler shipment, but it has no knowledge of the instances of heat exchanger replacements versus boiler replacements in repair/replace decisions. (Raypak, No. 35 at p. 5) Lochinvar comments that in cases where they are involved in the decision to repair or replace a heat exchanger, about 80% of the times the heat exchanger is replaced, and that it is consistent for condensing and non-condensing commercial packaged boilers they manufacture. Lochinvar has no data on repair or replacement percentages for cases in which they are not involved in the decision-making process. (Lochinvar, No. 34 at p. 5) Lochinvar further notes that the type of boiler impacts whether heat exchanger failure will result in replacement rather than repair. (Lochinvar, No. 34 at p. 4) PHCC opines that for smaller boilers, it is likely that the entire boiler would be replaced if there is a heat exchanger failure, but for larger boilers, it is more likely that the heat exchanger would be

[55] RS Means, 2015 Facilities Maintenance & Repair Cost Data (Available at: *http://rsmeans.com*).

repaired or replaced. (PHCC, Public Meeting Transcript, No. 39 at p. 148)

DOE appreciates the comments it received regarding repair costs for commercial packaged boilers. Regarding the comments noting an underestimation of repair costs, DOE notes that it used ''RS Means Facility Maintenance and Repair Cost Data'' [56] to determine repair costs, a well-documented and widely accepted data resource specifically developed for cost estimating purposes. With respect to heat exchanger repairs, DOE considered comments it received and adjusted the repair methodology to allow for noncondensing and condensing heat exchangers to be treated separately in the analysis to account for the impacts of condensation on heat exchanger surfaces.

In the NOPR, 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 assumes 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 the development of repair costs, see appendix 8E of the NOPR TSD.

DOE requests comments on the representativeness of using 1-year as warranty for parts and labor, and 10-years as warranty for the heat exchanger.

See section VII.E for a list of issues on which DOE seeks comment.

7. Lifetime

Equipment lifetime is defined as the age at which equipment is retired from service. DOE uses 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 NOPR TSD. In the Framework and preliminary analysis documents, DOE sought comment on how it characterized equipment lifetime. DOE also requested any data or information regarding the accuracy of its 24.8-year lifetime and whether equipment lifetime varies based on equipment class.

DOE received various comments regarding CPB lifetime. ABMA, AHRI, and Raypak commented that the average life assumption developed by DOE in the analysis for both condensing and non-condensing boilers is incorrect, noting that condensing boilers have only been on the market for about 15 years, so using an average life of 24.8 years for them in the analysis is unwarranted. ABMA further notes that the preliminary analysis TSD Table 8–F.2.1 shows condensing boilers listed as having 10–15 year life, but the analysis sets lifetime as 24.8 years regardless of CPB technology. ABMA, and Raypak believe the average life of condensing boilers to be in the neighborhood of 15 years, and Lochinvar suggested that condensing product life should be in the range of 19 to 20 years. (ABMA, Public Meeting Transcript, No. 39 at p. 152; Lochinvar, No. 34 at p. 6; Raypak, No. 35 at p. 6; Raypak, Public Meeting Transcript, No. 39 at p. 208) PHCC stated that 25 year lifetime is high for condensing technology. (PHCC, Public Meeting Transcript, No. 39 at p. 149) Lochinvar commented that non-condensing product lifetime estimates are consistent with their experience, but that lifetime calculations must not aggregate condensing and non-condensing products for average lifetime cost calculations. (Lochinvar, No. 34 at p. 6) ACEEE commented that the material the heat exchanger is made of is likely to be as relevant as the condensing versus non-condensing operation of the boiler. (ACEEE, No. 39 at p. 154) AHRI also suggested that lifetime for condensing commercial packaged boilers be determined differently based on their limited history. (AHRI, No. 37 at p. 6) PVI agreed that there is insufficient historical data on condensing boilers to confirm that their lifetime is similar to traditional boilers, but that early evidence suggests they have shorter lives. (PVI, Public Meeting Transcript, No. 39 at p. 151) ABMA and PVI suggested that the life-cycle cost of a condensing boiler installation should consider accelerated replacement of commercial packaged boilers, with ABMA noting that calculations using this proposed lifetime is highly suspect unless the life cycle cost of a condensing boiler installation includes the cost of two condensing boilers, rather than one. (ABMA, No. 33 at p. 2)

In response, DOE notes that in developing the residential Boilers Specification Version 3.0 for the ENERGY STAR® program in 2013, the Environmental Protection Agency (EPA) held numerous discussions with manufacturers and technical experts to explore the concern that condensing boilers may have a shorter lifetime. In the absence of data showing otherwise, EPA concluded that if condensing boilers are properly installed and maintained, the life expectancy should be similar to noncondensing boilers.[57]

EPA also discussed boiler life expectancy with the Department for Environment, Food & Rural Affairs (DEFRA) in the United Kingdom, and stated that DEFRA has no data which contradict EPA's conclusion that with proper maintenance, condensing and non-condensing modern boilers have similar life expectancy.[58] Regarding the preliminary analysis TSD Table 8–F.2.1 showing condensing boilers listed as having 10–15 year life, DOE agrees 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 believes that the values captured in those 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 2019 and beyond would be expected to be similar to their noncondensing counterparts. While commenters opined on a shorter life for condensing products, no commenters provided definitive data that illustrate a shorter life for condensing boilers relative to their noncondensing counterparts. For the NOPR, DOE did not apply different lifetimes for non-condensing and condensing commercial packaged boilers. However, as noted in the discussion of repair costs in section IV.F.6 of this document, commenters noted the option for and higher likelihood of heat exchanger replacements for commercial packaged boilers instead of boiler replacement. DOE did consider 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

[56] RS Means, 2015 Facilities Maintenance & Repair Cost Data (Available at: *http://rsmeans.com/60305.aspx*).

[57] Stakeholder Comments on Draft 1 Version 3.0 Boilers Specification (August 5, 2013) (Available at *http://www.energystar.gov/products/spec/boilers_specification_version_3_0_pd.*).

[58] *Energy Efficiency Best Practice in Housing, Domestic Condensing Boilers—'The Benefits and the Myths'* (2003) (Available at *http://www.west-norfolk.gov.uk/pdf/CE52.pdf.*).

exchangers that are exposed to such condensate.

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

8. Discount Rate

The discount rate is the rate at which future expenditures and savings are discounted to establish their present value. DOE estimates discount rates separately for commercial and residential end users. For commercial end users, DOE calculates commercial discount rates as the weighted average cost of capital (WACC), using the Capital Asset Pricing Model (CAPM). For residential end users, DOE calculates discount rates as the weighted average real interest rate across consumer debt and equity holdings.

DOE derived the discount rates by estimating the cost of capital of 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 data for the commercial discount rate analysis.[59] To derive discount rates for residential applications, DOE used publicly available data (the Federal Reserve Board's ''Survey of Consumer Finances'') to estimate a consumer's opportunity cost of funds related to appliance energy cost savings and maintenance costs.[60] More details regarding DOE's estimates of consumer discount rates are provided in chapter 8 of the NOPR TSD.

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

For the LCC analysis, DOE analyzes 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.

In its preliminary analysis, DOE used the AHRI directory to analyze trends in product classes and efficiency levels from 2007 to 2014 to determine the anticipated no-new-standards-case efficiency distribution in 2019, the assumed compliance year for amended standards. The trends show the market moving toward higher efficiency commercial packaged boilers, and DOE accounted for the trend in its no-new-standards-case projection.

In the preliminary analysis, DOE requested data on current CPB efficiency market shares (of shipments) by equipment class, and also similar historical data. DOE also requested information on expected trends in efficiency over the next five years.

DOE received various comments regarding the data contained in the AHRI database and its use in the analysis. PVI commented that there is no link between the number of listings in the AHRI directory and sales volumes of any particular product type. (PVI, Public Meeting Transcript, No. 39 at pp. 158–159) Raypak noted that the trend toward condensing technologies for some product classes is evident in the number of series of boilers now in their catalog that are condensing, compared to 10 years ago when only one single system was available. (Raypak, No. 35 at p. 4) AHRI similarly noted the continuing growth in condensing boilers and improvements in overall efficiencies and offered to provide additional data related to distribution of equipment by efficiencies. (AHRI, Public Meeting Transcript, No. 39 at p. 158) Relative to trends in condensing oil boilers, AHRI commented that oil condensing products are rare and there may not be a big enough sample to establish any trends in the technology. (AHRI, Public Meeting Transcript, No. 39 at pp. 176–177)

DOE recognizes that the AHRI directory of commercial packaged boilers is not an indicator of shipments in the industry, but it does reflect the general trends taken by manufacturers to meet their consumer's needs. Due to the lack of any other data source documenting the historical trend for product efficiency and condensing technology, the NOPR analysis used the AHRI directory to analyze trends in product classes and efficiency levels from 2007 to 2015 to determine the anticipated no-new-standards-case efficiency distribution in 2019, the assumed compliance year for amended standards. The trends show the market moving toward higher efficiency commercial packaged boilers, and DOE accounted for the trend in its no-new-standards-case projection. As it relates to condensing oil boilers, DOE observed, as a result of incorporating 2015 AHRI directory data, that for a second year in a row (in 2014 and 2015), the number of condensing oil boilers in the AHRI directory was lower than in previous years. As a result, DOE adjusted the condensing boiler trends for small and large oil commercial packaged boilers. DOE considered alternatives to estimate sales, and the shipments methodology has been updated to not depend on the AHRI directory. An overview of the shipments methodology is provided in section IV.G of this document.

Table IV.8 presents the estimated no-new-standards-case efficiency market shares for each analyzed CPB equipment class in 2019.

TABLE IV.8—ESTIMATED NO-NEW-STANDARDS CASE BOILER EFFICIENCY DISTRIBUTION * OF ANALYZED COMMERCIAL PACKAGED BOILER EQUIPMENT CLASSES ** IN 2019

Efficiency	SGHW (%)	LGHW (%)	SOHW (%)	LOHW (%)	SGST (%)	LGST (%)	SOST (%)	LOST (%)
77					47	13		
78					7	31		
79					16	13		
80	7				16	21		
81	8				10	5	34	41
82	12	17	35			11		
83		21	24		4		51	39
84	11	6	9	44		7	10	
85	22	16	16					19

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

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

TABLE IV.8—ESTIMATED NO-NEW-STANDARDS CASE BOILER EFFICIENCY DISTRIBUTION * OF ANALYZED COMMERCIAL PACKAGED BOILER EQUIPMENT CLASSES ** IN 2019—Continued

Efficiency	SGHW (%)	LGHW (%)	SOHW (%)	LOHW (%)	SGST (%)	LGST (%)	SOST (%)	LOST (%)
86				42			5	
87			11					† 0
88			3	9				
89				1				
90								
91								
92								
93	19							
94		37						
95	19							
96								
97		3	3	4				
98								
99	3							

* 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.
† Result is zero due to rounding.

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 covered by this NOPR 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 2019 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.

11. Rebuttable-Presumption Payback Period

EPCA establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing equipment complying with an energy conservation standard level will be less than three times the value of the energy (and, as applicable, water) savings during the first year that the consumer will receive as a result of the standard, as calculated under the test procedure in place for that standard. For each considered efficiency level, DOE determines the value of the first year's energy savings by calculating the quantity of those savings in accordance with the applicable DOE test procedure and multiplying that amount by the average energy price forecast for the year in which compliance with the amended standards would be required. The rebuttable presumption criteria of less than 3-year payback was not achieved for any of the equipment classes analyzed for this rulemaking. More details on this may be found in Table V.27.

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 uses the shipments projection and the equipment stock to calculate the national impacts of potential amended energy conservation standards on energy use, NPV, and future manufacturer cash flows. DOE develops shipment projections based on estimated historical shipment and an analysis of key market drivers for each kind of equipment.

In the preliminary analysis, DOE estimated historical shipments of commercial packaged boilers based on historical shipments of residential boilers and percent share of equipment classes in the AHRI model directory. During the preliminary public meeting and in written comments in response to DOE's preliminary analysis, the stakeholders questioned the data sources DOE used in its shipment analysis. PVI commented that the number of listings in the AHRI model directory and sales volumes of any particular equipment class are not correlated. (PVI, Public Meeting Transcript, No. 39 at pp. 158–159)

DOE recognizes that the AHRI directory of commercial packaged boilers is not an indicator of shipments in the industry and DOE modified its analysis approach to project shipments from 2014 through the end of the thirty year analysis period 2018–2047. DOE estimated historical shipments in its NOPR analysis 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 separate 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 and oil to gas shift trends DOE derived from the EPA database for space heating boilers. 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 *AEO2015*. DOE assumes 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 size distribution of space heating boilers in an EPA database. For estimation of saturation rates in the new construction, DOE compared the area heated by boilers in commercial buildings for two different nine year periods (*i.e.,* 2000–2012 covered in CBECS 2012 and 1995–2003 covered in CBECS 2003). The new construction saturation rates were derived from the calculated saturation rate averaged over the 1995–2003 period and adjusted for the trends in the area heated by boilers, as well as oil to gas shift trends in CBECS 2012. The new construction saturation rates were projected into the future considering currently observed trends from CBECS 2012 and *AEO2015* (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 trend in multi-family buildings for the period of analysis is identical to that for commercial buildings. DOE applied these new construction saturation rates to new building additions in each year over the analysis period (2018–2049), yielding shipments to new buildings. The building stock and additions projections from the *AEO2015* are shown in Table IV.9.

In addition, DOE received several comments on results of the preliminary shipment analysis. Lochinvar commented that the flat shipment projection from 2020 shown in the preliminary analysis is unrealistic under the growing national economy. (Lochinvar, No.34 at p. 6) Lochinvar further commented that the rapid decline of natural draft boilers assumed in the preliminary shipment analysis is highly overstated and the impact of any proposed efficiency standard on shipment of non-condensing, natural draft and steam boilers would be insignificant under less stringent efficiency standards, but could be significant under very stringent standards. (Lochinvar, No.34 at pp. 6 and 7) In the NOPR analysis, DOE analyzed eight equipment classes that are no longer separated by different draft types. Consequently, DOE's shipment projections were made on an aggregate basis including both natural draft and mechanical draft equipment for each equipment class examined. As to the impact of the stringency of standards on shipments of lower efficiency boilers like natural draft and steam boilers, DOE notes that its method of analysis takes how consumers and manufacturers are impacted by the proposed standards into full consideration.

AHRI commented that DOE should make an effort to determine the trend for numbers of boilers installed in new building construction in order to improve the shipments projection. (AHRI, Public Meeting Transcript, No. 39 at p. 168–169) In the NOPR shipment analysis, DOE used a different methodology that takes into consideration the current trends of usage of commercial packaged boilers for heating in commercial buildings as evidenced in CBECS 2012. This analysis could be refined further as more data from CBECS 2012 become available. AHRI also indicated that it is in discussions with its members to estimate shipments in different efficiency bins and historical shipment weighted efficiency levels. (AHRI, Public Meeting Transcript No. 39 at p. 96) DOE has not received this data from AHRI. ACEEE commented that it would like to see capacity class shipment estimates. (ACEEE, No. 39 at p. 50) DOE estimated percent share of different capacity bins across the equipment classes as detailed in the TSD chapter 9 of this document.

TABLE IV.9—BUILDING STOCK PROJECTIONS

Year	Total commercial building floorspace million sq. ft.	Commercial building floorspace additions million sq. ft.	Total residential building stock millions of units	Residential building additions millions of units
2014	81,879	1,546	114.80	1.06
2019	85,888	2,077	119.41	1.67
2020	86,938	2,089	120.51	1.69
2025	92,037	2,027	125.82	1.70
2030	96,380	1,987	131.09	1.66
2035	100,920	2,302	136.04	1.62
2040	106,649	2,408	140.96	1.62
2045	112,186	2,651	146.22	1.73
2048	115,646	2,808	149.48	1.77

Source: EIA *AEO2015*.

DOE seeks 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 requests information on historical shipments of commercial packaged boilers including shipments by equipment class for small, large, and very large commercial packaged boilers.

See section VII.E for a list of issues on which DOE seeks comment.

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 assumes that a portion of affected commercial 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 models this impact using a relative price elasticity approach. When the extended repaired units fail after 6 more years, DOE assumes they will be replaced with new ones. A detailed description of the extended repair calculations is provided in chapter 9 of the NOPR TSD.

In response to the extrapolation of a residential product price elasticity to commercial packaged boilers used in the preliminary analyses, interested parties noted concerns regarding the application of residential data to commercial equipment. Specifically, AHRI noted that residential and commercial boiler consumers have a different pricing structure and consumer relationship, and expressed concern over the use of residential data for commercial packaged boilers. (AHRI, Public Meeting Transcript, No. 39 at p. 169–170)

AHRI also noted that, because of the higher installation costs and time involved, commercial boiler owners would be more likely to repair an existing boiler than to replace it. (AHRI, No. 37 at p. 6) Similarly, ACEEE expressed concerns regarding price sensitivity and the application of a residential price elasticity to a commercial equipment and how the resulting numbers will be interpreted in downstream analyses. (ACEEE, Public Meeting Transcript, No. 39 at p. 172–173) Both AHRI and Raypak remarked that while an incremental increase in the cost associated with a new standard would not be expected to have a significant effect on shipments, larger increases associated with the cost of the standard would result in lower shipments as existing consumers would be more likely to repair an existing boiler rather than replace it. (AHRI, No. 37 at p. 7; Raypak, No. 35 at p. 7)

Given the AHRI and Raypak 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 for the NOPR analysis. In response to the AHRI and ACEEE comments, DOE revised the price elasticity from a residential product study to use sales and price data for commercial unitary air conditioners[61] 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 NOPR TSD.

The resulting shipment projection is shown in Table IV.10.

TABLE IV.10—SHIPMENTS OF COMMERCIAL PACKAGED BOILER EQUIPMENT

[Thousands]

Year	SGHW CPB *	LGHW CPB	SOHW CPB	LOHW CPB	SGST CPB	LGST CPB	SOST CPB	LOST CPB
2014	14,270	2,282	792	114	1,933	251	416	97
2019	16,907	2,707	868	119	1,854	240	399	93
2020	17,201	2,754	877	121	1,838	238	396	92
2025	18,512	2,963	910	125	1,663	216	380	88
2030	19,066	3,052	932	129	1,406	182	364	85
2035	21,025	3,365	969	133	1,135	147	349	81
2040	22,953	3,674	1,014	139	846	110	335	78
2045	24,363	3,900	1,053	144	522	68	321	75
2048	25,409	4,067	1,076	147	312	40	313	73

* 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.

Because the estimated energy usage of CPB equipment differs by commercial and residential setting, the NIA employs the same fractions of shipments (or sales) to commercial and to residential commercial consumers as is used in the LCC analysis. The fraction of shipments by type of commercial consumer is shown in Table IV.11.

TABLE IV.11—SHIPMENT SHARES BY TYPE OF COMMERCIAL CONSUMER

Equipment class	Commercial (%)	Residential (%)
Small Gas-Fired Hot Water Commercial Packaged Boiler	85	15
Large Gas-Fired Hot Water Commercial Packaged Boiler	85	15
Small Oil-Fired Hot Water Commercial Packaged Boiler	85	15
Large Oil-Fired Hot Water Commercial Packaged Boiler	85	15
Small Gas-Fired Steam Commercial Packaged Boiler	85	15
Large Gas-Fired Steam Commercial Packaged Boiler	85	15
Small Oil-Fired Steam Commercial Packaged Boiler	85	15
Large Oil-Fired Steam Commercial Packaged Boiler	85	15

DOE requests feedback on the assumptions used to estimate the impact of relative price increases on commercial packaged boiler shipments due to proposed standards.

See section VII.E for a list of issues on which DOE seeks comment.

H. National Impact Analysis

The national impact analysis (NIA) analyzes the effects of a potential energy conservation standard from a national perspective. The NIA assesses the national energy savings (NES) and the national NPV of total consumer costs and savings that would be expected to result from amended standards at specific efficiency levels. The NES and NPV are analyzed at specific efficiency levels (*i.e.,* TSLs) for each equipment class of CPB equipment. DOE calculates the NES and NPV based on projections

[61] 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).

of annual equipment shipments, along with the annual energy consumption and total installed cost data from the LCC analysis. For the NOPR analysis, DOE forecasted the energy savings, operating cost savings, equipment costs, and NPV of commercial consumer benefits for equipment sold from 2019 through 2048—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.[62] Chapter 10 and appendix 10A of the NOPR TSD explain the models and how to use them, and interested parties can review DOE's analyses by interacting with these spreadsheets. The models and documentation are available on DOE's Web site.[63] 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 forecasted the lifetime energy savings, energy cost savings, equipment costs, and NPV of consumer benefits for each equipment class for equipment sold from 2019 through 2048—the year in which the last standards-compliant equipment would be shipped during the 30-year analysis period.

DOE evaluated the impacts of potential new and 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 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 assumed 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 proposed standard level, and equipment already being purchased at efficiency levels at or above the proposed standard level would remain unaffected.

Unlike the LCC analysis, the NES 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 from the *AEO2015* Reference case. Additionally, DOE analyzed scenarios that used inputs from the *AEO2015* Low Economic Growth and High Economic Growth cases. These cases have lower and higher energy price trends, respectively, compared to the reference case. NIA results based on these cases are presented in appendix 10D of the NOPR TSD.

A detailed description of the procedure to calculate NES and NPV and inputs for this analysis are provided in chapter 10 of the NOPR TSD. Table IV.12 summarizes the inputs and methods DOE used for the NIA analysis.

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

Inputs	Method
Shipments	Annual shipments from shipments model.
First Year of Analysis Period	2019.
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 product prices based on historical data.
Annual Energy Cost per Unit	Annual weighted-average values as a function of the annual energy consumption per unit, and energy prices.
Energy Prices	*AEO2015* forecasts (to 2040) and extrapolation through 2110.
Energy Site-to-Source Conversion Factors	Varies yearly and is generated by NEMS-BT.
Discount Rate	3 and 7 percent real.
Present Year	Future expenses discounted to 2015, when the NOPR 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 uses 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 each efficiency level analyzed, DOE used a ''roll-up'' scenario to establish the market shares by efficiency level for the year that compliance would be required with amended standards. The analysis starts with the no-new-standards-case distributions wherein shipments are assumed to be distributed across efficiency levels. When potential standard levels above the base level are analyzed, as the name implies, the shipments in the no-new-standards case that did not meet the efficiency standard level being considered would roll up to meet the amended standard level. This information also suggests that equipment efficiencies in the no-new-standards case that were above the standard level under consideration would not be affected.

[62] DOE understands that MS 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 MS Excel as the basis for the spreadsheet models provides interested parties with access to the models within a familiar context.

[63] DOE's Web page on commercial packaged boiler equipment is available at: *http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/74.*

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

2. National Energy Savings

For each year in the forecast period, DOE calculates the national energy savings for each standard level by multiplying the shipments of commercial packaged boilers by the per-unit annual energy savings. Cumulative energy savings are the sum of the annual energy savings over the lifetime of all equipment shipped during 2019–2048.

The inputs for determining the NES are (1) annual energy consumption per unit, (2) shipments, (3) equipment stock, and (4) site-to-source and full-fuel-cycle conversion factors.

DOE calculated the NES associated with the difference between the per-unit energy use under a standards-case scenario and the per-unit energy use in the no-new-standards case. The average energy per unit used by the CPB equipment stock gradually decreases in the standards case relative to the no-new-standards case as more-efficient CPB units gradually replaces less-efficient units.

Unit energy consumption values for each equipment class are taken from the LCC spreadsheet for each efficiency level and weighted based on market efficiency distributions. To estimate the total energy savings for each efficiency level, DOE first calculated the per-unit energy reduction (*i.e.,* the difference between the energy directly consumed by a unit of equipment in operation in the no-new-standards case and the standards case) for each class of CPB equipment for each year of the analysis period. The analysis period begins with the expected compliance date of amended energy conservation standards (*i.e.,* 2019, or 3 years after the publication of a final rule issued as a result of this rulemaking). Second, DOE determined the annual site energy savings by multiplying the stock of each equipment class by vintage (*i.e.,* year of shipment) by the per-unit energy reduction for each vintage (from step one). Third, DOE converted the annual site electricity savings into the annual amount of energy saved at the source of electricity generation (the source or primary energy), using a time series of conversion factors derived from the latest version of EIA's National Energy Modeling System (NEMS). Finally, DOE summed the annual primary energy savings for the lifetime of units shipped over a 30-year period to calculate the total NES. DOE performed these calculations for each efficiency level considered for CPB equipment in this rulemaking.

DOE has historically presented NES in terms of primary energy savings. In the case of electricity use and savings, primary energy savings includes the energy lost in the power system in the form of losses as well as the energy input required at the electric generation station in order to convert and deliver the energy required at the site of consumption. DOE uses a multiplicative factor called ''site-to-source conversion factor'' to convert site energy consumption to primary energy consumption. 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 (August 18, 2011). While DOE stated in that notice that it intended to use the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model to conduct the analysis, it also said it would review alternative methods, including the use of EIA's NEMS. After evaluating both models and the approaches discussed in the August 18, 2011 notice, DOE published a statement of amended policy in the **Federal Register**, in which DOE explained its determination that NEMS is a more appropriate tool for its FFC analysis as well as its intention to use NEMS for that purpose. 77 FR 49701 (August 17, 2012). DOE received one comment, which was supportive of the use of NEMS for DOE's FFC analysis.[64] The approach used for this NOPR analysis, the site-to-source ratios, and the FFC multipliers that were applied, are described in appendix 10B of the NOPR TSD. NES results are presented in both primary and FFC savings in section V.B.3 of this document.

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, and (3) a discount factor. DOE calculates the lifetime net savings for equipment shipped each year as the difference between 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 forecast period.

a. Total Annual Installed 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

DOE determined the difference between the no-new-standards-case operating costs and the standard-level operating costs in order to obtain the net operating cost savings from each higher efficiency level. DOE determined the difference between the net operating cost savings and the net equipment cost increase in order to obtain the net savings (or expense) for each year.

c. Discount Rate

DOE discounted the annual net savings (or expenses) to 2015 for CPB equipment bought on or after 2019 and summed the discounted values to provide the NPV for an efficiency level.

In accordance with the OMB's guidelines on regulatory analysis,[65] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. The 7-percent rate is an estimate of the average before-tax rate of return on private capital in the U.S. economy. DOE used this discount rate to approximate the opportunity cost of capital in the private sector, because recent OMB analysis has found the average rate of return on capital to be near this rate. DOE used the 3-percent rate to capture the potential effects of standards on private consumption (*e.g.,* through higher prices for products and reduced purchases of energy). This rate represents the rate at which society discounts future consumption flows to their present value. This rate can be approximated by the real rate of return on long-term government debt (*i.e.,* yield on United States Treasury notes minus annual rate of change in the

[64] Docket ID: EERE–2010–BT–NOA–0028–0048, comment by Kirk Lundblade. Available at *http://www.regulations.gov/#!docketDetail;D=EERE-2010-BT-NOA-0028.*

[65] Office of Management and Budget, section E in *OMB Circular A–4* (Sept. 17, 2003) (Available at: *www.whitehouse.gov/omb/circulars_a004_a-4*).

Consumer Price Index), which has averaged about 3 percent on a pre-tax basis for the past 30 years.

I. Consumer Subgroup Analysis

In analyzing the potential impacts of new or amended standards, DOE evaluates impacts on identifiable groups (*i.e.,* subgroups) that may be disproportionately affected by a national energy conservation standard. DOE received comments from manufacturers regarding identification of subgroups. Lochinvar and AHRI suggested that DOE talk to mechanical contractors, design engineers, and the Association of Facilities Engineers to determine appropriate consumer subgroups. (Lochinvar, No. 34 at p. 7; AHRI, No. 37 at p. 7) For the NOPR analysis, DOE identified 'low-income households for residential and small businesses for commercial sectors as subgroups and evaluated impacts using the LCC spreadsheet model. The consumer subgroup analysis is discussed in detail in chapter 11 of the NOPR TSD.

J. Manufacturer Impact Analysis

DOE performed an MIA to determine the financial impact of amended energy conservation standards on manufacturers of commercial packaged boilers and to estimate the potential impact of such standards on employment and manufacturing capacity. The MIA has both quantitative and qualitative aspects. The quantitative part of the MIA primarily relies on the Government Regulatory Impact Model (GRIM), an industry cash-flow model with inputs specific to this rulemaking. The key GRIM inputs are industry cost structure data, shipment data, product costs, and assumptions about markups and conversion costs. The key output is the industry net present value (INPV). DOE used the GRIM to calculate cash flows using standard accounting principles and to compare changes in INPV between a no-new-standards case and various TSLs (the standards case). The difference in INPV between the no-new-standards case and standards cases represents the financial impact of amended energy conservation standards on CPB manufacturers. DOE used different sets of assumptions (markup scenarios) to represent the uncertainty surrounding potential impacts on prices and manufacturer profitability as a result of amended standards. These different assumptions produce a range of INPV results. The qualitative part of the MIA addresses the proposed standard's potential impacts on manufacturing capacity and industry competition, as well as any differential impacts the proposed standard may have on any particular subgroup of manufacturers. The qualitative aspect of the analysis also addresses product characteristics, as well as any significant market or product trends. The complete MIA is outlined in chapter 12 of the NOPR TSD.

DOE conducted the MIA for this rulemaking in three phases. In Phase 1 of the MIA, DOE prepared an industry characterization based on the market and technology assessment, preliminary manufacturer interviews, and publicly available information. As part of its profile of the residential boilers industry, DOE also conducted a top-down cost analysis of manufacturers in order to derive preliminary financial inputs for the GRIM (*e.g.,* sales, general, and administration (SG&A) expenses; research and development (R&D) expenses; and tax rates). DOE used public sources of information, including company SEC 10–K filings,[66] corporate annual reports, the U.S. Census Bureau's Economic Census,[67] and Hoover's reports[68] 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. In general, energy conservation standards can affect manufacturer cash flow in three distinct ways. These include: (1) Creating a need for increased investment; (2) raising production costs per unit; and (3) altering revenue due to higher per-unit prices and possible changes in sales volumes. DOE estimated industry cash flows in the GRIM at various potential standard levels using industry financial parameters derived in Phase 1.

In Phase 3 of the MIA, DOE conducted structured, detailed interviews with a variety of manufacturers that represent approximately 40 percent of domestic CPB product offerings covered by this rulemaking. During these interviews, DOE discussed engineering, manufacturing, procurement, and financial topics to validate assumptions used in the GRIM. DOE also solicited information about manufacturers' views of the industry as a whole and their key concerns regarding this rulemaking. See section IV.J.3 for a description of the key issues manufacturers raised during the interviews.

Additionally, in Phase 3, DOE also evaluated subgroups of manufacturers that may be disproportionately impacted by amended standards or that may not be accurately represented by the average cost assumptions used to develop the industry cash-flow analysis. For example, small manufacturers, niche players, or manufacturers exhibiting a cost structure that largely differs from the industry average could be more negatively affected by amended energy conservation standards. DOE identified one subgroup (small manufacturers) for a separate impact analysis.

To identify small businesses for this analysis, DOE applied the small business size standards published by the Small Business Administration (SBA) to determine whether a company is considered a small business. 65 FR 30836, 30848 (May 15, 2000), as amended at 65 FR 53533, 53544 (Sept. 5, 2000) and codified at 13 CFR part 121. To be categorized as a small business under North American Industry Classification System (NAICS) code 333414, ''Heating Equipment (except Warm Air Furnaces) Manufacturing,'' a residential boiler manufacturer and its affiliates may employ a maximum of 500 employees. The 500-employee threshold includes all employees in a business's parent company and any other subsidiaries. Based on this classification, DOE identified 34 CPB companies that qualify as small businesses. The CPB small manufacturer subgroup is discussed in section 0 of this document and in chapter 12 of the NOPR TSD.

1. 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

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

[67] U.S. Census Bureau, Annual Survey of Manufacturers: General Statistics: Statistics for Industry Groups and Industries (2013) (Available at: *http://factfinder2.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t*).

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

industry financial parameters as inputs for the GRIM analysis, which it develops by collecting and analyzing publically available industry financial information. The GRIM spreadsheet uses the inputs to arrive at a series of annual cash flows, beginning in 2014 (the base year of the analysis) and continuing to 2048 (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 publically-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 NOPR TSD.

a. Government Regulatory Impact Model Key Inputs

Manufacturer Production Costs

Manufacturing a higher-efficiency product is typically more expensive than manufacturing a baseline product 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 products can affect the revenues, gross margins, and cash flow of the industry, making these product cost data key GRIM inputs for DOE's analysis.

In the MIA, DOE used the MPCs for each considered efficiency level that were calculated using product pricing found in the engineering analysis, as described in section IV.C and further detailed in chapter 5 of the NOPR TSD. In addition, DOE used information from its teardown analysis (described in chapter 5 of the TSD) to disaggregate the MPCs into material, labor, and overhead costs. To determine the industry manufacturer selling price-efficiency relationship, DOE used data from the market and technology assessment, publicly available equipment literature and research reports, and information from manufacturers, distributors, and contractors. Using these resources, DOE calculated manufacturer selling prices of commercial packaged boilers for a given fuel input rate (representative fuel input rate) for each manufacturer at different efficiency levels spanning from the minimum allowable standard (*i.e.,* baseline level) to the maximum technologically feasible efficiency level. DOE then used product markups along with the product pricing to determine MPCs for each efficiency level. These cost breakdowns and product markups were validated and revised with input from manufacturers during manufacturer interviews.

Shipments Forecast

The GRIM estimates manufacturer revenues based on total unit shipment forecasts 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 forecasts derived from the shipments analysis from 2015 (the base year) to 2048 (the end year of the analysis period). The shipments model divides the shipments of commercial packaged boilers into specific market segments. The model starts from a historical base year and calculates retirements and shipments by market segment for each year of the analysis period. This approach produces an estimate of the total product stock, broken down by age or vintage, in each year of the analysis period. In addition, the product stock efficiency distribution is calculated for the no-new-standards case and for each standards case for each product class. The NIA shipments forecasts are, in part, based on a roll-up scenario. The forecast assumes that a product 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 2019. See section IV.G of this document and chapter 9 of the NOPR TSD for additional details.

Equipment and Capital Conversion Costs

Amended energy conservation standards would cause manufacturers to incur one-time conversion costs to bring their production facilities and product designs into compliance. DOE evaluated the level of conversion-related expenditures that would be needed to comply with each considered efficiency level in each product class. For the MIA, DOE classified these conversion costs into two major groups: (1) Capital conversion costs; and (2) product conversion costs. Capital conversion costs are 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 AHRI and ABMA, DOE developed a market-share-weighted manufacturer average capital expenditure which it then scaled up and applied to the entire industry. DOE supplemented manufacturer comments and tailored its analyses with information obtained during engineering analysis described in chapter 5 of the TSD.

DOE assessed the product conversion costs at each considered efficiency level by integrating data from quantitative and qualitative sources. DOE considered market-share-weighted feedback regarding the potential costs of each efficiency level from multiple manufacturers to estimate product conversion costs (*e.g.,* 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 notice. For additional information on the estimated product and capital conversion costs, see chapter 12 of the NOPR TSD.

DOE received limited information on the conversion costs for oil-fired products in interviews. Using product listing counts, DOE scaled the feedback on gas-fired equipment to estimate the conversion cost for oil-fired equipment.

DOE requests additional information from manufacturers regarding conversion costs for oil-fired products. Specifically, DOE is interested in estimates of capital conversion costs at each TSL and the change in manufacturing equipment associated with those costs.

See section VII.E for a list of issues on which DOE seeks comment.

b. Government Regulatory Impact Model Scenarios

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 non-production cost markups to the MPCs estimated in the engineering analysis for each product class and efficiency level. Modifying these markups in the standards case yields different sets of impacts on manufacturers. For the MIA, DOE modeled two standards-case markup scenarios to represent 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 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'' 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 a product class. As production costs increase with efficiency, this scenario implies that the absolute dollar markup will increase as well. Based on publicly-available financial information for manufacturers of commercial packaged boilers, as well as comments from manufacturer interviews, DOE assumed the average non-production cost 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. This markup scenario represents the upper bound of the CPB industry's profitability in the standards case because manufacturers are able to fully pass through additional costs due to standards to consumers.

DOE decided to include the preservation of per-unit operating profit scenario in its analysis because manufacturers stated that they do not expect to be able to mark up the full cost of production 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 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. This is because manufacturers are not able to fully pass through to consumers the additional costs necessitated by CPB standards, as they are able to do in the preservation of gross margin percentage markup scenario.

2. Manufacturer Interviews

DOE interviewed manufacturers representing approximately 95 percent of the CPB market by revenue. DOE contractors endeavor to conduct interviews with a representative cross section of manufacturers (including large and small manufacturers, covering all equipment classes and product offerings). DOE contractors reached out to all the small business manufacturers that were identified as part of the analysis, as well as larger manufacturers that have significant market share in the CPB market. These interviews were in addition to those DOE conducted as part of the engineering analysis. The information gathered during these interviews enabled DOE to tailor the GRIM to reflect the unique financial characteristics of the CPB industry. The information gathered during these interviews enabled DOE to tailor the GRIM to reflect the unique financial characteristics of the CPB industry. All interviews provided information that DOE used to evaluate the impacts of potential amended energy conservation standards on manufacturer cash flows, manufacturing capacities, and employment levels.

In interviews, DOE asked manufacturers to describe their major concerns with potential standards arising from a rulemaking involving commercial packaged boilers. Manufacturer interviews are conducted under non-disclosure agreements (NDAs), so DOE does not document these discussions in the same way that it does public comments in the comment summaries and DOE's responses throughout the rest of this notice. The following sections highlight the most significant manufacturers' statements that helped shape DOE's understanding of potential impacts of an amended standard on the industry. Manufacturers raised a range of general issues for DOE to consider, including a diminished ability to serve the replacement market, concerns that condensing boilers may not perform as rated without heating system modifications, and concerns about reduced product durability. Below, DOE summarizes these issues, which were raised in manufacturer interviews, in order to obtain public comment and related data.

a. Testing Burden

Several manufacturers expressed concern regarding the testing burden associated with amended energy conservation standards. Manufacturers noted that amended standards and an altered test procedure will result in them having to retest all of their equipment, which they pointed out is a costly and logistically challenging process due to the large size of the equipment and the fact that a lot of commercial packaged boilers are customized for particular customers. Manufacturers stated that retesting all of their models would put a strain on their lab resources and would be financially burdensome.

b. Condensing Boilers Not Appropriate for Many Commercial Applications

Several manufacturers expressed concern that they would only be able to meet certain efficiency levels with condensing technology in gas-fired hot water equipment. They argued that this technology would not be effective in many commercial applications. Several manufacturers pointed out that that condensing boilers will not operate in condensing mode in larger applications and they will not realize any efficiency gains when buildings and heat distribution systems are not designed around condensing technology. Manufacturers noted that it is very difficult to sell condensing boilers in the replacement market (which, according to manufacturers, comprises about 90% of boiler sales) because customers would have to make expensive retrofit changes to venting and distribution systems.

Manufacturers also pointed out that condensing boilers may not save energy in commercial applications, even if they were to operate in condensing mode. Several manufacturers argued that condensing equipment requires higher pump force power and higher horsepower blower motors, and thus they consume more electricity. They noted that even if the boiler were operating in condensing mode, the fuel savings could be partially offset by higher electricity use.

c. Not Many American Companies Produce Condensing Heat Exchangers

Several manufacturers expressed concern that if DOE were to mandate efficiency levels that could only be achieved with condensing technology for gas-fired hot water equipment, companies would likely face high conversion costs. While many companies in the U.S. currently produce condensing equipment, most condensing heat exchangers are sourced from European or Asian companies. American companies would have to decide whether to develop their own condensing heat exchanger production capacity or assemble a baseline product around a condensing heat exchanger. Developing condensing heat exchanger production capacity would require large capital investments in new production lines and new equipment to handle the different metals that are required. Companies that are currently heavily invested in lower-efficiency products may not be able to make these investments. The other option would be for companies to drop their noncondensing equipment and assemble equipment around a sourced heat exchanger. In this scenario, companies would lose a significant piece of the value chain.

d. Reduced Product Durability and Reliability

Several manufacturers commented that higher-efficiency condensing boilers on the market have not demonstrated the same level of durability and reliability as lower-efficiency products. Manufacturers stated that condensing products require more upkeep and maintenance and generally do not last as long as non-condensing products. Several manufacturers pointed out that they generally incur large after-sale costs with their condensing products because of additional warranty claims. Maintenance calls for these boilers require more skilled technicians and occur more frequently than they do with non-condensing boilers.

3. Discussion of Comments

During the preliminary analysis public meeting, interested parties commented on the assumptions and results of the preliminary analysis. Oral and written comments addressed several topics, including concerns regarding the impact condensing technology has on the industry.

a. Impacts on Condensing Technology

In written comments, Lochinvar expressed concern that setting a stringent standard, specifically at condensing levels, will cause significant impacts to the CPB industry. 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. To limit significantly negative industry impacts on manufacturers and product offerings, Lochinvar recommends that DOE does not set a standard that requires condensing technology. (Lochinvar, No. 31 at p. 6)

Additionally, Lochinvar states 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)

While DOE acknowledges that a stringent standard, specifically condensing technology, may negatively impact INPV and limit industry product offerings, the proposed standards in this document do not mandate condensing technology. Moreover, EPCA requires DOE to set forth energy conservation standards that are technologically feasible and economically justified and would result in significant additional energy conservation, supported by clear and convincing evidence. 42 U.S.C. 6313(a)(6)(A)(ii)(II) and (C)(i). In determining whether a standard is economically justified, DOE considers, to the greatest extent practicable, the following factors: (1) The economic impact of the standard on the manufacturers and on the consumers of the products subject to such 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, or in the initial charges for, or maintenance expenses of the covered products which are likely to result from the imposition of the standard; (3) the total projected amount of energy (or as applicable, water) savings likely to result directly from the imposition of the standard; (4) any lessening of the utility or performance of the covered products likely to result directly from the imposition of the standard; (5) the impact of any lessening competition, as determined in the writing by the Attorney General, that is likely to result from the imposition of the standard; (6) the need for national energy and water conservation; and (7) other factors the Secretary considers relevant.

As such, DOE assesses impacts on competition, manufacturing capacity, employment, cumulative regulatory burden and impacts on INPV in the Manufacturer Impact Analysis, which is discussed in greater detail in chapter 12 of the CPB NOPR TSD.

K. Emissions Analysis

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

The analysis of power sector emissions uses marginal emissions factors that were derived from data in *AEO2015,* as described in section IV.M of this document. The analysis of power sector emissions uses marginal emissions factors that were derived from data in *AEO2015,* as described in section IV.M of this document. The methodology is described in chapter 13 and chapter 15 of the NOPR TSD.

Combustion emissions of CH_4 and N_2O are estimated using emissions intensity factors published by the EPA, GHG Emissions Factors Hub.[69] The FFC upstream emissions are estimated based on the methodology described in appendix 10D of the NOPR 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 MMBtu of site energy savings. Total emissions reductions are estimated using the energy savings calculated in the national impact analysis.

For CH_4 and N_2O, DOE calculated emissions reduction in tons and also in terms of units of carbon dioxide equivalent (CO_{2eq}). Gases are converted to CO_{2eq} by multiplying each ton of gas by the gas' global warming potential (GWP) over a 100-year time horizon. Based on the Fifth Assessment Report of the Intergovernmental Panel on Climate Change,[70] DOE used GWP values of 28 for CH_4 and 265 for N_2O.

Because the on-site operation of commercial packaged boilers requires use 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 were estimated using emissions intensity factors from an EPA publication.[71]

The *AEO* incorporates the projected impacts of existing air quality regulations on emissions. *AEO2015* generally represents current legislation and environmental regulations, including recent government actions, for which implementing regulations were available as of October 31, 2014. DOE's estimation of impacts accounts for the presence of the emissions control programs discussed in the following paragraphs.

SO_2 emissions from affected electric generating units (EGUs) are subject to nationwide and regional emissions cap-and-trade programs. Title IV of the Clean Air Act sets an annual emissions cap on SO_2 for affected EGUs in the 48 contiguous states and the District of Columbia (DC). (42 U.S.C. 7651 *et seq.*) SO_2 emissions from 28 eastern states and DC were also limited under the Clean Air Interstate Rule (CAIR). 70 FR 25162 (May 12, 2005). 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 DC Circuit, but it remained in effect.[72] In 2011, EPA issued a replacement for CAIR, the Cross-State Air Pollution Rule (CSAPR). 76 FR 48208 (August 8, 2011). On August 21, 2012, the DC Circuit issued a decision to vacate CSAPR,[73] and the court ordered EPA to continue administering CAIR. On April 29, 2014, the U.S. Supreme Court reversed the judgment of the DC Circuit and remanded the case for further proceedings consistent with the Supreme Court's opinion.[74] On October 23, 2014, the DC Circuit lifted the stay of CSAPR.[75] Pursuant to this action, CSAPR went into effect (and CAIR ceased to be in effect) as of January 1, 2015. On July 28, 2015, the DC Circuit issued its opinion regarding CSAPR on remand from the Supreme Court. The court largely upheld CSAPR, but remanded to EPA without vacateur certain states' emissions budgets for reconsideration.[76]

EIA was not able to incorporate CSAPR into *AEO2015,* so DOE's analysis used emissions factors that assume that CAIR, not CSAPR, is the regulation in force. However, the difference between CAIR and CSAPR is not significant for the purpose of DOE's analysis of emissions impacts from energy conservation standards.

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

Beginning in 2016, however, SO_2 emissions will fall as a result of the Mercury and Air Toxics Standards (MATS) for power plants. 77 FR 9304 (Feb. 16, 2012). In the MATS rule, EPA established a standard for hydrogen chloride as a surrogate for acid gas hazardous air pollutants (HAP), and also established a standard for SO_2 (a non-HAP acid gas) as an alternative equivalent surrogate standard for acid gas HAP. The same controls are used to reduce HAP and non-HAP acid gas; thus, SO_2 emissions will be reduced as a result of the control technologies installed on coal-fired power plants to comply with the MATS requirements for acid gas. *AEO2015* assumes that, in order to continue operating, coal plants must have either flue gas desulfurization or dry sorbent injection systems installed by 2016. Both technologies, which are used to reduce acid gas emissions, also reduce SO_2 emissions. Under the MATS, emissions will be far below the cap established by CAIR, so it is unlikely that excess SO_2 emissions allowances resulting from the lower electricity demand would be needed or used to permit offsetting increases in SO_2 emissions by any regulated EGU.[77] Therefore, DOE believes that energy conservation standards will generally reduce SO_2 emissions in 2016 and beyond.

[69] Available at: *http://www.epa.gov/climateleadership/inventory/ghg-emissions.html.*

[70] 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.

[71] U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, AP–42, Fifth Edition, Volume I: Stationary Point and Area Sources (1998). Available at: *http://www.epa.gov/ttn/chief/ap42/index.html*).

[72] *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).

[73] *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).

[74] 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.

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

[76] See *EME Homer City Generation, LP* v. *EPA 795 F.3d 118 (D.C. Cir. 2015).*

[77] DOE notes that the Supreme Court remanded EPA's 2012 rule regarding national emission standards for hazardous air pollutants from certain electric utility steam generating units. See *Michigan* v. *EPA* (Case No. 14–46, 2015). DOE has tentatively determined that the remand of the MATS rule does not change the assumptions regarding the impact of energy efficiency standards on SO_2 emissions (see chapter 13 of the NOPR TSD for further discussion). Further, while the remand of the MATS rule may have an impact on the overall amount of mercury emitted by power plants, it does not change the impact of the energy efficiency standards on mercury emissions. DOE will continue to monitor developments related to this case and respond to them as appropriate.

CAIR established a cap on NO_X emissions in 28 eastern states and the District of Columbia.[78] Energy conservation standards are expected to have little effect on NO_X emissions in those states covered by CAIR because excess NO_X emissions allowances resulting from the lower electricity demand could be used to permit offsetting increases in NO_X emissions from other facilities. However, standards would be expected to reduce NO_X emissions in the states not affected by the caps, so DOE estimated NO_X emissions 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 *AEO2015,* which incorporates the MATS.

L. Monetizing Carbon Dioxide and Other Emissions Impacts

As part of the development of this proposed rule, DOE considered the estimated monetary benefits from the reduced emissions of CO_2 and NO_X that are expected to result from each of the TSLs considered. In order to make this calculation analogous to the calculation of the NPV of consumer benefit, DOE considered the reduced emissions expected to result over the lifetime of products shipped in the forecast period for each TSL. This section summarizes the basis for the monetary values used for each of these emissions and presents the values considered in this document.

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) 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 recent report from the National Research Council[79] 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. The agency can estimate the benefits from reduced (or costs from increased) emissions in any future year by multiplying the change in emissions in that year by the SCC value appropriate for that year. The net present value of the benefits can then be calculated by multiplying the future benefits by an appropriate discount factor and summing across all affected years.

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

b. Development of Social Cost of Carbon Values

In 2009, an interagency process was initiated to offer a preliminary assessment of how best to quantify the benefits 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. These models are frequently cited in the peer-reviewed literature and

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

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

were used in the last assessment of the Intergovernmental Panel on Climate Change (IPCC). Each model was given equal weight in the SCC values that were developed.

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

In 2010, the interagency group selected four sets of SCC values for use in regulatory analyses. Three sets of values are based on the average SCC from three integrated assessment models, at discount rates of 2.5 percent, 3 percent, and 5 percent. The fourth set, which represents the 95th-percentile SCC estimate across all three models at a 3-percent discount rate, is included to represent higher than expected impacts from climate change further out in the tails of the SCC distribution. The values grow in real terms over time.

Additionally, the interagency group determined that a range of values from 7 percent to 23 percent should be used to adjust the global SCC to calculate domestic effects,[80] although preference is given to consideration of the global benefits of reducing CO_2 emissions. Table IV.13 presents the values in the 2010 interagency group report,[81] which is reproduced in appendix 14A of the NOPR TSD.

TABLE IV.13—ANNUAL SCC VALUES FROM 2010 INTERAGENCY REPORT, 2010–2050

[2007$ per metric ton CO_2]

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

The SCC values used for this NOPR analysis were generated using the most recent versions of the three integrated assessment models that have been published in the peer-reviewed literature, as described in the 2013 update from the interagency working group (revised July 2015).[82]

Table IV.14 shows the updated sets of SCC estimates from the latest interagency update in five-year increments from 2010 to 2050. Appendix 14B of the NOPR TSD provides the full set of values and a discussion of the revisions made in 2015. The central value that emerges is the average SCC across models at a 3-percent discount rate. However, for purposes of capturing the uncertainties involved in regulatory impact analysis, the interagency group emphasizes the importance of including all four sets of SCC values.

TABLE IV.14—ANNUAL SCC VALUES FROM 2013 INTERAGENCY UPDATE (REVISED JULY 2015), 2010–2050

[2007$ per metric ton CO_2]

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

[80] It is recognized that this caculation 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.

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

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

TABLE IV.14—ANNUAL SCC VALUES FROM 2013 INTERAGENCY UPDATE (REVISED JULY 2015), 2010–2050—Continued

[2007$ per metric ton CO_2]

Year	Discount rate			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
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 above 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. Although uncertainties remain, the revised estimates used for this NOPR 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, and with input from the public. In November 2013, OMB announced a new opportunity for public comments 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.[83] It 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.

In summary, in considering the potential global benefits resulting from reduced CO_2 emissions resulting from this proposed rule, DOE used the values from the 2013 interagency report, adjusted to 2014$ 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 $12.2, $40.0, $62.3, and $117 per metric ton avoided (values expressed in 2014$). DOE derived values after 2050 using the relevant growth rates for the 2040–2050 period 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 using benefit per ton estimates from the Regulatory Impact Analysis titled, ''Proposed Carbon Pollution Guidelines for Existing Power Plants and Emission Standards for Modified and Reconstructed Power Plants,'' published in June 2014 by EPA's Office of Air Quality Planning and Standards. The report includes high and low values for NO_X (as $PM_{2.5}$) for 2020, 2025, and 2030 discounted at 3 percent and 7 percent (see chapter 14 of the NOPR TSD).[84] DOE assigned values for 2021–2024 and 2026–2029 using, respectively, the values for 2020 and 2025. DOE assigned values after 2030 using the 2030 value. DOE multiplied the emissions reduction in each year by the associated $/ton values, and then discounted each series using discount rates of 3 percent and 7 percent as appropriate. DOE will continue to evaluate the monetization of avoided NO_X emissions and will make appropriate updates of the current analysis for the final rulemaking. DOE is evaluating appropriate monetization of avoided SO_2 and Hg emissions in energy conservation standards rulemakings. DOE has not included monetization of those emissions in the current analysis.

M. Utility Impact Analysis

The utility impact analysis estimates several effects on the electric power 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 *AEO2015.* NEMS produces the *AEO* Reference case, as well as a number of side cases that estimate the economy-wide impacts of changes to energy supply and demand. DOE uses published side cases to estimate the marginal impacts of reduced energy demand on the utility sector. These marginal factors are estimated based on the changes to electricity sector generation, installed capacity, fuel consumption and emissions in the *AEO* Reference case and various side cases.

The output of this analysis is a set of time-dependent coefficients that capture the change in electricity generation, primary fuel consumption, installed capacity, and power sector emissions due to a unit reduction in demand for a given end use. These coefficients are multiplied by the stream of electricity savings calculated in the NIA to provide estimates of selected utility impacts of new or amended energy conservation standards. See chapter 15 of the NOPR TSD for further details regarding the utility impact analysis.

N. Employment Impact Analysis

Employment impacts from new or amended energy conservation standards include direct and indirect impacts. Direct employment impacts are any changes in the number of employees of manufacturers of the equipment subject

[83] Available at: *https://www.whitehouse.gov/blog/2015/07/02/estimating-benefits-carbon-dioxide-emissions-reductions.*

[84] U.S. Environmental Protection Agency, *Sector-based $PM_{2.5}$ Benefit Per Ton Estimates* (Available at: *http://www2.epa.gov/benmap/sector-based-pm25-benefit-ton-estimates.*

to standards; the MIA addresses those impacts. Indirect employment impacts are changes in national employment that occur due to the shift in expenditures and capital investment caused by the purchase and operation of more efficient 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, due to (1) reduced spending by end users on energy, (2) reduced spending on new energy supply by the utility industry, (3) increased consumer spending on the purchase of new equipment, and (4) the effects of those three factors throughout the economy.

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

For the standard levels considered in this document, DOE estimated indirect national employment impacts using an input/output model of the U.S. economy called Impact of Sector Energy Technologies, Version 3.1.1 (ImSET). ImSET is a special-purpose version of the ''U.S. Benchmark National Input-Output'' (I–O) model, which was designed to estimate the national employment and income effects of energy-saving technologies. The ImSET software includes a computer-based I–O model having structural coefficients that characterize economic flows among the 187 sectors. ImSET's national economic I–O structure is based on a 2002 U.S. benchmark table specially aggregated to the 187 sectors most relevant to industrial, commercial, and residential building energy use. DOE notes that ImSET is not a general equilibrium forecasting model and understands the uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Because ImSET does not incorporate price changes, the employment effects predicted by ImSET may over-estimate actual job impacts over the long run. For the NOPR analysis, DOE used ImSET only to estimate short-term employment impacts.

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

V. Analytical Results

The following sections address the results from DOE's analyses with respect to potential amended energy conservation standards for the CPB equipment that is the subject of this rulemaking. They address the TSLs examined by DOE, the projected impacts of each of these levels if adopted as energy conservation standards for CPB equipment, and the standard levels that DOE is proposing in this NOPR. Additional details regarding DOE's analyses are contained in the relevant TSD chapters supporting this NOPR.

A. Trial Standard Levels

At the NOPR stage, DOE develops trial standard levels (TSLs) for consideration. DOE established TSLs for this document by grouping different efficiency levels, which are potential standard levels for each equipment class. DOE analyzed the benefits and burdens of the TSLs developed for this proposed rule. DOE examined five TSLs for commercial packaged boilers.

Table V.1 and Table V.2 present the TSLs analyzed and the corresponding efficiency levels 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% 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 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	4	6	7	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	5	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	85%	n/a	95%	n/a	99%	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	88%	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

As discussed in section II.A of this document, EPCA provides seven factors to be evaluated in determining whether a more stringent standard for commercial packaged boilers is economically justified. (42 U.S.C. 6313(a)(6)(B)(ii) and (C)(i)) The following sections generally discuss how DOE is addressing each of those factors in this rulemaking.

1. Economic Impacts on Individual Consumers

DOE analyzed the economic impacts on CPB consumers by looking at the effects standards would have on the LCC and PBP. DOE also examined the impacts of potential standards on consumer subgroups. These analyses are discussed below.

a. Life-Cycle Cost and Payback Period

To evaluate the net economic impact of proposed standards on CPB consumers, DOE conducted LCC and PBP analyses for each TSL. In general, higher-efficiency equipment would affect consumers in two ways: (1) Annual operating expense would decrease, and (2) purchase price would increase. LCC and PBP include total installed costs (*i.e.,* product price plus installation costs), and operating costs (*i.e.,* annual energy cost, repair costs, and maintenance costs). The LCC calculation also uses product lifetime and a discount rate. Chapter 8 of the NOPR TSD and section IV.F of this document discuss the detailed information on the LCC and PBP analysis.

DOE's LCC and PBP analyses provided key outputs for each efficiency level above the baseline for each equipment class, as reported in Table V.3 to Table V.18. Two tables are presented for each equipment class. The first table presents the results of the LCC analysis by efficiency levels and TSLs and shows installed costs, first year's operating cost, lifetime operating cost, and mean LCC, as well as simple PBP. The second table presents the percentage of consumers who experience a net cost, as well as the mean LCC savings for all commercial consumers.

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 (2014$)				Simple payback period (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC	
0	0	$25,571	$12,551	$218,155	$243,727	
	1	26,427	12,420	215,863	242,290	6.5
	2	27,350	12,292	213,627	240,977	6.9
1	3	30,302	12,046	209,326	239,627	9.4
2	4	31,573	11,927	207,252	238,826	9.6
	5	40,896	11,587	202,027	242,924	15.9
3	6	41,637	11,371	198,263	239,901	13.6
4, 5	7	47,145	10,969	191,355	238,500	13.6

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 EFFICIENCY DISTRIBUTION FOR SMALL GAS-FIRED HOT WATER COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Life-cycle cost savings	
		% of commercial consumers that experience a net cost	Average life-cycle cost savings * (2014$)
0	0	0	
	1	2	$106
	2	4	318
1	3	20	223
2	4	23	521
	5	46	−2,031
3	6	42	302
4, 5	7	56	1,656

* The calculation includes consumers with zero LCC savings (no impact).

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 (2014$)				Simple payback period *years*
		Installed cost	First year's operating cost	Lifetime operating cost	LCC	
0	0	$94,053	$49,620	$842,932	$936,985	
	1	99,700	49,025	832,857	932,556	9.5
1	2	106,020	48,445	823,055	929,074	10.2
2, 3	3	113,093	47,881	813,516	926,609	11.0
	4	169,571	45,655	779,745	949,315	19.0
4, 5	5	178,725	44,197	755,202	933,927	15.6

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

TABLE V.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	
		% of commercial consumers that experience a net cost	Average life-cycle cost savings * (2014$)
0	0	0	
	1	10	$924
1	2	21	2,419
2, 3	3	27	3,647
	4	57	−13,074
4, 5	5	56	2,062

* The calculation includes consumers with zero LCC savings (no impact).

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 (2014$)				Simple payback period (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC	
0	0	$27,566	$17,797	$323,016	$350,583	
	1	28,457	17,607	319,481	347,938	4.7
	2	29,414	17,422	316,032	345,447	4.9
	3	30,444	17,242	312,666	343,110	5.2

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

TSL	Thermal efficiency (E_T) level	Average costs (2014$)				Simple payback period (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC	
1, 2, 3	4	32,742	16,893	306,170	338,912	5.7
4	5	34,666	16,724	303,036	337,701	6.6
5	6	51,938	16,087	292,517	344,455	14.3

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

TABLE V.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	
		% of commercial consumers that experience a net cost	Average life-cycle cost savings* (2014$)
0	0	0	
	1	8	$1,040
	2	13	2,544
	3	16	4,208
1, 2, 3	4	20	7,799
4	5	26	8,939
5	6	56	2,333

*The calculation includes consumers with zero LCC savings (no impact).

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 (2014$)				Simple payback period (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC	
0	0	$66,053	$101,507	$1,804,595	$1,870,649	
1	1	74,942	99,348	1,766,049	1,840,992	4.1
2, 3	2	86,080	97,281	1,729,192	1,815,272	4.7
4	3	92,980	96,281	1,711,365	1,804,345	5.2
5	4	159,031	93,901	1,670,295	1,829,325	12.2

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

TABLE V.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	
		% of commercial consumers that experience a net cost	Average life-cycle cost savings* (2014$)
0	0	0	
1	1	1	$10,108
2, 3	2	5	30,834
4	3	7	40,983

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

TSL	Combustion efficiency (E_C) level	Life-cycle cost savings	
		% of commercial consumers that experience a net cost	Average life-cycle cost savings * (2014$)
5	4	46	17,076

* The calculation includes consumers with zero LCC savings (no impact).

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 (2014$)				Simple payback period (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC	
0	0	$22,540	$12,354	$212,456	$234,996	
	1	23,330	12,228	210,244	233,574	6.3
	2	24,183	12,106	208,090	232,274	6.6
1	3	25,107	11,987	205,992	231,098	7.0
2, 3	4	26,105	11,871	203,946	230,051	7.4
4, 5	5	28,350	11,647	200,010	228,360	8.2

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

TABLE V.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	
		% of commercial consumers that experience a net cost	Average life-cycle cost savings * (2014$)
0	0	0	
	1	10	$600
	2	12	1,205
1	3	18	1,933
2, 3	4	26	2,782
4, 5	5	34	4,383

* The calculation includes consumers with zero LCC savings (no impact).

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 (2014$)				Simple payback period (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC	
0	0	$82,527	$53,362	$926,128	$1,008,655	
	1	84,898	52,735	915,193	1,000,091	3.8
	2	87,405	52,125	904,540	991,946	3.9
	3	90,056	51,529	894,159	984,215	4.1
1	4	92,859	50,949	884,039	976,898	4.3
2, 3	5	96,563	50,383	874,171	970,734	4.7

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

TSL	Thermal efficiency (E_T) level	Average costs (2014$)				Simple payback period (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC	
4, 5	6	103,011	49,292	855,155	958,165	5.0

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

TABLE V.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	
		% of commercial consumers that experience a net cost	Average life-cycle cost savings * (2014$)
0	0	0	
	1	1	880
	2	5	3,528
	3	7	7,059
1	4	12	12,255
2, 3	5	15	16,802
4, 5	6	19	28,295

* The calculation includes consumers with zero LCC savings (no impact).

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 2014$				Simple payback period (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC	
0	0	$21,965	$20,964	$375,253	$397,218	
1	1	24,212	20,513	366,987	391,199	5.0
2, 3	2	25,527	20,296	363,005	388,532	5.3
4, 5	3	28,615	19,876	355,328	383,942	6.1

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

TABLE V.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	
		% of commercial consumers that experience a net cost	Average life-cycle cost savings * (2014$)
0	0	0	
1	1	4	1,985
2, 3	2	12	4,256
4, 5	3	16	8,637

* The calculation includes consumers with zero LCC savings (no impact).

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 2014$				Simple payback period (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC	
0	0	$67,991	$99,776	$1,738,018	$1,806,009	
1	1	73,849	97,444	1,697,166	1,771,014	2.5
2, 3	2	80,651	95,223	1,658,263	1,738,914	2.8
4, 5	3	88,551	93,105	1,621,176	1,709,727	3.1

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

TABLE V.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	
		% of commercial consumers that experience a net cost	Average life-cycle cost savings * (2014$)
0	0	0	
1	1	0	13,243
2, 3	2	1	36,128
4, 5	3	1	65,128

* The calculation includes consumers with zero LCC savings (no impact).

b. Consumer Subgroup Analysis

In the consumer subgroup analysis, DOE estimated the impacts of the considered TSLs on low-income 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 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. 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 NOPR TSD presents detailed results of the consumer subgroup analysis.

TABLE V.19—COMPARISON OF IMPACTS FOR CONSUMER SUBGROUPS WITH ALL CONSUMERS, SMALL GAS-FIRED HOT WATER COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Average LCC savings (2014$) *			Simple payback period (years)		
		Residential low-income	Commercial small business	All	Residential low-income	Commercial small business	All
	1	$185	$86	$106	4.2	6.9	6.5
	2	549	252	318	4.4	7.2	6.9
1	3	1,126	−27	223	6.2	9.8	9.4
2	4	1,839	152	521	6.3	10.1	9.6
	5	1,011	−2,933	−2,031	11.0	16.6	15.9
3	6	4,554	−960	302	9.2	14.3	13.6
4, 5	7	9,657	−532	1,656	9.0	14.3	13.6

* Parentheses indicate negative values.

TABLE V.20—COMPARISON OF IMPACTS FOR CONSUMER SUBGROUPS WITH ALL CONSUMERS, LARGE GAS-FIRED HOT WATER COMMERCIAL PACKAGED BOILERS

TSL	Combustion efficiency (E_C) level	Average LCC savings (2014$) *			Simple payback period (years)		
		Residential low-income	Commercial small business	All	Residential low-income	Commercial small business	All
	1	$1,634	$671	$924	7.9	9.5	9.5
1	2	4,456	1,639	2,419	8.5	10.2	10.2
2, 3	3	7,172	2,265	3,647	9.1	11.0	11.0
	4	−2,683	−17,455	−13,074	17.1	19.1	19.0
4, 5	5	18,622	−5,178	2,062	13.6	15.7	15.6

* Parentheses indicate negative values.

TABLE V.21—COMPARISON OF IMPACTS FOR CONSUMER SUBGROUPS WITH ALL CONSUMERS, SMALL OIL-FIRED HOT WATER COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Average LCC savings (2014$) *			Simple payback period (years)		
		Residential low-income	Commercial small business	All	Residential low-income	Commercial small business	All
	1	$2,045	$562	$1,040	2.7	6.5	4.7
	2	5,065	1,355	2,544	2.8	6.8	4.9
	3	8,466	2,189	4,208	3.0	7.2	5.2
1, 2, 3	4	16,048	3,832	7,799	3.3	7.9	5.7
4	5	18,773	4,172	8,939	4.2	8.8	6.6
5	6	22,248	−7,130	2,333	8.4	19.3	14.3

* Parentheses indicate negative values.

TABLE V.22—COMPARISON OF IMPACTS FOR CONSUMER SUBGROUPS WITH ALL CONSUMERS, LARGE OIL-FIRED HOT WATER COMMERCIAL PACKAGED BOILERS

TSL	Combustion efficiency (E_C) level	Average LCC savings (2014$) *			Simple payback period (years)		
		Residential low-income	Commercial small business	All	Residential low-income	Commercial small business	All
1	1	$16,193	$8,602	$10,108	2.9	4.3	4.1
2, 3	2	50,146	25,900	30,834	3.3	4.9	4.7
4	3	67,827	34,104	40,983	3.6	5.3	5.2
5	4	49,517	6,596	17,076	9.5	12.5	12.2

* Parentheses indicate negative values.

TABLE V.23—COMPARISON OF IMPACTS FOR CONSUMER SUBGROUPS WITH ALL CONSUMERS, SMALL GAS-FIRED STEAM COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Average LCC savings (2014$) *			Simple payback period (years)		
		Residential low-income	Commercial small business	All	Residential low-income	Commercial small business	All
	1	$930	$503	$600	4.5	6.5	6.3
	2	1,897	1,004	1,205	4.8	6.8	6.6
1	3	3,084	1,597	1,933	5.0	7.2	7.0
2, 3	4	4,556	2,277	2,782	5.3	7.6	7.4
4, 5	5	7,591	3,507	4,383	5.9	8.4	8.2

* Parentheses indicate negative values.

TABLE V.24—COMPARISON OF IMPACTS FOR CONSUMER SUBGROUPS WITH ALL CONSUMERS, LARGE GAS-FIRED STEAM COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Average LCC savings (2014$) *			Simple payback period (years)		
		Residential low-income	Commercial small business	All	Residential low-income	Commercial small business	All
	1	$877	$795	$880	3.6	3.8	3.8
	2	3,433	3,161	3,528	3.8	3.9	3.9
	3	6,930	6,308	7,059	3.9	4.1	4.1
1	4	12,169	10,892	12,255	4.1	4.3	4.3
2, 3	5	16,849	14,792	16,802	4.5	4.7	4.7
4, 5	6	28,667	24,796	28,295	4.8	5.0	5.0

* Parentheses indicate negative values.

TABLE V.25—COMPARISON OF IMPACTS FOR CONSUMER SUBGROUPS WITH ALL CONSUMERS, LARGE GAS-FIRED STEAM COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Average LCC savings (2014$) *			Simple payback period (years)		
		Residential low-income	Commercial small business	All	Residential low-income	Commercial small business	All
1	1	$3,135	$1,687	$1,985	3.7	5.2	5.0
2, 3	2	6,704	3,577	4,256	4.0	5.5	5.3
4, 5	3	13,943	7,123	8,637	4.5	6.3	6.1

* Parentheses indicate negative values.

TABLE V.26—COMPARISON OF IMPACTS FOR CONSUMER SUBGROUPS WITH ALL CONSUMERS, LARGE OIL-FIRED STEAM COMMERCIAL PACKAGED BOILERS

TSL	Thermal efficiency (E_T) level	Average LCC savings (2014$) *			Simple payback period (years)		
		Residential low-income	Commercial small business	All	Residential low-income	Commercial small business	All
1	1	$19,961	$11,806	$13,243	1.7	2.5	2.5
2, 3	2	54,869	32,079	36,128	1.9	2.8	2.8
4, 5	3	100,020	57,562	65,128	2.1	3.1	3.1

* Parentheses indicate negative values.

c. Rebuttable Presumption Payback

As discussed in section III.E.2 of this document, EPCA provides 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. DOE calculated a rebuttable-presumption PBP for each TSL to determine whether DOE could presume that a standard at that level is economically justified.

DOE calculated a rebuttable presumption payback period for each TSL using average installed cost to the commercial consumers and first year energy savings. As a result, DOE calculated a single rebuttable-presumption payback value, and not a distribution of PBPs, for each TSL. Table V.27 shows the rebuttable-presumption PBPs for the considered TSLs. The rebuttable presumption is fulfilled in those cases where the PBP is three years or less. However, DOE routinely conducts an economic analysis that considers the full range of impacts to the consumer, manufacturer, Nation, and environment, as required by EPCA. 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 three-year PBP analysis). Section V.C of this document addresses how DOE considered the range of impacts to select the proposed standards.

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	8.0	8.2	11.4	11.5	11.5
Large Gas-Fired Hot Water Commercial Packaged Boilers	8.3	9.0	9.0	12.7	12.7
Small Oil-Fired Hot Water Commercial Packaged Boilers	11.2	11.2	11.2	12.9	27.4
Large Oil-Fired Hot Water Commercial Packaged Boilers	7.6	8.8	8.8	9.5	22.7

TABLE V.27—REBUTTABLE PRESUMPTION PAYBACK PERIODS FOR COMMERCIAL PACKAGED BOILER EQUIPMENT CLASSES—Continued

Equipment class	Rebuttable presumption payback (years)				
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Small Gas-Fired Steam Commercial Packaged Boilers	6.0	6.3	6.3	7.1	7.1
Large Gas-Fired Steam Commercial Packaged Boilers	3.6	3.9	3.9	4.2	4.2
Small Oil-Fired Steam Commercial Packaged Boilers	9.2	9.8	9.8	11.3	11.3
Large Oil-Fired Steam Commercial Packaged Boilers	4.6	5.1	5.1	5.6	5.6

2. Economic Impacts on Manufacturers

As noted above, DOE performed an MIA to estimate the impact of amended energy conservation standards on manufacturers of commercial packaged boilers. The following section describes the expected impacts on manufacturers at each considered TSL. Chapter 12 of the NOPR TSD explains the analysis in further detail.

a. Industry Cash-Flow Analysis Results

Table V.28 and Table V.29 depict the estimated financial impacts (represented by changes in INPV) of amended energy conservation standards on manufacturers of commercial packaged boilers, as well as the conversion costs that DOE expects manufacturers would incur for all product classes at each TSL. To evaluate the range of cash-flow impacts on the CPB industry, 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 upper (less severe) bound of the range of potential impacts, DOE modeled a preservation of gross margin percentage markup scenario, in which a uniform ‘‘gross margin percentage’’ markup is applied across all potential efficiency levels. In this scenario, DOE assumed that a manufacturer's absolute dollar markup would increase as production costs increase in the standards case.

To assess the lower (more severe) bound of the range of potential impacts, DOE modeled the preservation of operating profit markup scenario, which assumes that manufacturers would 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 products 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.

As noted in the MIA methodology discussion (see IV.J.1), in addition to markup scenarios, the MPC, shipments, and conversion cost assumptions also affect INPV results.

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.

Each of the modeled scenarios in the analysis 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 results from the sum of discounted cash flows from the base year 2014 through 2048, the end of the analysis period.

To provide perspective on the short-run cash flow impact, DOE discusses the change in free cash flow between the no-new-standards case and the standards case at each TSL in the year before new standards would take effect. These figures provide an understanding of the magnitude of the required conversion costs at each TSL relative to the cash flow generated by the industry in the no-new-standards case.

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	*2014$ millions*	180.1	173.7	167.0	157.7	145.9	146.7
Change in INPV	*2014$ millions*		(6.4)	(13.1)	(22.4)	(34.3)	(33.4)
	%		(3.6)	(7.3)	(12.4)	(19.0)	(18.6)
Product Conversion Costs	*2014$ millions*		10.7	18.2	19.3	20.8	21.4
Capital Conversion Costs	*2014$ millions*		4.8	9.3	20.8	33.9	35.2
Total Conversion Costs	*2014$ millions*		15.5	27.5	40.1	54.7	56.6
Free Cash Flow (no-new-standards case = 2019).	*2014$ millions*	12.8	7.2	2.7	(2.8)	(9.2)	(9.9)
Decrease in Free Cash Flow (change from no-new-standards case).	*2014$ millions*		5.6	10.1	15.6	22.0	22.8
	%		43.9	78.7	121.7	171.5	177.4

* Parentheses indicate negative values.

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	*2014*$ millions	180.1	166.8	156.3	116.2	56.1	51.2
Change in INPV	*2014*$ millions		(13.4)	(23.8)	(64.0)	(124.1)	(128.9)
	%		(7.4)	(13.2)	(35.5)	(68.9)	(71.6)
Product Conversion Costs	*2014*$ millions		10.7	18.2	19.3	20.8	21.4
Capital Conversion Costs	*2014*$ millions		4.8	9.3	20.8	33.9	35.2
Total Conversion Costs	*2014*$ millions		15.5	27.5	40.1	54.7	56.6
Free Cash Flow (2018)	*2014*$ millions	12.8	7.2	2.7	(2.8)	(9.2)	(9.9)
Decrease in Free Cash Flow (2018).	*2014*$ millions		5.6	10.1	15.6	22.0	22.8
	%		43.9	78.7	121.7	171.5	177.4

* Parentheses indicate negative values.

TSL 1 represents EL 3 (84%) for small gas-fired hot water boilers, EL 2 (84%) for large gas-fired hot water boilers, EL 4 (87%) for small oil-fired hot water boilers, EL 1 (86%) for large oil-fired hot water boilers, EL 3 (80%) for small gas-fired steam boilers, EL 4 (81%) for large gas-fired steam boilers, EL 1 (83%) for small oil-fired steam boilers, and EL 1 (83%) for large oil-fired steam boilers. At TSL 1, DOE estimates impacts on INPV for CPB manufacturers to range from −7.4 percent to −3.6 percent, or a change in INPV of −$13.4 million to −$6.4 million. At this potential standard level, industry free cash flow would be estimated to decrease by approximately 43.9 percent to $7.2 million, compared to the no-new-standards case value of $12.8 million in 2018, the year before the compliance date. Overall, DOE expects industry to incur product conversion costs of $10.7 million and capital conversion costs of $4.8 million to reach this standard level.

TSL 2 sets the efficiency level at EL 4 (85%) for small gas-fired hot water boilers, EL 3 (85%) for large gas-fired hot water boilers, EL 4 (87%) for small oil-fired hot water boilers, EL 2 (88%) for large oil-fired hot water, EL 4 (81%) for small gas-fired steam boilers, EL 5 (82%) for large gas-fired steam boilers, EL 2 (84%) for small oil-fired steam boilers, and EL 2 (85%) for large oil-fired steam boilers. At TSL 2, DOE estimates impacts on INPV for commercial packaged boilers manufacturers to range from −13.2 percent to −7.3 percent, or a change in INPV of −$23.8 million to −$13.1 million. At this potential standard level, industry free cash flow would be estimated to decrease by approximately 78.7 percent to $2.7 million, compared to the no-new-standards case value of $12.8 million in 2018, the year before the compliance date. Overall, DOE estimates manufactures would incur product conversion costs of $18.2 million and capital conversion costs of $9.3 million at this standard level.

TSL 3 represents EL 6 (95%) for small gas-fired hot water boilers, EL 5 (85%) for large gas-fired hot water boilers, EL 4 (87%) for small oil-fired hot water boilers, EL 2 (88%) for large oil-fired hot water boilers, EL 4 (81%) for small gas-fired steam boilers, EL 5 (82%) for large gas-fired steam boilers, EL 2 (84%) for small oil-fired steam boilers, and EL 2 (85%) for large oil-fired steam boilers. At TSL 3, DOE estimates impacts on INPV for CPB manufacturers to range from −35.5 percent to −12.4 percent, or a change in INPV of −$64.0 million to −$22.4 million. At this potential standard level, industry free cash flow would be estimated to decrease by approximately 121.7 percent in 2018, the year before compliance to −$2.8 million compared to the no-new-standards case value of $12.8 million. DOE estimates manufactures would incur product conversion costs of $19.3 million and capital conversion costs of 20.8 million to reach this standard level.

TSL 4 represents EL 7 (99%) for small gas-fired hot water boilers, EL 5 (97%) for large gas-fired hot water boilers, EL 5 (88%) for small oil-fired hot water boilers, EL 3 (89%) for large oil-fired hot water boilers, EL 5 (83%) for small gas-fired steam boilers, EL 6 (84%) for large gas-fired steam boilers, EL 3 (86%) for small oil-fired steam boilers, and EL 3 (87%) for large oil-fired steam boilers. At TSL 4, DOE estimates impacts on INPV for CPB manufacturers to range from −68.9 percent to −19.0 percent, or a change in INPV of −$124.1 million to −$34.3 million. At this potential standard level, industry free cash flow would be estimated to decrease by approximately 171.5 percent in the year before compliance (2018) to −$9.2 million relative to the no-new-standards case value of $12.8 million. DOE estimates that manufacturers would incur product conversion costs of $20.8 million and capital conversion costs of $33.9 million to reach this standard level.

TSL 5 represents EL 7 (99%) for small gas-fired hot water boilers, EL 5 (97%) for large gas-fired hot water boilers, EL 6 (97%) for small oil-fired hot water boilers, EL 4 (97%) for large oil-fired hot water boilers, EL 5 (83%) for small gas-fired steam boilers, EL 6 (84%) for large gas-fired steam boilers, EL 3 (86%) for small oil-fired steam boilers, and EL 3 (87%) for large oil-fired steam boilers. TSL 5 represents max-tech for all product classes. At TSL 5, DOE estimates impacts on INPV for CPB manufacturers to range from −71.6 percent to −18.6 percent, or a change in INPV of -$128.9 million to −$33.4 million. At this potential standard level, industry free cash flow would be estimated to decrease by approximately 177.4 percent in the year before compliance (2018) to −$9.9 million relative to the no-new-standards case value of $12.8 million. DOE estimates manufacturers would incur product conversion costs of $21.4 million and capital conversion costs of $35.2 million to reach this standard level.

b. Impacts on Direct Employment

To quantitatively assess the impacts of energy conservation standards on direct employment in the CPB industry, DOE used the GRIM to estimate the domestic labor expenditures and number of employees in the no-new-standards case and at each TSL in 2019. DOE used statistical data from the U.S. Census Bureau's 2013 Annual Survey of Manufacturers (ASM) [85], the results of the engineering analysis, and interviews with manufacturers to determine the inputs necessary to calculate industry-

[85] U.S. Census Bureau, Annual Survey of Manufacturers: General Statistics: Statistics for Industry Groups and Industries (2013) (Available at: *http://factfinder2.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t*).

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 2013 ASM). The estimates of production workers in this section cover workers, including line-supervisors who are directly involved in fabricating and assembling a product 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. DOE's estimates only account for production workers who manufacture the specific products covered by this rulemaking. The total direct employment impacts calculated in the GRIM are the sum of the changes in the number of production workers resulting from the amended energy conservation standards for commercial packaged boilers, as compared to the no-new-standards case. In general, more-efficient commercial packaged boilers are more complex and more labor intensive and require specialized knowledge about control systems, electronics, and the different metals needed for the heat exchanger. Per-unit labor requirements and production time requirements increase with higher energy conservation standards. As a result, the total labor calculations described in this paragraph (which are generated by the GRIM) are considered an upper bound to direct employment forecasts.

DOE estimates that in the absence of amended energy conservation standards, there would be 464 domestic production workers in the CPB industry in 2019, the year of compliance. DOE estimates that 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 workers of commercial packaged boilers.

TABLE V.30—POTENTIAL CHANGES IN THE TOTAL NUMBER OF COMMERCIAL PACKAGED BOILERS PRODUCTION WORKERS IN 2019

	No-new-standards case	Trial standard level*				
		1	2	3	4	5
Total Number of Domestic Production Workers in 2019 (without changes in production locations)	464	371 to 495	292 to 516	232 to 522	130 to 608	32 to 629
Potential Changes in Domestic Production Workers in 2019	....	(93) to 31	(172) to 52	(232) to 58	(334) to 144	(431) to 165

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

At the upper end of the range, all examined TSLs show positive impacts on domestic employment levels. Producing more-efficient commercial packaged boilers 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 products 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 products that do not meet the proposed standard. Production worker employment drops in proportion with the percentage of products which are retired. Since this is a lower bound, DOE does not account for additional production labor needed for higher efficiency products. 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 product classes and oil-fired hot water boiler product 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 products. If amended energy conservation standards were to require condensing efficiency levels, these employees would no longer be needed for that function, and manufacturers would have to decide whether to develop their own condensing heat exchanger production, source heat exchangers from Asia or Europe and assemble higher-efficiency products, 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 NOPR TSD.

c. Impacts on Manufacturing Capacity

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 would use condensing technology for hot water boilers would not have a large effect on capacity. The impacts of a potential condensing standard on manufacturer capacity are difficult to quantify. Some manufacturers who are already making condensing products with a sourced heat exchanger said they would likely be able to increase production using the equipment they already have by utilizing a second shift. Others said a condensing standard would idle a large portion of their business, causing stranded assets and decreased capacity. These manufacturers would 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 products. 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 products were broadly adopted. However, because TSL 2 (the proposed level) would not require condensing standards, DOE does not expect manufacturers to face long-term capacity constraints due to the standard levels proposed in this notice.

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 34 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 0 of this document and chapter 12 of the NOPR TSD.

e. Cumulative Regulatory Burden

While any one regulation may not impose a significant burden on manufacturers, the combined effects of recent or impending regulations may have serious consequences for some manufacturers, groups of manufacturers, or an entire industry. Assessing the impact of a single regulation may overlook this cumulative regulatory burden. In addition to energy conservation standards, other regulations can significantly affect manufacturers' financial operations. Multiple regulations affecting the same manufacturer can strain profits and lead companies to abandon product lines or markets with lower expected future returns than competing products. For these reasons, DOE conducts an analysis of cumulative regulatory burden as part of its rulemakings pertaining to equipment efficiency.

For the cumulative regulatory burden analysis, DOE looks at other regulations that could affect CPB manufacturers that will take effect approximately three years before or after the 2019 compliance date of amended energy conservation standards for these products. 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

Regulation*	Comm. Air Conditioners/ Heat Pumps (Air-Cooled)	Comm. Warm Air Furnaces	Res. Furnace Fans	Comm. Water Heaters	Res. Boilers	Res. Furnaces	Res. Central Air Condi-tioners/Heat Pumps	Res. Water Heaters	Res. Pool Heaters
Approximate Compliance Date	2018	2018	2019	2019	2020	2021	2021	2021	2021
Industry Conversion Costs (*$M*)	226.4**	19.9**	40.6	TBD	4.3				
Ace Heating Solutions LLC				x					
ACV International NV (Triangle Tube/Phase III Co.)				x	x			x	
AESYS Technologies, LLC.									
AO Smith (Lochinvar)				x	x			x	x
Axeman-Anderson					x			x	
Bradford White (Laars Heating Systems)				x	x			x	
Burnham Holdings		x	x	x	x	x	x	x	
Camus Hydronics				x	x			x	
Dennison Holdings Ltd (NY Thermal)					x				
ECR International			x	x	x	x	x	x	
E–Z Rect Manufacturing (Allied Engineering Company)					x				
Fulton Heating Solutions.									
Gasmaster Industries				x					
Hamilton Engineering				x	x				
Harbour Group Industries (Cleaver-Brooks).									
Harsco Industrial, Patterson-Kelley.									
HTP, Inc				x	x				
Hurst Boiler & Welding Company.									
IBC Technologies, Inc					x				
Lanair Holdings, LLC (Clean Burn, LLC)					x			x	
Mestek					x		x	x	
National Combustion Co, Inc				x					
Paloma Co, Ltd (Raypak, Inc)	x	x	x	x		x	x	x	x
Parker Boiler Company				x					
Peerless Boilers (PB Heat LLC)					x			x	
Rite Engineering & Manufacturing Corp (Rite Boiler).									
Robert Bosch (Bosch Thermotechnology Corp)				x	x				
SIME (SIME North America)					x			x	
Slant/Fin Corporation					x			x	
SPX					x			x	
Stichting Aandelen Remeha (Baxi S.P.A.)					x				
Superior Holdings, Inc.									
Tennessee Valley Ventures LP (Precision Boiler).									
Unilux Advanced Manufacturing.									
Vari Corp					x			x	
Watts Water Technologies, Inc (AERCO International, Inc)				x					
Williams & Davis Boilers.									

* The final rule for this energy conversation standard has not been published. The compliance date and analysis of conversion costs have not been finalized at this time. (If a value is provided for total industry conversion expense, this value represents an estimate from the NOPR.)

In addition to Federal energy conservation standards, DOE identified other regulatory burdens that would affect manufacturers of commercial packaged boilers:

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

Any amended standard that DOE establishes would also impose accompanying CC&E requirements for manufacturers of commercial packaged boilers. 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. In the final rule, DOE is allowing manufacturers of commercial packaged boilers to rate basic models using AEDMs, 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://www1.eere.energy.gov/buildings/appliance_standards/implement_cert_and_enforce.html*.

3. National Impact Analysis

a. Significance of Energy Savings

For each TSL, DOE projected energy savings for commercial packaged boilers purchased in the 30-year period that begins in the year of anticipated compliance with amended standards (2019–2048). The savings are measured over the entire lifetime of equipment purchased in the 30-year 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. Table V.32 presents the estimated primary energy savings for each considered TSL, and Table V.33 presents the estimated FFC energy savings for each TSL. Table V.34 shows cumulative primary national energy savings by TSL as a percentage of the no-new-standards-case primary energy usage. The approach for estimating national energy savings is further described in section IV.H of this document.

TABLE V.32—CUMULATIVE NATIONAL PRIMARY ENERGY SAVINGS FOR COMMERCIAL PACKAGED BOILERS PURCHASED IN 2019–2048

[Quads]

Equipment class	Trial standard level *				
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Small Gas-Fired Hot Water Commercial Packaged Boilers	0.138	0.199	0.708	1.332	1.332
Large Gas-Fired Hot Water Commercial Packaged Boilers	0.043	0.075	0.075	0.617	0.617
Small Oil-Fired Hot Water Commercial Packaged Boilers	0.019	0.019	0.019	0.023	0.043
Large Oil-Fired Hot Water Commercial Packaged Boilers	0.004	0.012	0.012	0.017	0.029
Small Gas-Fired Steam Commercial Packaged Boilers	0.009	0.018	0.018	0.038	0.038
Large Gas-Fired Steam Commercial Packaged Boilers	0.009	0.014	0.014	0.026	0.026
Small Oil-Fired Steam Commercial Packaged Boilers	0.002	0.004	0.004	0.010	0.010
Large Oil-Fired Steam Commercial Packaged Boilers	0.003	0.008	0.008	0.014	0.014
Total	0.226	0.349	0.859	2.077	2.108

* Numbers may not add to totals, due to rounding.

TABLE V.33—CUMULATIVE NATIONAL FULL-FUEL-CYCLE ENERGY SAVINGS FOR COMMERCIAL PACKAGED BOILERS PURCHASED IN 2019–2048

[Quads]

Equipment class	Trial standard level *				
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Small Gas-Fired Hot Water Commercial Packaged Boilers	0.155	0.223	0.797	1.497	1.497
Large Gas-Fired Hot Water Commercial Packaged Boilers	0.049	0.085	0.085	0.693	0.693
Small Oil-Fired Hot Water Commercial Packaged Boilers	0.022	0.022	0.022	0.027	0.050
Large Oil-Fired Hot Water Commercial Packaged Boilers	0.004	0.015	0.015	0.020	0.033
Small Gas-Fired Steam Commercial Packaged Boilers	0.010	0.020	0.020	0.042	0.042
Large Gas-Fired Steam Commercial Packaged Boilers	0.010	0.016	0.016	0.029	0.029
Small Oil-Fired Steam Commercial Packaged Boilers	0.002	0.005	0.005	0.011	0.011
Large Oil-Fired Steam Commercial Packaged Boilers	0.003	0.009	0.009	0.017	0.017
Total	0.255	0.394	0.967	2.336	2.373

* Numbers may not add to totals, due to rounding.

TABLE V.34—CUMULATIVE PRIMARY NATIONAL ENERGY SAVINGS BY TSL AS A PERCENTAGE OF CUMULATIVE NO-NEW-STANDARDS-CASE ENERGY USAGE OF COMMERCIAL PACKAGED BOILERS PURCHASED IN 2019–2048

Equipment class	No-new-standards-case energy usage quads	TSL savings as percent of no-new-standards-case usage *				
		TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Small Gas-Fired Hot Water Commercial Packaged Boilers	21.053	0.7	0.9	3.4	6.3	6.3
Large Gas-Fired Hot Water Commercial Packaged Boilers	15.097	0.3	0.5	0.5	4.1	4.1
Small Oil-Fired Hot Water Commercial Packaged Boilers	0.807	2.3	2.3	2.3	2.9	5.4
Large Oil-Fired Hot Water Commercial Packaged Boilers	0.782	0.5	1.6	1.6	2.2	3.7
Small Gas-Fired Steam Commercial Packaged Boilers	1.633	0.5	1.1	1.1	2.3	2.3
Large Gas-Fired Steam Commercial Packaged Boilers	1.035	0.8	1.3	1.3	2.5	2.5
Small Oil-Fired Steam Commercial Packaged Boilers	0.453	0.4	1.0	1.0	2.2	2.2
Large Oil-Fired Steam Commercial Packaged Boilers	0.551	0.5	1.4	1.4	2.6	2.6
Total	41.411	0.5	0.8	2.1	5.0	5.1

* Components may not sum to total due to rounding.

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.[86] 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.[87] 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 estimated national primary and full-fuel-cycle energy savings results based on a nine-year analytical period are presented in Table V.35 and Table V.36, respectively. The impacts are counted over the lifetime of equipment purchased in 2019–2027.

TABLE V.35—CUMULATIVE NATIONAL PRIMARY ENERGY SAVINGS FOR COMMERCIAL PACKAGED BOILER EQUIPMENT PURCHASED IN 2019–2027

Equipment class	Trial standard level *				
	1	2	3	4	5
	quads				
Small Gas-Fired Hot Water Commercial Packaged Boilers	0.045	0.065	0.223	0.392	0.392
Large Gas-Fired Hot Water Commercial Packaged Boilers	0.022	0.038	0.038	0.226	0.226
Small Oil-Fired Hot Water Commercial Packaged Boilers	0.005	0.005	0.005	0.007	0.013
Large Oil-Fired Hot Water Commercial Packaged Boilers	0.001	0.003	0.003	0.005	0.008
Small Gas-Fired Steam Commercial Packaged Boilers	0.005	0.009	0.009	0.018	0.018
Large Gas-Fired Steam Commercial Packaged Boilers	0.004	0.006	0.006	0.012	0.012
Small Oil-Fired Steam Commercial Packaged Boilers	0.001	0.001	0.001	0.003	0.003
Large Oil-Fired Steam Commercial Packaged Boilers	0.001	0.003	0.003	0.005	0.005
Total	0.084	0.131	0.289	0.667	0.676

* Numbers may not add to totals, due to rounding.

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

[87] 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.

TABLE V.36—CUMULATIVE FULL-FUEL-CYCLE NATIONAL ENERGY SAVINGS FOR COMMERCIAL PACKAGED BOILER EQUIPMENT PURCHASED IN 2019–2027

Equipment class	Trial standard level *				
	1	2	3	4	5
	quads				
Small Gas-Fired Hot Water Commercial Packaged Boilers	0.050	0.073	0.251	0.441	0.441
Large Gas-Fired Hot Water Commercial Packaged Boilers	0.025	0.043	0.043	0.254	0.254
Small Oil-Fired Hot Water Commercial Packaged Boilers	0.006	0.006	0.006	0.008	0.015
Large Oil-Fired Hot Water Commercial Packaged Boilers	0.001	0.004	0.004	0.006	0.010
Small Gas-Fired Steam Commercial Packaged Boilers	0.005	0.010	0.010	0.020	0.020
Large Gas-Fired Steam Commercial Packaged Boilers	0.005	0.007	0.007	0.013	0.013
Small Oil-Fired Steam Commercial Packaged Boilers	0.001	0.002	0.002	0.004	0.004
Large Oil-Fired Steam Commercial Packaged Boilers	0.001	0.003	0.003	0.005	0.005
Total	0.094	0.148	0.326	0.750	0.761

* Numbers may not add to totals, due to rounding.

b. Net Present Value of Consumer Costs and Benefits

DOE estimated the cumulative NPV of the total costs and savings for consumers that would result from the TSLs considered for commercial packaged boilers. In accordance with OMB's guidelines on regulatory analysis,[88] DOE calculated the NPV using both a 7-percent and a 3-percent real discount rate. The 7-percent rate is an estimate of the average before tax rate of return on private capital in the U.S. economy, and reflects the returns on real estate and small business capital as well as corporate capital. This discount rate approximates the opportunity cost of capital in the private sector (OMB analysis has found the average rate of return on capital to be near this rate). The 3-percent rate reflects the potential effects of standards on private consumption (*e.g.,* through higher prices for equipment and reduced purchases of energy). This rate represents the rate at which society discounts future consumption flows to their present value. It can be approximated by the real rate of return on long-term government debt (*i.e.,* yield on United States Treasury notes), which has averaged about 3 percent for the past 30 years.

Table V.37 and Table V.38 show 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 2019–2048.

TABLE V.37—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFIT FOR CPB TRIAL STANDARD LEVELS AT A 3-PERCENT DISCOUNT RATE FOR EQUIPMENT PURCHASED IN 2019–2048

[Billion 2014$]

Equipment class	Trial standard level *				
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Small Gas-Fired Hot Water Commercial Packaged Boilers	0.463	0.665	1.570	3.187	3.187
Large Gas-Fired Hot Water Commercial Packaged Boilers	0.129	0.208	0.208	1.446	1.446
Small Oil-Fired Hot Water Commercial Packaged Boilers	0.278	0.278	0.278	0.337	0.372
Large Oil-Fired Hot Water Commercial Packaged Boilers	0.063	0.199	0.199	0.271	0.331
Small Gas-Fired Steam Commercial Packaged Boilers	0.038	0.074	0.074	0.145	0.145
Large Gas-Fired Steam Commercial Packaged Boilers	0.039	0.060	0.060	0.110	0.110
Small Oil-Fired Steam Commercial Packaged Boilers	0.032	0.070	0.070	0.148	0.148
Large Oil-Fired Steam Commercial Packaged Boilers	0.048	0.134	0.134	0.244	0.244
Total	1.090	1.687	2.593	5.888	5.982

* Numbers may not add to totals, due to rounding.

TABLE V.38—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFIT FOR CPB TRIAL STANDARD LEVELS AT A 7-PERCENT DISCOUNT RATE FOR EQUIPMENT PURCHASED IN 2019–2048

[Billion 2014$]

Equipment class	Trial standard level *				
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Small Gas-Fired Hot Water Commercial Packaged Boilers	0.092	0.132	0.052	0.209	0.209
Large Gas-Fired Hot Water Commercial Packaged Boilers	0.027	0.036	0.036	0.089	0.089
Small Oil-Fired Hot Water Commercial Packaged Boilers	0.080	0.080	0.080	0.093	0.040

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

TABLE V.38—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFIT FOR CPB TRIAL STANDARD LEVELS AT A 7-PERCENT DISCOUNT RATE FOR EQUIPMENT PURCHASED IN 2019–2048—Continued

[Billion 2014$]

Equipment class	Trial standard level *				
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Large Oil-Fired Hot Water Commercial Packaged Boilers	0.019	0.059	0.059	0.080	0.067
Small Gas-Fired Steam Commercial Packaged Boilers	0.012	0.022	0.022	0.038	0.038
Large Gas-Fired Steam Commercial Packaged Boilers	0.013	0.020	0.020	0.035	0.035
Small Oil-Fired Steam Commercial Packaged Boilers	0.010	0.021	0.021	0.044	0.044
Large Oil-Fired Steam Commercial Packaged Boilers	0.016	0.044	0.044	0.079	0.079
Total	0.269	0.414	0.334	0.668	0.603

* Numbers may not add to totals, due to rounding.

The NPV results based on the aforementioned nine-year analytical period are presented in Table V.39 and Table V.40. The impacts are counted over the lifetime of commercial packaged boilers purchased in 2019–2027. As mentioned previously, this information is presented for informational purposes only and is not indicative of any change in DOE's analytical methodology or decision criteria.

TABLE V.39—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFIT FOR CPB TRIAL STANDARD LEVELS AT A 3-PERCENT DISCOUNT RATE FOR EQUIPMENT PURCHASED IN 2019–2027

[Billion 2014$]

Equipment class	Trial standard level *				
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Small Gas-Fired Hot Water Commercial Packaged Boilers	0.153	0.220	0.417	0.829	0.829
Large Gas-Fired Hot Water Commercial Packaged Boilers	0.066	0.105	0.105	0.375	0.375
Small Oil-Fired Hot Water Commercial Packaged Boilers	0.082	0.082	0.082	0.099	0.096
Large Oil-Fired Hot Water Commercial Packaged Boilers	0.018	0.057	0.057	0.078	0.089
Small Gas-Fired Steam Commercial Packaged Boilers	0.022	0.038	0.038	0.071	0.071
Large Gas-Fired Steam Commercial Packaged Boilers	0.020	0.029	0.029	0.053	0.053
Small Oil-Fired Steam Commercial Packaged Boilers	0.011	0.024	0.024	0.050	0.050
Large Oil-Fired Steam Commercial Packaged Boilers	0.017	0.046	0.046	0.084	0.084
Total	0.389	0.602	0.799	1.639	1.647

* Numbers may not add to totals, due to rounding.

TABLE V.40—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFIT FOR CPB TRIAL STANDARD LEVELS AT A 7-PERCENT DISCOUNT RATE FOR EQUIPMENT PURCHASED IN 2019–2027

[Billion 2014$]

Equipment class	Trial standard level *				
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Small Gas-Fired Hot Water Commercial Packaged Boilers	0.038	0.054	−0.044	−0.020	−0.020
Large Gas-Fired Hot Water Commercial Packaged Boilers	0.015	0.020	0.020	−0.058	−0.058
Small Oil-Fired Hot Water Commercial Packaged Boilers	0.032	0.032	0.032	0.038	0.006
Large Oil-Fired Hot Water Commercial Packaged Boilers	0.008	0.024	0.024	0.032	0.023
Small Gas-Fired Steam Commercial Packaged Boilers	0.008	0.014	0.014	0.023	0.023
Large Gas-Fired Steam Commercial Packaged Boilers	0.008	0.012	0.012	0.021	0.021
Small Oil-Fired Steam Commercial Packaged Boilers	0.005	0.010	0.010	0.020	0.020
Large Oil-Fired Steam Commercial Packaged Boilers	0.007	0.021	0.021	0.037	0.037
Total	0.122	0.186	0.089	0.093	0.052

* Numbers may not add to totals, due to rounding.

c. Indirect Impacts on Employment

DOE expects energy conservation standards for commercial packaged boilers to reduce energy costs for equipment owners, and the resulting net savings to be redirected to other forms of economic activity. Those shifts in spending and economic activity could affect the demand for labor. As described in section IV.N 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 time frames (2019–

2025), where these uncertainties are reduced.

The results suggest that the proposed 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 would be imperceptible in national labor statistics and might be offset by other, unanticipated effects on employment. Chapter 16 of the NOPR TSD presents detailed results.

4. Impact on Utility or Performance

DOE has tentatively concluded that the standards it is proposing in this document would not lessen the utility or performance of commercial packaged boilers.

5. Impact of Any Lessening of Competition

DOE considers any lessening of competition that is likely to result from amended standards. The Attorney General determines the impact, if any, of any lessening of competition likely to result from a proposed standard, and transmits such determination to the Secretary, together with an analysis of the nature and extent of such impact. (42 U.S.C. 6313(a)(6)(B)(ii)(V) and (C)(i))

To assist the Attorney General in making such determination, DOE has provided DOJ with copies of this document and the TSD for review. DOE will consider DOJ's comments on the proposed rule in preparing the final rule, and DOE will publish and respond to DOJ's comments in that document.

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 NOPR TSD presents the estimated reduction in generating capacity, relative to the no-new-standards case, for the TSLs that DOE considered in this rulemaking.

Potential energy savings from the proposed amended standards for the considered CPB equipment classes could also produce environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases. Table V.41 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 upstream emissions were calculated using the multipliers discussed in section IV.K of this document. DOE reports annual CO_2, NO_X, and Hg emissions reductions for each TSL in chapter 13 of the NOPR TSD.

TABLE V.41—CUMULATIVE EMISSIONS REDUCTION FOR POTENTIAL STANDARDS OF COMMERCIAL PACKAGED BOILERS SHIPPED IN 2019–2048

	TSL				
	1	2	3	4	5
Power Sector and Site Emissions					
CO_2 (*million metric tons*)	12.66	19.61	46.61	111.89	114.33
NO_X (*thousand tons*)	74.66	118.07	156.81	294.40	366.68
Hg (*tons*)	0.0002	0.0002	(0.002)	(0.002)	(0.002)
N_2O (*thousand tons*)	0.07	0.11	0.15	0.32	0.37
CH_4 (*thousand tons*)	0.29	0.45	0.95	2.34	2.41
SO_2 (*thousand tons*)	1.24	1.96	1.49	2.87	4.18
Upstream Emissions					
CO_2 (*million metric tons*)	1.84	2.85	6.84	16.28	16.66
NO_X (*thousand tons*)	28.43	43.99	108.03	258.23	263.07
Hg (*tons*)	0.00003	0.0001	0.00003	0.0001	0.0001
N_2O (*thousand tons*)	0.01	0.01	0.02	0.03	0.04
CH_4 (*thousand tons*)	150.66	232.21	616.94	1,502.56	1,507.48
SO_2 (*thousand tons*)	0.08	0.13	0.14	0.25	0.34
Total Emissions					
CO_2 (*million metric tons*)	14.50	22.46	53.45	128.17	130.99
NO_X (*thousand tons*)	103.09	162.06	264.84	552.63	629.75
Hg (*tons*)	0.0002	0.0003	(0.002)	(0.002)	(0.002)
N_2O (*thousand tons*)	0.07	0.12	0.17	0.36	0.41
N_2O (*thousand tons CO_2eq*) *	19.42	30.55	44.39	94.37	109.42
CH_4 (*thousand tons*)	150.95	232.66	617.89	1,504.90	1,509.89
CH_4 (*thousand tons CO_2eq*) *	4,226.55	6,514.58	17,300.87	42,137.12	42,276.97
SO_2 (*thousand tons*)	1.32	2.10	1.63	3.12	4.53

* CO_2eq is the quantity of CO_2 that would have the same global warming potential (GWP).
Note: Parentheses indicate negative values.

As part of the analysis for this NOPR, 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 values for the SCC developed by an interagency process. The interagency group selected four sets of SCC values for use in regulatory analyses. The four SCC values for CO_2 emissions reductions in 2015, expressed in 2014$, are $12.2 per metric ton (the average value from a distribution that uses a 5-percent discount rate), $40.0 per metric ton (the average value from a distribution that uses a 3-percent discount rate), $62.3 per metric ton (the average value from a distribution that uses a 2.5-percent discount rate), and $117 per metric ton (the 95th-percentile value from a distribution that uses a 3-percent discount rate). The fourth set, which represents the 95th-percentile SCC estimate across all three models at a 3-percent discount rate, is included to represent higher-than-expected impacts from temperature change further out in the tails of the SCC distribution. The values for later years are higher due to increasing emissions-related costs as the magnitude of projected climate change increases.

Table V.42 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 NOPR TSD.

TABLE V.42—ESTIMATE OF GLOBAL PRESENT VALUE OF CO_2 EMISSIONS REDUCTION FOR POTENTIAL STANDARDS OF COMMERCIAL PACKAGED BOILERS SHIPPED IN 2019–2048

TSL	SCC Scenario* million 2014$			
	5% discount rate, average	3% discount rate, average	2.5% discount rate, average	3% discount rate, 95th percentile
Power Sector and Site Emissions				
1	76	369	594	1,125
2	118	572	920	1,744
3	275	1,343	2,165	4,096
4	655	3,208	5,175	9,784
5	670	3,278	5,287	9,996
Upstream Emissions				
1	11	54	86	163
2	17	83	134	254
3	40	197	318	602
4	95	467	753	1,424
5	98	478	770	1,457
Total Emissions				
1	87	423	680	1,288
2	136	655	1,054	1,998
3	316	1,540	2,483	4,697
4	751	3,675	5,928	11,208
5	767	3,755	6,057	11,452

* For each of the four cases, the corresponding SCC value for emissions in 2015 is $12.2, $40.0, $62.3 and $117 per metric ton (2014$). 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 continues to evolve rapidly regarding the contribution of CO_2 and other greenhouse gas (GHG) emissions to changes in the future global climate and the potential resulting damages to the world economy. Thus, any value placed in this rulemaking on reducing CO_2 emissions 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 NOPR 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 values that DOE used are discussed in section IV.L of this document. Table V.43 presents the cumulative present value for NO_X emissions 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.45. Detailed discussions on NO_X emissions reductions are available in chapter 14 of the NOPR TSD.

TABLE V.43—PRESENT VALUE OF NO_X EMISSIONS REDUCTION FOR POTENTIAL STANDARDS FOR COMMERCIAL PACKAGED BOILERS

TSL	3% Discount rate	7% Discount rate
	million 2014$	
Power Sector and Site Emissions		
1	203	71
2	322	112
3	428	149
4	802	279
5	997	346
Upstream Emissions		
1	80	29
2	125	46
3	299	106
4	708	248
5	721	253
Total Emissions		
1	284	100
2	447	158
3	727	255
4	1,510	527
5	1,718	599

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.44 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 values used in the columns correspond to the four sets of SCC values discussed in section IV.L.1 of this document.

TABLE V.44—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 at 5% discount rate* and 3% low NO_X value	SCC at 3% discount rate* and 3% low NO_X value	SCC at 2.5% discount rate* and 3% low NO_X value	95th percentile SCC at 3% discount rate* and 3% low NO_X value
	(billion 2014$)			
1	1.461	1.797	2.054	2.662
2	2.269	2.789	3.188	4.132
3	3.635	4.860	5.802	8.017
4	8.148	11.073	13.325	18.605
5	8.467	11.455	13.757	19.152
TSL	Consumer NPV at 7% Discount Rate added with:			
	SCC at 5% discount rate* and 7% low NO_X value	SCC at 3% discount rate* and 7% low NO_X value	SCC at 2.5% discount rate* and 7% low NO_X value	95th percentile SCC at 3% discount rate* and 7% low NO_X value
	(billion 2014$)			
1	0.456	0.792	1.049	1.658
2	0.707	1.227	1.625	2.569
3	0.905	2.129	3.072	5.286
4	1.946	4.870	7.123	12.403

TSL	Consumer NPV at 7% Discount Rate added with:			
	SCC at 5% discount rate* and 7% low NO_X value	SCC at 3% discount rate* and 7% low NO_X value	SCC at 2.5% discount rate* and 7% low NO_X value	95th percentile SCC at 3% discount rate * and 7% low NO_X value
	(billion 2014$)			
5	1.969	4.957	7.259	12.654

* The interagency group selected four sets of SCC values for use in regulatory analyses. Three sets of values are based on the average SCC from the integrated assessment models, at discount rates of 5, 3, and 2.5 percent. For example, for 2015 emissions, these values are $12.2/metric ton, $40.0/metric ton, and $62.3/metric ton, in 2014$, respectively. The fourth set ($117 per metric ton in 2014$ for 2015 emissions), which represents the 95th percentile SCC estimate across all three models at a 3-percent discount rate, is included to represent higher-than-expected impacts from temperature change further out in the tails of the SCC distribution. The SCC values are emission year specific.

In considering the above results, two issues are relevant. First, the national operating cost savings are domestic U.S. commercial consumer monetary savings that occur as a result of market transactions, while the value of CO_2 reductions is based on a global value. Second, the assessments of operating cost savings and the SCC are performed with different methods that use quite different time frames for analysis. The national operating cost savings is measured for the lifetime of products shipped in 2019–2048. Because CO_2 emissions have a very long residence time in the atmosphere,[89] the SCC values in future years reflect future CO_2 emissions impacts that continue beyond 2100.

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.

C. Conclusion

To adopt national standards more stringent than the current standards for commercial packaged boilers, DOE must determine that such action would result in significant additional conservation of energy and is 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 NOPR, 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 efficiency level that is both technologically feasible and economically justified and saves a significant amount of energy.

To aid the reader in understanding the benefits and/or burdens of each TSL, tables in this section 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.

1. Benefits and Burdens of Trial Standard Levels Considered for Commercial Packaged Boilers

Table V.45, Table V.46, and Table V.47 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 year of compliance with amended standards (2019–2048). The energy savings, emissions reductions, and value of emissions reductions refer to full-fuel-cycle results.

TABLE V.45—SUMMARY OF ANALYTICAL RESULTS FOR COMMERCIAL PACKAGED BOILERS: NATIONAL IMPACTS

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
National FFC Energy Savings (*quads*)	0.25	0.39	0.97	2.34	2.37.
NPV of Commercial consumer Benefits (billion 2014$)					
3% discount rate	1.09	1.69	2.59	5.89	5.98.
7% discount rate	0.27	0.41	0.33	0.67	0.60.
Manufacturer Impacts					
Industry NPV (*2014$ million*)	166.8 to 173.7	156.3 to 167.0	116.2 to 157.7	56.1 to 145.9	51.2 to 146.7.
Change in Industry NPV (%)	(7.4) to (3.6)	(13.2) to (7.3)	(35.5) to (12.4)	(68.9) to (19.0)	(71.6) to (18.6).
Cumulative Emissions Reduction (Total FFC Emissions)					
CO_2 (*million metric tons*)	15	22	53	128	131

[89] The atmospheric lifetime of CO_2 is estimated of 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).

TABLE V.45—SUMMARY OF ANALYTICAL RESULTS FOR COMMERCIAL PACKAGED BOILERS: NATIONAL IMPACTS—Continued

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
NO_X (*thousand tons*)	103	162	265	553	630
Hg (tons)	0.0002	0.0003	(0.002)	(0.002)	(0.002)
N_2O (*thousand tons*)	0.07	0.12	0.17	0.36	0.41
N_2O (*thousand tons CO_2eq*)	19	31	44	94	109
CH_4 (*thousand tons*)	151	233	618	1,505	1,510
CH_4 (*thousand tons CO_2eq*)	4,227	6,515	17,301	42,137	42,277
SO_2 (*thousand tons*)	1.3	2.1	1.6	3.1	4.5
Value of Emissions Reduction (Total FFC Emissions)					
CO_2 (*2014$ million*)*	87 to 1,288	136 to 1,998	316 to 4,697	751 to 11,208	767 to 11,452
NO_X—3% discount rate (*2014$ million*)	284 to 627	447 to 988	727 to 1,605	1,510 to 3,335	1,718 to 3,794
NO_X—7% discount rate (*2014$ million*)	100 to 223	158 to 353	255 to 570	527 to 1,177	599 to 1,338.

* Range of the economic value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions.
Note: Parentheses indicate negative values.

TABLE V.46—NPV OF COMMERCIAL CONSUMER BENEFITS BY EQUIPMENT CLASS

Equipment class	Discount rate %	Trial standard level (billion 2014$)				
		1	2	3	4	5
Small Gas-Fired Hot Water Commercial Packaged Boilers	3	0.463	0.665	1.570	3.187	3.187
	7	0.092	0.132	0.052	0.209	0.209
Large Gas-Fired Hot Water Commercial Packaged Boilers	3	0.129	0.208	0.208	1.446	1.446
	7	0.027	0.036	0.036	0.089	0.089
Small Oil-Fired Hot Water Commercial Packaged Boilers	3	0.278	0.278	0.278	0.337	0.372
	7	0.080	0.080	0.080	0.093	0.040
Large Oil-Fired Hot Water Commercial Packaged Boilers	3	0.063	0.199	0.199	0.271	0.331
	7	0.019	0.059	0.059	0.080	0.067
Small Gas-Fired Steam Commercial Packaged Boilers	3	0.038	0.074	0.074	0.145	0.145
	7	0.012	0.022	0.022	0.038	0.038
Large Gas-Fired Steam Commercial Packaged Boilers	3	0.039	0.060	0.060	0.110	0.110
	7	0.013	0.020	0.020	0.035	0.035
Small Oil-Fired Steam Commercial Packaged Boilers	3	0.032	0.070	0.070	0.148	0.148
	7	0.010	0.021	0.021	0.044	0.044
Large Oil-Fired Steam Commercial Packaged Boilers	3	0.048	0.134	0.134	0.244	0.244
	7	0.016	0.044	0.044	0.079	0.079
Total—All Classes	3	1.090	1.687	2.593	5.888	5.982
	7	0.269	0.414	0.334	0.668	0.603

TABLE V.47—SUMMARY OF ANALYTICAL RESULTS FOR CPB CONSUMER IMPACTS

	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Commercial Consumer Mean LCC Savings 2014$					
Small Gas-Fired Hot Water Commercial Packaged Boilers	$223	$521	$302	$1,656	$1,656
Large Gas-Fired Hot Water Commercial Packaged Boilers	2,419	3,647	3,647	2,062	2,062
Small Oil-Fired Hot Water Commercial Packaged Boilers	7,799	7,799	7,799	8,939	2,333
Large Oil-Fired Hot Water Commercial Packaged Boilers	10,108	30,834	30,834	40,983	17,076
Small Gas-Fired Steam Commercial Packaged Boilers	1,933	2,782	2,782	4,383	4,383
Large Gas-Fired Steam Commercial Packaged Boilers	12,255	16,802	16,802	28,295	28,295
Small Oil-Fired Steam Commercial Packaged Boilers	1,985	4,256	4,256	8,637	8,637
Large Oil-Fired Steam Commercial Packaged Boilers	13,243	36,128	36,128	65,128	65,128
Commercial Consumer Simple PBP Years					
Small Gas-Fired Hot Water Commercial Packaged Boilers	9.4	9.6	13.6	13.6	13.6
Large Gas-Fired Hot Water Commercial Packaged Boilers	10.2	11.0	11.0	15.6	15.6
Small Oil-Fired Hot Water Commercial Packaged Boilers	5.7	5.7	5.7	6.6	14.3
Large Oil-Fired Hot Water Commercial Packaged Boilers	4.1	4.7	4.7	5.2	12.2
Small Gas-Fired Steam Commercial Packaged Boilers	7.0	7.4	7.4	8.2	8.2
Large Gas-Fired Steam Commercial Packaged Boilers	4.3	4.7	4.7	5.0	5.0
Small Oil-Fired Steam Commercial Packaged Boilers	5.0	5.3	5.3	6.1	6.1
Large Oil-Fired Steam Commercial Packaged Boilers	2.5	2.8	2.8	3.1	3.1

TABLE V.47—SUMMARY OF ANALYTICAL RESULTS FOR CPB CONSUMER IMPACTS—Continued

	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Distribution of Commercial Consumer LCC Impacts					
Small Gas-Fired Hot Water Commercial Packaged Boilers Net Cost (%)	20%	23%	42%	56%	56%
Large Gas-Fired Hot Water Commercial Packaged Boilers Net Cost (%)	21%	27%	27%	56%	56%
Small Oil-Fired Hot Water Commercial Packaged Boilers Net Cost (%)	20%	20%	20%	26%	56%
Large Oil-Fired Hot Water Commercial Packaged Boilers Net Cost (%)	1%	5%	5%	7%	46%
Small Gas-Fired Steam Commercial Packaged Boilers Net Cost (%)	18%	26%	26%	34%	34%
Large Gas-Fired Steam Commercial Packaged Boilers Net Cost (%)	12%	15%	15%	19%	19%
Small Oil-Fired Steam Commercial Packaged Boilers Net Cost (%)	4%	12%	12%	16%	16%
Large Oil-Fired Steam Commercial Packaged Boilers Net Cost (%)	0%	1%	1%	1%	1%

Note: Parentheses indicate negative values.

TSL 5 corresponds to the max-tech level for all the equipment classes and offers the potential for the highest cumulative energy savings through the analysis period from 2019 through 2048. The estimated energy savings from TSL 5 are 2.37 quads of energy. TSL 5 has an estimated NPV of consumer benefit of $0.60 billion using a 7-percent discount rate, and $6.0 billion using a 3-percent discount rate.

The cumulative emissions reductions at TSL 5 are 131 million metric tons of CO_2, 4.53 thousand tons of SO_2, 630 thousand tons of NO_X, 1,510 thousand tons of CH_4, and 0.41 thousand tons of N_2O, and an emissions increase of 0.002 tons of Hg. The estimated monetary value of the CO_2 emissions reductions at TSL 5 ranges from $767 million to $11,452 million.

At TSL 5, the average LCC savings range from $1,656 to $65,128 depending on equipment class. The fraction of consumers incurring a net cost range from 1 percent for large oil-fired steam CPB equipment class to 56 percent for small gas-fired hot water CPB equipment class.

At TSL 5, the projected change in INPV ranges from a decrease of $128.9 million to a decrease of $33.4 million, which corresponds to a change in INPV of −71.6 percent to −18.6 percent, respectively. The industry is expected to incur $56.6 million in total conversion costs at this level. Approximately 98.7 percent of industry equipment listings would require additional engineering expertise and production lines, or possibly source parts from other manufacturers.

Accordingly, the Secretary tentatively 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 would be outweighed by the very large negative change in INPV for manufacturers. Consequently, DOE has tentatively concluded that TSL 5 is not economically justified.

TSL 4 corresponds to the efficiency level within each equipment class that provides the highest consumer NPV at a 7% discount rate over the analysis period from 2019 through 2048. The estimated energy savings from TSL 4 are 2.34 quads of energy. TSL 4 has an estimated NPV of consumer benefit of $0.67 billion using a 7-percent discount rate, and $5.9 billion using a 3-percent discount rate.

The cumulative emissions reductions at TSL 4 are 128 million metric tons of CO_2, 3.1 thousand tons of SO_2, 553 thousand tons of NO_X, 1,505 thousand tons of CH_4, and 0.36 thousand tons of N_2O, and an emissions increase of 0.002 tons of Hg. The estimated monetary value of the CO_2 emissions reductions at TSL 4 ranges from $751 million to $11,208 million.

At TSL 4, the average LCC savings range from $1,656 to $65,128 depending on equipment class. The fraction of consumers incurring a net cost range from 1 percent for large oil-fired steam CPB equipment class to 56 percent for small gas-fired hot water CPB equipment class.

At TSL 4, the projected change in INPV ranges from a decrease of $124.1 million to a decrease in $34.3 million, which corresponds to a change of −68.9 percent to −19.0 percent, respectively. The industry is expected to incur $54.7 million in total conversion costs at this level. Approximately 98.4 percent of industry equipment listings require redesign to meet this standard level today.

Accordingly, the Secretary tentatively 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 would be outweighed by the negative change in INPV for manufacturers. Consequently, DOE has tentatively concluded that TSL 4 is not economically justified.

TSL 3 corresponds to the intermediate level with both condensing and high efficiency noncondensing standard levels, depending on equipment class, and offers the potential for significant cumulative energy savings over the analysis period from 2019 through 2048. The estimated energy savings from TSL 3 are 0.97 quads of energy. TSL 3 has an estimated NPV of consumer benefit of $0.33 billion using a 7-percent discount rate, and $2.6 billion using a 3-percent discount rate.

The cumulative emissions reductions at TSL 3 are 53 million metric tons of CO_2, 1.63 thousand tons of SO_2, 265 thousand tons of NO_X, 618 thousand tons of CH_4, and 0.17 thousand tons of N_2O, and an emissions increase of 0.002 tons of Hg. The estimated monetary value of the CO_2 emissions reductions at TSL 3 ranges from $316 million to $4,698 million.

At TSL 3, the average LCC savings range from $302 to $36,128 depending on equipment class. The fraction of consumers incurring a net cost range from 1 percent for large oil-fired steam CPB equipment class to 42 percent for small gas-fired hot water CPB equipment class.

At TSL 3, the projected INPV ranges from a decrease of $64.0 million to a decrease of $22.4 million, which corresponds to a change of −35.5 percent to −12.4 percent, respectively. The industry is expected to incur $40.1 million in total conversion costs at this level. Approximately 73.8 percent of industry equipment listings require redesign to meet this standard level today.

The Secretary carefully considered proposing TSL 3. However, in weighing the benefits of energy savings, NPV of consumer benefits, emission reductions, and the estimated monetary value of the CO_2 emissions reductions against the negative change in INPV for manufacturers, DOE has tentatively concluded that TSL 3 is not economically justified. DOE may reexamine this decision based on the public comments received in response to this NOPR.

TSL 2 corresponds to the highest noncondensing efficiency level analyzed for the gas-fired hot water equipment classes and efficiency levels for oil-fired hot water equipment classes that are 2 or 3 percentage points above the equivalent size gas-fired hot water equipment classes, depending on equipment class, and one level below max tech for all steam CPB equipment classes and offers the potential for significant energy savings through the analysis period from 2019 through 2048. The estimated energy savings from TSL 2 are 0.39 quads of energy. TSL 2 has an estimated NPV of consumer benefit of $0.41 billion using a 7-percent discount rate, and $1.69 billion using a 3-percent discount rate.

The cumulative emissions reductions at TSL 2 are 22 million metric tons of CO_2, 2.1 thousand tons of SO_2, 162 thousand tons of NO_X, 0.0003 tons of Hg, 233 thousand tons of CH_4, and 0.12 thousand tons of N_2O. The estimated monetary value of the CO_2 emissions reductions at TSL 2 ranges from $136 million to $1,998 million.

At TSL 2, the average LCC savings range from $521 to $36,128 depending on equipment class. The fraction of consumers incurring a net cost range from 1 percent for large oil-fired steam CPB equipment class to 27 percent for large gas-fired hot water CPB equipment class.

At TSL 2, the projected INPV ranges from a decrease of $23.8 million to a decrease of $13.1 million, which corresponds to a change of −13.2 percent to −7.3 percent, respectively. The industry is expected to incur $27.5 million in total conversion costs at this level. Approximately 52.5 percent of industry equipment listings require redesign to meet this standard level today.

Accordingly, the Secretary tentatively 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 would outweigh the negative change in INPV for manufacturers. Consequently, DOE has tentatively concluded that TSL 2 is economically justified.

After carefully considering the analysis results and weighing the benefits and burdens of TSL 2, DOE believes that setting the standards for commercial packaged boilers at TSL 2 represents the maximum improvement in energy efficiency that is technologically feasible and economically justified. 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 at 7 percent, and emissions reductions outweigh the costs associated with reduced INPV. Therefore, DOE proposes to adopt amended energy conservation standards for commercial packaged boilers at the levels established by TSL 2 and presented in

However, the only difference between TSL 2 and TSL 3 is in the small gas-fired hot water CPB equipment class. TSL 3 includes the 95% TE level while TSL 2 includes the 85% TE level for that equipment class. TSL 3 results in energy savings that are 250 percent greater than TSL 2. Approximately 72 percent of small gas-fired hot water CPB equipment manufacturers offer at least one product that meets TSL 3.

DOE requests comment on whether DOE should adopt TSL 3.

See section VII.E for a list of issues on which DOE seeks comment.

Table V.48.

However, the only difference between TSL 2 and TSL 3 is in the small gas-fired hot water CPB equipment class. TSL 3 includes the 95% TE level while TSL 2 includes the 85% TE level for that equipment class. TSL 3 results in energy savings that are 250 percent greater than TSL 2. Approximately 72 percent of small gas-fired hot water CPB equipment manufacturers offer at least one product that meets TSL 3.

DOE requests comment on whether DOE should adopt TSL 3.

See section VII.E for a list of issues on which DOE seeks comment.

TABLE V.48—PROPOSED ENERGY CONSERVATION STANDARDS FOR COMMERCIAL PACKAGED BOILERS EVALUATED IN THIS NOPR

[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	85	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 Proposed Standards

The benefits and costs of this NOPR's proposed energy conservation standards, for covered commercial packaged boilers sold in 2019–2048, 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 (expressed in 2014$) of the benefits from consumer operation of equipment that meets the proposed standards (consisting primarily of operating cost savings from using less energy, minus increases in equipment purchase and installation costs), and (2) the annualized value of the benefits of CO_2 and NO_X emission reductions.[90]

[90] To convert the time-series of costs and benefits into annualized values, DOE calculated a present value in 2015, 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

Continued

The national operating savings are domestic private U.S. consumer monetary savings that occur as a result of purchasing these equipment. The national operating cost savings is measured for the lifetime of commercial packaged boilers shipped in 2019–2048.

The CO_2 reduction is a benefit that accrues globally due to decreased domestic energy consumption that is expected to result from this proposed rule. Because CO_2 emissions have a very long residence time in the atmosphere, the SCC values in future years reflect future CO_2-emissions impacts that continue beyond 2100 through 2300.

Estimates of annualized benefits and costs of the proposed standards for commercial packaged boilers under TSL 2 are shown in Table V.49. The results under the primary estimate are as follows. Using a 7-percent discount rate for benefits and costs other than CO_2 reduction, for which DOE used a 3-percent discount rate along with the average SCC series that uses a 3-percent discount rate, the cost of the standards proposed in this rulemaking is $51 million per year in increased equipment costs; while the estimated benefits are $91 million per year in reduced equipment operating costs, $37 million in CO_2 reductions, and $16 million in reduced NO_X emissions. In this case, the net benefit would amount to $93 million per year. Using a 3-percent discount rate for all benefits and costs and the average SCC series, the estimated cost of the standards proposed in this rulemaking is $48 million per year in increased equipment costs; while the estimated benefits are $142 million per year in reduced operating costs, $37 million in CO_2 reductions, and $25 million in reduced NO_X emissions. In this case, the net benefit would amount to approximately $156 million per year.

TABLE V.49—ANNUALIZED BENEFITS AND COSTS OF PROPOSED STANDARDS (TSL 2) FOR COMMERCIAL PACKAGED BOILERS *

	Discount rate	Million 2014$/year		
		Primary estimate	Low net benefits estimate	High net benefits estimate
Benefits				
Consumer Operating Cost Savings *	7%	91	84	101.
	3%	142	129	160.
CO_2 Reduction (using mean SCC at 5% discount rate) ***	5%	10	10	11.
CO_2 Reduction (using mean SCC at 3% discount rate) ***	3%	37	34	39.
CO_2 Reduction (using mean SCC at 2.5% discount rate) ***.	2.5%	54	51	58.
CO_2 Reduction (using 95th percentile SCC at 3% discount rate) ***.	3%	111	104	119.
NO_X Reduction †	7%	16	15	37.
	3%	25	23	59.
Total Benefits ††	7% plus CO_2 range	117 to 218	108 to 203	149 to 258.
	7%	143	133	177.
	3% plus CO_2 range	177 to 278	162 to 256	230 to 338.
	3%	204	186	258.
Costs				
Consumer Incremental Equipment Costs	7%	51	54	47.
	3%	48	52	45.
Net Benefits				
Total ††	7% plus CO_2 range	67 to 168	54 to 149	102 to 210.
	7%	93	79	130.
	3% plus CO_2 range	129 to 230	110 to 205	185 to 293.
	3%	156	135	213.

* This table presents the annualized costs and benefits associated with commercial packaged boilers shipped in 2019–2048. These results include benefits to consumers which accrue after 2048 from the equipment purchased in 2019–2048. 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 AEO2015 Reference case, Low Economic Growth case, and 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 TSD.

** The interagency group selected four sets of SCC values for use in regulatory analyses. Three sets of values are based on the average SCC from the integrated assessment models, at discount rates of 5, 3, and 2.5 percent. For example, for 2015 emissions, these values are $12.2/metric ton, $40.0/metric ton, and $62.3/metric ton, in 2014$, respectively. The fourth set ($117 per metric ton in 2014$ for 2015 emissions), which represents the 95th percentile of the SCC distribution calculated using SCC estimate across all three models at 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.

shipments occur (2020, 2030, *etc.*), and then discounted the present value from each year to 2015. 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.

† The $/ton values used for NO_X are described in section IV.L. DOE estimated the monetized value of NO_X emissions reductions using benefit per ton estimates from the Regulatory Impact Analysis titled, "Proposed Carbon Pollution Guidelines for Existing Power Plants and Emission Standards for Modified and Reconstructed Power Plants," published in June 2014 by EPA's Office of Air Quality Planning and Standards. (Available at *www3.epa.gov/ttnecas1/regdata/RIAs/111dproposalRIAfinal0602.pdf.*) See section IV.L.2 for further discussion. Note that the agency is presenting a national benefit-per-ton estimate for particulate matter emitted from the Electric 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. Because of the sensitivity of the benefit-per-ton estimate to the geographical considerations of sources and receptors of emissions, DOE intends to investigate refinements to the agency's current approach of one national estimate by assessing the regional approach taken by EPA's Regulatory Impact Analysis for the Clean Power Plan Final Rule.

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

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 appliances that are not captured by the users of such equipment. These benefits include externalities related to public health, environmental protection, and national 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.

The Administrator of the Office of Information and Regulatory Affairs (OIRA) in the OMB has determined that the proposed regulatory action 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 proposed regulatory action is an "economically significant regulatory action" under section (3)(f)(1) of Executive Order 12866. Accordingly, pursuant to section 6(a)(3)(C) of the Order, DOE has provided to OIRA an assessment, including the underlying analysis, of benefits and costs anticipated from the regulatory action, together with, to the extent feasible, a quantification of those costs; and an assessment, including the underlying analysis, of costs and benefits of potentially effective and reasonably feasible alternatives to the planned regulation, and an explanation why the planned regulatory action is preferable to the identified potential alternatives. These assessments can be found in the technical support document for this rulemaking.

DOE has also reviewed this regulation pursuant to Executive Order 13563. 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 believes that this NOPR is consistent with these principles, including the requirement that, to the extent permitted by law, benefits justify costs and that net benefits are maximized.

B. Review Under the Regulatory Flexibility Act

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

Administration (SBA) for review under 5 U.S.C 605(b).

The Small Business Administration (SBA) considers a business entity to be a small business, if, together with its affiliates, it employs less than a threshold number of workers specified in 13 CFR part 121. These size standards and codes are established by the North American Industry Classification System (NAICS). The threshold number for NAICS classification code 333414, which applies to ''heating equipment (except warm air furnaces) manufacturing'' and includes commercial packaged boilers, is 500 employees.

1. Statement of the Need for, Objectives of, and Legal Basis for, the Rule

A statement of the need for, objectives of, and legal basis for, the proposed rule is stated elsewhere in the preamble and not repeated here.

2. Description on Estimated Number of Small Entities Regulated

To estimate the number of companies that could be small business manufacturers of products covered by this rulemaking, DOE conducted a market survey using publically-available information to identify potential small manufacturers. DOE's research involved industry trade association membership directories (including AHRI), public databases (*e.g.,* AHRI Directory,[91] ABMA Directory [92]), individual company Web sites, and market research tools (*e.g.,* Hoovers reports) to create a list of companies that manufacture or sell products 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 reviewed publicly-available data and contacted companies on its list, as necessary, to determine whether they met the SBA's definition of a small business manufacturer of covered commercial packaged boilers. DOE screened out companies that do not offer products covered by this rulemaking, do not meet the definition of a ''small business,'' or are foreign owned and operated.

DOE initially identified 45 potential manufacturers of commercial packaged boilers sold in the U.S. DOE then determined that 15 are large manufacturers, manufacturers that are foreign owned and operated. DOE was able to determine that 30 manufacturers meet the SBA's definition of a ''small business.'' Of these 30 small businesses, DOE estimates that 23 domestically manufacture commercial packaged boilers covered by this rulemaking.

Before issuing this NOPR, DOE attempted to contact all the small business manufacturers of commercial packaged boilers it had identified. Six small businesses agreed to take part in an MIA interview. DOE also obtained information about small business impacts while interviewing large manufacturers.

3. Description and Estimate of Compliance Requirements

In the engineering analysis, DOE compiled an equipment database based on equipment listing information provided by the AHRI and ABMA trade associations. However, DOE notes that it does not have product listings data for 11 of the identified 30 small manufacturers since they are not AHRI or ABMA trade association members. The following discussion reflects the available data provided by AHRI and ABMA and assumes the distribution of equipment efficiencies data to be representative of the industry. Additionally, despite extensive interviews with small and large companies, DOE was not able to obtain sufficient financial or sales data to determine typical small manufacturer revenue, operating profit and market share. The small manufacturers provided insufficient data to determine the effect these standards will have on small business revenue or operating profit.

However, in an effort to gauge the relative impacts of this rulemaking on small manufacturers, DOE has conducted a detailed product availability analysis. The analysis investigates the portion of small manufacturers that are currently able to meet the proposed standard. Additionally, it looks that number of equipment models small manufacturers must redesign or eliminate relative to the industry-at-large.

DOE identified 18 small manufacturers and 13 large manufactures that produce gas-fired equipment covered by this rulemaking based on companies included in DOE's equipment database. Roughly 56% of gas-fired equipment listings in the database already meet the proposed standard at TSL 2. This would suggest that TSL 2 already has a strong market presence. DOE's engineering analysis concludes that no proprietary technology is required to meet today's proposed standard level. Manufacturers would likely need to adopt one or a combination of different technology options: (1) Switch from natural or atmospheric draft systems to mechanical draft boilers; (2) improve heat exchanger design using tabulators, fins and multi-pass designs; (3) use high efficiency burner technology such as pulse combustion; or (4) increase jacket insulation (*e.g.* 3–4 inches of fiberglass wool).

Assuming the equipment database used in the engineering analysis is representative of the industry as a whole, small manufacturers have similar portions of product listings at TSL 2 as their larger competitors in the gas-fired sector. Industry conversion costs for gas-fired product at TSL 2 total $18.3 million. This results in an average conversion cost of approximately $0.42 million per manufacturer.[93]

Table VI.1 and Table VI.2 looks at the differential impacts of the standard on small manufacturers versus the industry at large. Table VI.1 estimates the percent of small manufacturers and their listings that currently comply with TSL 2. Table VI.2 estimates the percent of all manufacturers, both large and small, and their listings that currently comply with TSL 2.

[91] See *www.ahridirectory.org/ahriDirectory/pages/home.aspx*.

[92] See *http://www.abma.com/*.

[93] This estimate was derived by taking total conversion costs for gas-fired equipment divided by total gas-fired equipment manufacturers.

TABLE VI.1—SMALL GAS-FIRED MANUFACTURERS COMPLIANT AT THE PROPOSED STANDARD LEVEL

Product class	Small manufacturers: manufacturers with products compliant at TSL 2 (%)	Small manufacturers: total listings	Small manufacturers: listings compliant at TSL 2	Small manufacturers: listings compliant at TSL 2 (%)
Small Gas Hot Water	100	433	348	80
Large Gas Hot Water	67	220	120	55
Small Gas Steam	50	106	26	25
Large Gas Steam	71	127	46	36

TABLE VI.2—INDUSTRY GAS-FIRED MANUFACTURERS COMPLIANT AT THE PROPOSED STANDARD LEVEL

Product class	Small manufacturers: manufacturers with products compliant at TSL 2 (%)	Small manufacturers: total listings	Small manufacturers: listings compliant at TSL 2	Small manufacturers: listings compliant at TSL 2 (%)
Small Gas Hot Water	97	1,149	712	62
Large Gas Hot Water	78	373	188	50
Small Gas Steam	67	252	72	29
Large Gas Steam	82	186	80	43

Using product listings as representative market data, DOE estimates average conversion costs of $0.63 million for large manufacturers and $0.31 million for small manufacturers of gas-fired equipment. Since this is a relatively low volume market where most products are built-to-order, DOE assumes that capital conversion costs do not vary significantly between large and small manufacturers.[94]

In the market for oil-fired equipment, DOE identified seven small manufacturers and six large manufacturers producing equipment covered by this rulemaking based on the equipment database. Combined, they sell roughly 1,000 units per year, or 5% of the total annual market for CPB equipment. Due to the small size of the oil-fired market, DOE expects that the manufacturing processes and production costs to be similar for both small and large manufacturers. 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 product 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) Integrate oxygen trimmers; (2) improve heat exchanger design; (3) use high efficiency burner technology such as pulse combustion; or (4) increase jacket insulation. Thus, DOE would expect similar conversion costs for small and large manufacturers on a per product basis.

Table VI.3 estimates the percent of small manufacturers and their listings that currently comply with TSL 2.

Table VI.4 estimates the percent of all manufacturers, both large and small, and their listings that currently comply with TSL 2.

TABLE VI.3—SMALL OIL-FIRED MANUFACTURERS COMPLIANT AT THE PROPOSED STANDARD LEVEL

Product class	Small manufacturers: manufacturers with products compliant at TSL 2 (%)	Small manufacturers: total listings	Small manufacturers: listings compliant at TSL 2	Small manufacturers: listings compliant at TSL 2 (%)
Small Oil Hot Water	33	31	1	3
Large Oil Hot Water	25	24	3	13
Small Oil Steam	25	49	5	10
Large Oil Steam	17	45	6	13

[94] The amount of engineering effort is proportional to the number of models that require redesign. For this estimate, DOE used its product database to determine what portion of industry models would need to be redesigned for large and small manufacturers to determine the values for each. DOE used the number of models requiring redesign to scale large versus small product conversion costs. For gas-fired equipment, DOE used gas-fired model listings.

TABLE VI.4—INDUSTRY OIL-FIRED MANUFACTURERS COMPLIANT AT THE PROPOSED STANDARD LEVEL

Product class	Small manufacturers: manufacturers with products compliant at TSL 2 (%)	Small manufacturers: total listings	Small manufacturers: listings compliant at TSL 2	Small manufacturers: listings compliant at TSL 2 (%)
Small Oil Hot Water	36	124	17	14
Large Oil Hot Water	20	83	5	6
Small Oil Steam	44	127	32	25
Large Oil Steam	40	109	36	33

Using product listings as representative market data, DOE estimates average conversion costs of $0.90 million for large manufacturers and $0.28 million for small manufacturers of oil-fired equipment. Since this is a relatively low volume market where most products are built-to-order, DOE assumes that capital conversion costs do not vary significantly between large and small manufacturers.[95]

DOE assumed the data for small manufacturer's products in the AHRI and ABMA databases are representative of all small manufacturers.

DOE requests comment on the appropriateness of the Manufacturer Impact Analysis' assumption that the AHRI and ABMA equipment databases are representative of all small manufacturers.

DOE also requests product listing data from small manufacturers that are not AHRI or ABMA trade association members—including model numbers, capacity, and efficiency ratings.

DOE also continues to seek financial, sales, and market share data from small manufacturers to better understand and analyze the impact of these proposed standards and conversion costs on the revenue and operating profit of a small business.

See section VII.E for a list of issues on which DOE seeks comment.

4. Duplication, Overlap, and Conflict With Other Rules and Regulations

DOE is not aware of any rules or regulations that duplicate, overlap, or conflict with the rulemaking being proposed today.

[95] The amount of engineering effort is proportional to the number of models that require redesign. For this estimate, DOE used its product database to determine what portion of industry models would need to be redesigned for large and small manufacturers to determine the values for each. DOE used the number of models requiring redesign to scale large versus small product conversion costs. For oil-fired equipment, DOE used oil-fired model listings to scale product conversion costs.

5. Significant Alternatives to the Rule

The discussion above analyzes impacts on small businesses that would result from DOE's proposed rule. 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) consumer rebates; (3) consumer tax credits; (4) voluntary energy efficiency targets; and (5) bulk government purchases. 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 adoption of the proposed standard levels. Accordingly, DOE is declining to adopt any of these alternatives and is proposing the standards set forth in this rulemaking. (See chapter 17 of the NOPR TSD for further detail on the policy alternatives DOE considered.)

Additional compliance flexibilities may be available through other means. For example, individual manufacturers may petition for a waiver of the applicable test procedure. (See 10 CFR 431.401) Further, EPCA provides that a manufacturer whose annual gross revenue from all of its operations does not exceed $8 million may apply for an exemption from all or part of an energy conservation standard for a period not longer than 24 months after the effective date of a final rule establishing the standard. Additionally, section 504 of the Department of Energy Organization Act, 42 U.S.C. 7194, provides authority for the Secretary to adjust a rule issued under EPCA in order to prevent ''special hardship, inequity, or unfair distribution of burdens'' that may be imposed on that manufacturer as a result of such rule. Manufacturers should refer to 10 CFR part 430, subpart E, and Part 1003 for additional details.

C. Review Under the Paperwork Reduction Act

Manufacturers of 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 the proposed rule fits within the category of actions included in Categorical Exclusion (CX) B5.1 and otherwise meets the requirements for application of a CX. See 10 CFR part 1021, App. B, B5.1(b); 1021.410(b) and Appendix B, B(1)–(5). The proposed rule fits within the category of actions because it is a rulemaking that establishes energy conservation standards for consumer 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 proposed rule. DOE's CX determination for this proposed rule is available at *http://cxnepa.energy.gov/.*

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 proposed rule and has tentatively 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 are the subject of this proposed 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 proposed 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. Pub. L. 104–4, sec. 201 (codified at 2 U.S.C. 1531). For a proposed 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 proposed ''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 small governments. 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/gc/office-general-counsel.*

Although this proposed rule does not contain a Federal intergovernmental mandate, it may require expenditures of $100 million or more on the private sector. Specifically, the proposed rule will likely result in a final rule that could require expenditures of $100 million or more. 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 proposed 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 NOPR and the ''Regulatory Impact Analysis'' section of the TSD for this proposed 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 proposed rule unless DOE publishes an explanation for doing otherwise, or the selection of such an alternative is inconsistent with law. As required by 42 U.S.C. 6313(a), this proposed rule would establish energy conservation standards for commercial packaged boilers that are designed to achieve the maximum improvement in energy efficiency that DOE has determined to be both technologically feasible and economically justified. A full discussion of the alternatives considered by DOE is presented in the ''Regulatory Impact Analysis'' section of the TSD for this proposed 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 proposed 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 NOPR under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

Executive Order 13211, ''Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use'' 66 FR 28355 (May 22, 2001), requires Federal agencies to prepare and submit to OIRA at OMB, a Statement of Energy Effects for any proposed significant energy action. A ''significant energy action'' is defined as any action by an agency that promulgates or is expected to lead to promulgation of a final rule, and that: (1) is a significant regulatory action under Executive Order 12866, or any successor order, and (2) is likely to have a significant adverse effect on the supply, distribution, or use of energy, or (3) is designated by the Administrator of OIRA as a significant energy action. For any proposed significant energy action, the agency must give a detailed statement of any adverse effects on energy supply, distribution, or use should the proposal be implemented, and of reasonable alternatives to the action and their expected benefits on energy supply, distribution, and use.

DOE has tentatively concluded that this regulatory action, which sets forth energy conservation standards for commercial packaged boilers, is not a significant energy action because the proposed 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 proposed rule.

L. Review Under the Information Quality Bulletin for Peer Review

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

In response to OMB's Bulletin, DOE conducted formal in-progress peer reviews of the energy conservation standards development process and analyses and has prepared a Peer Review Report pertaining to the energy conservation standards rulemaking analyses. Generation of this report involved a rigorous, formal, and documented evaluation using objective criteria and qualified and independent reviewers to make a judgment as to the technical/scientific/business merit, the actual or anticipated results, and the productivity and management effectiveness of programs and/or projects. The ''Energy Conservation Standards Rulemaking Peer Review Report'' dated February 2007 has been disseminated and is available at the following Web site: *http://energy.gov/eere/buildings/downloads/energy-conservation-standards-rulemaking-peer-review-report.*

VII. Public Participation

A. Attendance at the Public Meeting

The time, date, and location of the public meeting are listed in the **DATES** and **ADDRESSES** sections at the beginning of this document. If you plan to attend the public meeting, please notify Ms. Brenda Edwards at (202) 586–2945 or *Brenda.Edwards@ee.doe.gov*.

Please note that foreign nationals participating in the public meeting are subject to advance security screening procedures which require advance notice prior to attendance at the public meeting. If a foreign national wishes to participate in the public meeting, please inform DOE as soon as possible by contacting Ms. Regina Washington at (202) 586–1214 or by email: *Regina.Washington@ee.doe.gov* so that the necessary procedures can be completed.

DOE requires visitors to have laptops and other devices, such as tablets, checked upon entry into the building. Any person wishing to bring these devices into the Forrestal Building will be required to obtain a property pass. Visitors should avoid bringing these devices, or allow an extra 45 minutes to check in. Please report to the visitor's desk to have devices checked before proceeding through security.

Due to the REAL ID Act implemented by the Department of Homeland Security (DHS), there have been recent changes regarding ID requirements for individuals wishing to enter Federal buildings from specific states and U.S. territories. Driver's licenses from the following states or territory will not be accepted for building entry and one of the alternate forms of ID listed below will be required. DHS has determined that regular driver's licenses (and ID cards) from the following jurisdictions are not acceptable for entry into DOE facilities: Alaska, American Samoa, Arizona, Louisiana, Maine, Massachusetts, Minnesota, New York, Oklahoma, and Washington. Acceptable alternate forms of Photo-ID include: U.S. Passport or Passport Card; an Enhanced Driver's License or Enhanced ID-Card issued by the states of Minnesota, New York or Washington (Enhanced licenses issued by these states are clearly marked Enhanced or Enhanced Driver's License); a military ID or other Federal government issued Photo-ID card.

In addition, you can attend the public meeting via webinar. Webinar registration information, participant instructions, and information about the capabilities available to webinar participants will be published on DOE's Web site at: *https://attendee.gotowebinar.com/register/6872804566336170753*.

Participants are responsible for ensuring their systems are compatible with the webinar software.

B. Procedure for Submitting Prepared General Statements for Distribution

Any person who has plans to present a prepared general statement may request that copies of his or her statement be made available at the public meeting. Such persons may submit requests, along with an advance electronic copy of their statement in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format, to the appropriate address shown in the **ADDRESSES** section at the beginning of this document. The request and advance copy of statements must be received at least one week before the public meeting and may be emailed, hand-delivered, or sent by mail. DOE prefers to receive requests and advance copies via email. Please include a telephone number to enable DOE staff to make follow-up contact, if needed.

C. Conduct of the Public Meeting

DOE will designate a DOE official to preside at the public meeting and may also use a professional facilitator to aid discussion. The meeting will not be a judicial or evidentiary-type public hearing, but DOE will conduct it in accordance with section 336 of EPCA (42 U.S.C. 6306). A court reporter will be present to record the proceedings and prepare a transcript. DOE reserves the right to schedule the order of presentations and to establish the procedures governing the conduct of the public meeting. After the public meeting, interested parties may submit further comments on the proceedings as well as on any aspect of the rulemaking until the end of the comment period.

The public meeting will be conducted in an informal, conference style. DOE will present summaries of comments received before the public meeting, allow time for prepared general statements by participants, and encourage all interested parties to share their views on issues affecting this rulemaking. Each participant will be allowed to make a general statement (within time limits determined by DOE), before the discussion of specific topics. DOE will allow, as time permits, other participants to comment briefly on any general statements.

At the end of all prepared statements on a topic, DOE will permit participants to clarify their statements briefly and comment on statements made by others. Participants should be prepared to answer questions by DOE and by other participants concerning these issues. DOE representatives may also ask questions of participants concerning other matters relevant to this rulemaking. The official conducting the public meeting will accept additional comments or questions from those attending, as time permits. The presiding official will announce any further procedural rules or modification of the above procedures that may be needed for the proper conduct of the public meeting.

A transcript of the public meeting will be included in the docket, which can be viewed as described in the *Docket* section at the beginning of this document. In addition, any person may buy a copy of the transcript from the transcribing reporter.

D. Submission of Comments

DOE will accept comments, data, and information regarding this proposed rule before or after the public meeting, but no later than the date provided in the **DATES** section at the beginning of this proposed rule. Interested parties may submit comments, data, and other information using any of the methods described in the **ADDRESSES** section at the beginning of this document.

Submitting comments via *www.regulations.gov*. The *www.regulations.gov* Web page will require you to provide your name and contact information. Your contact information will be viewable to DOE Building Technologies staff only. Your contact information will not be publicly viewable except for your first and last names, organization name (if any), and submitter representative name (if any). If your comment is not processed properly because of technical difficulties, DOE will use this information to contact you. If DOE cannot read your comment due to technical difficulties and cannot contact you for clarification, DOE may not be able to consider your comment.

However, your contact information will be publicly viewable if you include it in the comment itself or in any documents attached to your comment. Any information that you do not want to be publicly viewable should not be included in your comment, nor in any document attached to your comment. Otherwise, persons viewing comments will see only first and last names, organization names, correspondence containing comments, and any documents submitted with the comments.

Do not submit to *www.regulations.gov* information for which disclosure is restricted by statute, such as trade secrets and commercial or financial information (hereinafter referred to as Confidential Business Information (CBI)). Comments submitted through *www.regulations.gov* cannot be claimed as CBI. Comments received through the Web site will waive any CBI claims for the information submitted. For information on submitting CBI, see the Confidential Business Information section below.

DOE processes submissions made through *www.regulations.gov* before posting. Normally, comments will be posted within a few days of being submitted. However, if large volumes of comments are being processed simultaneously, your comment may not be viewable for up to several weeks. Please keep the comment tracking number that regulations.gov provides after you have successfully uploaded your comment.

Submitting comments via email, hand delivery/courier, or mail. Comments and documents submitted via email, hand delivery, or mail also will be posted to *www.regulations.gov*. If you do not want your personal contact information to be publicly viewable, do not include it in your comment or any accompanying documents. Instead, provide your contact information in a cover letter. Include your first and last names, email address, telephone number, and optional mailing address. The cover letter will not be publicly viewable as long as it does not include any comments.

Include contact information each time you submit comments, data, documents, and other information to DOE. If you submit via mail or hand delivery/courier, please provide all items on a CD, if feasible, in which case it is not necessary to submit printed copies. No telefacsimiles (faxes) will be accepted.

Comments, data, and other information submitted to DOE electronically should be provided in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format. Provide documents that are not secured, that are written in English, and that are free of any defects or viruses. Documents should not contain special characters or any form of encryption and, if possible, they should carry the electronic signature of the author.

Campaign form letters. Please submit campaign form letters by the originating organization in batches of between 50 to 500 form letters per PDF or as one form letter with a list of supporters' names compiled into one or more PDFs. This reduces comment processing and posting time.

Confidential Business Information. According to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit via email, postal mail, or hand delivery/courier two well-marked copies: One copy of the document marked confidential including all the information believed to be confidential, and one copy of the document marked non-confidential with the information believed to be confidential deleted. Submit these documents via email or on a CD, if feasible. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

Factors of interest to DOE when evaluating requests to treat submitted information as confidential include: (1) A description of the items; (2) whether and why such items are customarily treated as confidential within the industry; (3) whether the information is generally known by or available from other sources; (4) whether the information has previously been made available to others without obligation concerning its confidentiality; (5) an explanation of the competitive injury to the submitting person which would result from public disclosure; (6) when such information might lose its confidential character due to the passage of time; and (7) why disclosure of the information would be contrary to the public interest.

It is DOE's policy that all comments may be included in the public docket, without change and as received, including any personal information provided in the comments (except information deemed to be exempt from public disclosure).

E. Issues on Which DOE Seeks Comment

Although DOE welcomes comments on any aspect of this proposal, DOE is particularly interested in receiving comments and views of interested parties concerning the following issues:

(1) DOE requests data on manufacturer selling prices, shipments and conversion costs of very large commercial packaged boilers with fuel input rate above 10,000 kBtu/h that can be used to supplement the analyses of such equipment in this rulemaking.

(2) DOE requests feedback on the methodology used to analyze all equipment classes and the results obtained. In particular DOE is interested in comments on whether the results are appropriate and representative of the current market prices for such type of equipment.

(3) DOE requests information or insight that can better inform its markups analysis.

(4) DOE requests feedback on the methodology and assumptions used for the building heat load adjustment.

(5) DOE requests information on what constitutes a reasonable baseline assumption about the current degree of adoption of hybrid boiler configurations in retrofit situations and on other related parameters such as percentage of total installed capacity typically assigned to the new condensing boilers, climate zones where it may be more prevalent and any other supporting documentation.

(6) DOE seeks input on its characterization and development of representative installation costs, including venting costs, in new and replacement commercial package boiler installations, including data to support assumptions on vent sizing, vent length distributions, and vent materials.

(7) DOE requests comment and seeks data on the assumption that a rebound effect is unlikely to occur for these commercial applications.

(8) DOE requests comments on the representativeness of using 1-year as warranty for parts and labor, and 10-years as warranty for the heat exchanger.

(9) DOE seeks 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 requests information on historical shipments of commercial packaged boilers including shipments by equipment class for small, large, and very large commercial packaged boilers.

(10) DOE requests feedback on the assumptions used to estimate the impact of relative price increases on commercial packaged boiler shipments due to proposed standards.

(11) DOE requests additional information from manufacturers regarding conversion costs for oil-fired products. Specifically, DOE is interested in estimates of capital conversion costs at each TSL and the change in manufacturing equipment associated with those costs.

(12) DOE requests comment on whether DOE should adopt TSL 3.

(13) DOE requests comment on the appropriateness of the Manufacturer Impact Analysis' assumption that the AHRI and ABMA equipment databases are representative of all small manufacturers.

(14) DOE also requests product listing data from small manufacturers that are not AHRI or ABMA trade association members—including model numbers, capacity, and efficiency ratings.

(15) DOE also continues to seek financial, sales, and market share data from small manufacturers to better understand and analyze the impact of these proposed standards and conversion costs on the revenue and operating profit of a small business.

VIII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this proposed rule.

List of Subjects in 10 CFR Part 431

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

Issued in Washington, DC, on March 11, 2016.

David Friedman,

Principal Deputy Assistant Secretary, Energy Efficiency and Renewable Energy.

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

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

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

Authority: 42 U.S.C. 6291–6317.

■ 3. Section 431.87 is revised to read as follows:

§ 431.87 Energy conservation standards and their effective dates.

(a) Each commercial packaged boilers listed in Table 1 to § 431.87 and manufactured on or after March 2, 2012 and prior to [DATE 3 YEARS AFTER PUBLICATION IN THE **FEDERAL REGISTER** OF THE FINAL RULE ESTABLISHING AMENDED ENERGY CONSERVATION STANDARDS FOR COMMERCIAL PACKAGED BOILERS], must meet the applicable energy conservation standard levels in Table 1.

TABLE 1 TO § 431.87—COMMERCIAL PACKAGED BOILER ENERGY CONSERVATIONS STANDARDS

Equipment	Subcategory	Size category (fuel input rate)	Energy conservation standard *
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

(b) Each commercial packaged boilers listed in Table 2 to § 431.87 and manufactured on or after [DATE 3 YEARS AFTER PUBLICATION IN THE **FEDERAL REGISTER** OF THE FINAL RULE ESTABLISHING AMENDED ENERGY CONSERVATION STANDARDS FOR COMMERCIAL PACKAGED BOILERS], must meet the applicable energy conservation standard levels in Table 2.

TABLE 2 TO § 431.87—COMMERCIAL PACKAGED BOILER ENERGY CONSERVATIONS STANDARDS

Equipment	Size category (fuel input rate)	Energy conservation standard *
Small Gas-Fired Hot Water Commercial Packaged Boilers	>300,000 Btu/h and ≤2,500,000 Btu/h	85.0% 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% is permitted and meets Federal commercial packaged boiler energy conservation standards.

[FR Doc. 2016–06588 Filed 3–23–16; 8:45 am]

BILLING CODE 6450–01–P