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[6450-01-P]

DEPARTMENT OF ENERGY

10 CFR Part 430

[Docket Number EERE–2012–BT–STD–0047]

RIN 1904–AC88

Energy Conservation Program: Energy Conservation Standards for Residential 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 products and certain commercial and industrial equipment, including residential boilers. EPCA also requires the U.S. Department of Energy (DOE) to periodically determine whether more-stringent, amended standards would be technologically feasible and economically justified, and would save a significant amount of energy. In this notice, DOE proposes amended energy conservation standards for residential boilers. The notice also announces a public meeting to receive comment on these proposed standards and associated analyses and results.

DATES: Meeting: DOE will hold a public meeting on Thursday, April 30, 2015 from 9:00 a.m. to 4:00 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 [**INSERT DATE 60 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER**]. See section VII, "Public Participation," for details.

ADDRESSES: The public meeting will be held at the U.S. Department of Energy, Forrestal Building, Room 8E-089, 1000 Independence Avenue, SW., Washington, DC 20585. To attend, please notify Ms. Brenda Edwards at (202) 586–2945. Please note that foreign nationals visiting DOE Headquarters are subject to advance security screening procedures. Any foreign national wishing to participate in the meeting should advise DOE as soon as possible by contacting Ms. Edwards to initiate the necessary procedures. Please also note that any person wishing to bring a laptop computer or tablet into the Forrestal Building will be required to obtain a property pass. Visitors should avoid bringing laptops, or allow an extra 45 minutes. Persons may also attend the public meeting via webinar. For more information, refer to section VII, "Public Participation," near the end of this notice.

Instructions: Any comments submitted must identify the NOPR for Energy Conservation Standards for Residential Boilers, and provide docket number EE-2012–BT–STD–0047 and/or regulatory information number (RIN) number 1904–AC88. Comments may be submitted using any of the following methods:

1. Federal eRulemaking Portal: www.regulations.gov. Follow the instructions for submitting comments.
2. E-mail: ResBoilers2012STD0047@ee.doe.gov. Include the docket number and/or RIN in the subject line of the message. Submit electronic comments in Word Perfect, Microsoft Word, PDF, or ASCII file format, and avoid the use of special characters or any form on 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 compact disc (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., Suite 600, Washington, DC, 20024. Telephone: (202) 586-2945. If possible, please submit all items on a 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 e-mail 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).

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

A link to the docket webpage can be found at: http://www.regulations.gov/#!docketDetail;D=EERE-2012-BT-STD-0047. This webpage contains a link to the docket for this notice on the www.regulations.gov site. The www.regulations.gov webpage contains simple instructions on how to access all documents, including public comments, in the docket. See section VII, "Public Participation," for further information on how to submit comments through www.regulations.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.

FOR FURTHER INFORMATION CONTACT:

Mr. Ronald Majette, 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) 586-7935. E-mail: residential_furnaces_and_boilers@ee.doe.gov.

Mr. Eric Stas, U.S. Department of Energy, Office of the General Counsel, GC-33, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. Telephone: (202)-586-9507. E-mail: Eric.Stas@hq.doe.gov.

For information on how to submit or review public comments, contact Ms. Brenda Edwards at (202) 586-2945 or by email: Brenda.Edwards@ee.doe.gov.

SUPPLEMENTARY INFORMATION:

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I. Summary of the Proposed Rule

Title III, Part B[1] of the Energy Policy and Conservation Act of 1975 (EPCA or the Act), Pub. L. 94-163 (42 U.S.C. 6291-6309, as codified), established the Energy

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

Conservation Program for Consumer Products Other Than Automobiles.[2] These products include residential boilers, the subject of today's notice.

Pursuant to EPCA, any new or amended energy conservation standard must be designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) Furthermore, the new or amended standard must result in a significant conservation of energy. (42 U.S.C. 6295(o)(3)(B)) EPCA specifically provides that DOE must conduct a second round of energy conservation standards rulemaking for residential boilers. (42 U.S.C. 6295(f)(4)(C)) The statute also provides that not later than 6 years after issuance of any final rule establishing or amending a standard, DOE must publish either a notice of determination that standards for the product do not need to be amended, or a notice of proposed rulemaking including new proposed energy conservation standards. (42 U.S.C. 6295(m)(1)) DOE initiated this rulemaking as required by 42 U.S.C. 6295(f)(4)(C), but once complete, this rulemaking will also satisfy the 6-year review provision under 42 U.S.C. 6295(m)(1).

Furthermore, EISA 2007 amended EPCA to require that any new or amended energy conservation standard adopted after July 1, 2010, shall address standby mode and off mode energy consumption pursuant to 42 U.S.C. 6295(o). (42 U.S.C. 6295(gg)(3)) If feasible, the statute directs DOE to incorporate standby mode and off mode energy consumption into a single standard with the product's active mode energy use. If a single

[2] All references to EPCA in this document refer to the statute as amended through the American Energy Manufacturing Technical Corrections Act (AEMTCA), Pub. L. 112-210 (Dec. 18, 2012).

standard is not feasible, DOE may consider establishing a separate standard to regulate standby mode and off mode energy consumption.

In accordance with these and other statutory provisions discussed in this notice, DOE proposes amending the existing AFUE energy conservation standards and adopting new standby mode off mode electrical energy conservation standards for residential boilers. The proposed AFUE standards for each product class (described in section IV.A.2) are expressed as minimum annual fuel utilization efficiencies (AFUE), as determined by the DOE test method (described in section III.B), and are shown in Table I.1. Table I.2 shows the proposed standards for standby and off mode. These proposed standards, if adopted, would apply to all products listed in Table I.1 and Table I.2 and manufactured in, or imported into, the United States on or after the date 5 years after the publication of the final rule for this rulemaking.

Table I.1. Proposed AFUE Energy Conservation Standards for Residential Boilers

Product Class*	Proposed Standard: AFUE** %	Design Requirement
Gas-fired hot water boiler	85	Constant-burning pilot not permitted. Automatic means for adjusting water temperature required (except for boilers equipped with tankless domestic water heating coils).
Gas-fired steam boiler	82	Constant-burning pilot not permitted.
Oil-fired hot water boiler	86	Automatic means for adjusting temperature required (except for boilers equipped with tankless domestic water heating coils).
Oil-fired steam boiler	86	None
Electric hot water boiler	None	Automatic means for adjusting

		temperature required (except for boilers equipped with tankless domestic water heating coils).
Electric steam boiler	None	None

* Product classes are separated by fuel source – gas, oil, or electricity – and heating medium – steam or hot water. See section IV.A.2 for a discussion of product classes.
** AFUE is an annualized fuel efficiency metric that fully accounts for fuel consumption in active, standby, and off modes. See section III.B for a discussion of the AFUE test method.

Table I.2. Proposed Energy Conservation Standards for Residential Boilers Standby Mode and Off Mode Electrical Energy Consumption

Product Class	**Proposed Standard: $P_{W,SB}$ watts**	**Proposed Standard: $P_{W,OFF}$ watts**
Gas-fired hot water boiler	9	9
Gas-fired steam boiler	8	8
Oil-fired hot water boiler	11	11
Oil-fired steam boiler	11	11
Electric hot water boiler	8	8
Electric steam boiler	8	8

A. Benefits and Costs to Consumers

Table I.3 presents DOE's evaluation of the economic impacts of the proposed AFUE and standby mode and off mode standards on consumers of residential boilers, as measured by the average life-cycle cost (LCC) savings and the median payback period (PBP).[3] Table I.4 presents the same results for standby mode and off mode. The average LCC savings are positive for all product classes. The estimated PBP for the standard levels proposed for all product classes fall below the average boiler lifetime, which is approximately 25 years.[4] DOE has not conducted an analysis of an AFUE standard level

[3] The average LCC savings and PBP are measured relative to the base case efficiency distribution, which depicts the boiler market in the compliance year (see section IV.F.2.e). The LCC savings and PBP calculations are further described in section IV.F and in chapter 8 of the NOPR TSD.
[4] DOE used a distribution of boiler lifetimes that ranges from 2 to 55 years. See appendix 8F of the NOPR TSD for details of the derivation of the average boiler lifetime.

for electric boilers as the efficiency of these products already approaches 100 percent AFUE.

Table I.3 Impacts of Proposed AFUE Energy Conservation Standards on Consumers of Residential Boilers

Product Class	Average LCC Savings 2013$	Median Payback Period years*
Gas-Fired Hot Water Boiler	123	7.7
Gas-Fired Steam Boiler	61	1.3
Oil-Fired Hot Water Boiler	257	7.6
Oil-Fired Steam Boiler	723	10.5
Electric Hot Water Boiler	N/A (No Standard)	N/A (No Standard)
Electric Steam Boiler	N/A (No Standard)	N/A (No Standard)

* The average PBP in years is 20.8 for Gas-Fired Hot Water Boiler, 3.7 for Gas-Fired Steam Boiler, 11.7 for Oil-Fired Hot Water Boiler, and 13.9 for Oil-Fired Steam Boiler.

Table I.4 Impacts of Proposed Standby Mode and Off Mode Electrical Energy Consumption Energy Conservation Standards on Consumers of Residential Boilers

Product Class	Average LCC Savings 2013$	Median Payback Period years
Gas-Fired Hot Water Boiler	14	7.8
Gas-Fired Steam Boiler	15	7.4
Oil-Fired Hot Water Boiler	15	7.4
Oil-Fired Steam Boiler	15	7.4
Electric Hot Water Boiler	8	11.0
Electric Steam Boiler	9	10.9

Estimates of the combined impact of the proposed AFUE and standby mode and off mode standards on the consumers are shown in Table I.5.[5]

[5] The average LCC savings and PBP for both standards are calculated for each household. To calculate the PBP, DOE determined the combined installed cost to the consumer and the first-year operating costs for both standards. The combined LCC savings and PBP are compared to the base case efficiency distribution for both standards, which depicts the boiler market in the compliance year (see section IV.F.2.e). The combined results for all households are used to derive the average LCC savings and the median payback period values shown in Table I.5.

Table I.5 Combined Impacts of Proposed AFUE and Standby Mode and Off Mode Energy Conservation Standards on Consumers of Residential Boilers

Product Class	Average LCC Savings <u>2013$</u>	Median Payback Period <u>years</u>
Gas-Fired Hot Water Boiler	137	7.8
Gas-Fired Steam Boiler	76	7.3
Oil-Fired Hot Water Boiler	272	7.4
Oil-Fired Steam Boiler	739	9.9
Electric Hot Water Boiler	8	11.0
Electric Steam Boiler	9	10.9

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 2049). Using a real discount rate of 8.0 percent, DOE estimates that the INPV for manufacturers is $380.96 million.[6] DOE analyzed the impacts of AFUE energy conservation standards and standby/off mode electrical energy consumption energy conservation standards on manufacturers separately. Under the proposed AFUE standards, DOE expects that the change in INPV will range from -2.10 to 0.20 percent, which is approximately equivalent to a reduction of $7.99 million to an increase of $0.77 million. DOE estimates that residential boiler manufacturers will incur $4.28 million in conversion costs as a result of this proposed AFUE standard. Under the proposed standby mode and off mode standards, DOE expects the change in INPV will range from -0.28 to 0.06 percent, which is approximately equivalent to a decrease of $1.08 million to an increase of $0.22 million. DOE estimates that residential boiler manufacturers will incur $0.21 million in

[6] All monetary values in this document are expressed in 2013 dollars; discounted values are discounted to 2014 unless explicitly stated otherwise.

conversion costs as a result of this this proposed standby and off mode standard. DOE expects the combined impact of the TSLs proposed for AFUE and standby and off mode electrical consumption in this NOPR to range from -2.38 to 0.26 percent, which is approximately equivalent to a reduction of $9.07 million to an increase of $0.99 million. DOE estimates that residential boiler manufacturers will incur $4.49 million in conversion costs as a result of both proposed standards. Based on DOE's interviews with residential boiler manufacturers, DOE does not expect any plant closings or significant loss of employment to result from the proposed standards for residential boilers. More information on DOE's direct employment impact analysis can be found in section V.B.2.b of this NOPR.

C. National Benefits[7]

DOE's analyses indicate that the proposed AFUE energy conservation standards for residential boilers would save a significant amount of energy. The lifetime energy savings for residential boilers purchased in the 30-year period that begins in the first full year of compliance with amended standards (2020-2049) amount to 0.21 quads[8] of full-fuel-cycle energy. This is a savings of 0.6 percent relative to the energy use of these products in the base case without amended standards.

The cumulative net present value (NPV) of total consumer costs and savings for the proposed residential boilers AFUE standards ranges from $0.4 billion to $1.3 billion at 7-percent and 3-percent discount rates, respectively. This NPV expresses the estimated

[7] Energy savings in this section refer to full-fuel-cycle savings (see section IV.H for discussion).
[8] A quad is equal to 10^{15} British thermal units (Btu).

total value of future operating-cost savings minus the estimated increased product costs for residential boilers purchased in 2020–2049.

In addition, the proposed residential boilers AFUE standards would have significant environmental benefits. The energy savings would result in cumulative emission reductions of 12.9 million metric tons (Mt)[9] of carbon dioxide (CO_2), 110.1 thousand tons of methane (CH_4), 0.1 thousand tons of nitrous oxide (N_2O), 0.3 thousand tons of sulfur dioxide (SO_2), 32.07 thousand tons of nitrogen oxides (NO_X), and -0.001 tons of mercury (Hg).[10] The cumulative reduction in CO_2 emissions through 2030 amounts to 1.4 Mt.

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.[11] The derivation of the SCC values is discussed in section IV.L. Using discount rates appropriate for each set of SCC values, DOE estimates the present monetary value of the CO_2 emissions reduction is between \$0.07 billion and \$1.14 billion. Additionally, DOE estimates the present monetary value of the

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

[10] DOE calculated emissions reductions relative to the Annual Energy Outlook 2013 (AEO 2013) Reference case, which generally represents current legislation and environmental regulations for which implementing regulations were available as of December 31, 2012. DOE notes that the proposed AFUE standards are estimated to cause a very slight increase in mercury emissions due to associated increase in boiler electricity use.

[11] 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 November 2013) (Available at: http://www.whitehouse.gov/sites/default/files/omb/assets/inforeg/technical-update-social-cost-of-carbon-for-regulator-impact-analysis.pdf).

NO_X emissions reduction to be $13.5 million to $35.5 million at 7-percent and 3-percent discount rates, respectively.[12]

Table I.5 summarizes the national economic benefits and costs expected to result from the proposed AFUE standards for residential boilers.

[12] DOE is currently investigating valuation of avoided Hg and SO_2 emissions.

Table I.6 Summary of National Economic Benefits and Costs of Proposed AFUE Energy Conservation Standards for Residential Boilers (TSL 3)*

Category	Present Value Billion 2013$	Discount Rate %
Benefits		
Consumer Operating Cost Savings	0.64	7
	1.82	3
CO_2 Reduction Monetized Value ($12.0/t case)**	0.07	5
CO_2 Reduction Monetized Value ($40.5/t case)**	0.37	3
CO_2 Reduction Monetized Value ($62.4/t case)**	0.60	2.5
CO_2 Reduction Monetized Value ($119/t case)**	1.14	3
NO_X Reduction Monetized Value (at $2,684/ton)**	0.01	7
	0.04	3
Total Benefits†	1.03	7
	2.22	3
Costs		
Consumer Incremental Installed Costs	0.29	7
	0.54	3
Total Net Benefits		
Including Emissions Reduction Monetized Value†	0.74	7
	1.69	3

* This table presents the costs and benefits associated with residential boilers shipped in 2020−2049. These results include benefits to consumers which accrue after 2049 from the products purchased in 2020−2049. The results account for the incremental variable and fixed costs incurred by manufacturers due to the standard, some of which may be incurred in preparation for the rule.
** The CO_2 values represent global monetized values of the SCC, in 2013$, in 2015 under several scenarios of the updated SCC values. The first three cases use the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The fourth case represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The SCC time series used by DOE incorporate an escalation factor. The value for NO_X is the average of the low and high values used in DOE's analysis.
† Total Benefits for both the 3% and 7% cases are derived using the series corresponding to average SCC with a 3-percent discount rate ($40.5/t in 2015).

For the proposed standby mode and off mode standards, the lifetime energy savings for residential boilers purchased in the 30-year period that begins in the first full year of compliance with amended standards (2020-2049) amount to 0.045 quads. This is a savings of 18 percent relative to the standby energy use of these products in the base case without amended standards.

The cumulative NPV of total consumer costs and savings for the proposed standby mode and off mode standards for residential boilers ranges from $0.17 billion to $0.44 billion at 7-percent and 3-percent discount rates, respectively. This NPV expresses the estimated total value of future operating-cost savings minus the estimated increased product costs for residential boilers purchased in 2020–2049.

In addition, the proposed standby mode and off mode standards would have significant environmental benefits. The energy savings would result in cumulative emission reductions of 2.1 million metric tons (Mt) of carbon dioxide (CO_2), 11.8 thousand tons of methane (CH_4), 0.1 thousand tons of nitrous oxide (N_2O), 2.2 thousand tons of sulfur dioxide (SO_2), 1.91 thousand tons of nitrogen oxides (NO_X), and 0.004 tons of mercury (Hg). The cumulative reduction in CO_2 emissions through 2030 amounts to 0.25 Mt.

As noted above, 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. The derivation of the SCC values is discussed in section IV.L. Using discount rates appropriate for each set of SCC values, DOE estimates the present monetary value of the CO_2 emissions reduction is between $0.01 billion and $0.18 billion. Additionally, DOE estimates the present monetary value of the NO_X emissions reduction to be $0.8 million to $2.1 million at 7-percent and 3-percent discount rates, respectively.

Table I.6 summarizes the national economic benefits and costs expected to result from the proposed standby mode and off mode standards for residential boilers.

Table I.7 Summary of National Economic Benefits and Costs of Proposed Standby Mode and Off Mode Energy Conservation Standards for Residential Boilers (TSL 3)*

Category	Present Value Billion 2013$	Discount Rate %
Benefits		
Consumer Operating Cost Savings	0.250	7
	0.596	3
CO_2 Reduction Monetized Value ($12.0/t case)**	0.012	5
CO_2 Reduction Monetized Value ($40.5/t case)**	0.058	3
CO_2 Reduction Monetized Value ($62.4/t case)**	0.094	2.5
CO_2 Reduction Monetized Value ($119/t case)**	0.180	3
NO_X Reduction Monetized Value (at $2,684/ton)**	0.001	7
	0.002	3
Total Benefits†	0.309	7
	0.657	3
Costs		
Consumer Incremental Installed Costs	0.082	7
	0.158	3
Total Net Benefits		
Including Emissions Reduction Monetized Value†	0.226	7
	0.499	3

* This table presents the costs and benefits associated with residential boilers shipped in 2020−2049. These results include benefits to consumers which accrue after 2049 from the products purchased in 2020−2049. The results account for the incremental variable and fixed costs incurred by manufacturers due to the standard, some of which may be incurred in preparation for the rule.
** The CO_2 values represent global monetized values of the SCC, in 2013$, in 2015 under several scenarios of the updated SCC values. The first three cases use the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The fourth case represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The SCC time series used by DOE incorporate an escalation factor. The value for NO_X is the average of the low and high values used in DOE's analysis.
† Total Benefits for both the 3% and 7% cases are derived using the series corresponding to average SCC with a 3-percent discount rate ($40.5/t in 2015).

The benefits and costs of today's proposed energy conservation standards, for residential boiler products sold in 2020-2049, can also be expressed in terms of annualized values. Benefits and costs for the AFUE standards are considered separately from benefits and costs for the standby mode and off mode electrical consumption standards, because for the reasons explained in section I.D below, it was not technically feasible to develop a single, integrated standard. The annualized monetary values are the sum of: (1) the annualized national economic value of the benefits from consumer operation of products that meet the proposed new or amended standards (consisting primarily of operating cost savings from using less energy, minus increases in product purchase price and installation costs, which is another way of representing consumer NPV), and (2) the annualized monetary value of the benefits of emission reductions, including CO_2 emission reductions.[13]

Although combining the values of operating savings and CO_2 emission reductions provides a useful perspective, two issues should be considered. First, the national operating savings are domestic U.S. consumer monetary savings that occur as a result of market transactions, whereas the value of CO_2 reductions is based on a global value. Second, the assessments of operating cost savings and CO_2 savings are performed with different methods that use different time frames for analysis. The national operating cost savings is measured for the lifetime of residential boilers shipped in 2020–2049. The SCC values, on the other hand, reflect the present value of some future climate-related

[13] DOE used a two-step calculation process to convert the time-series of costs and benefits into annualized values. First, DOE calculated a present value in 2014, the year used for discounting the NPV of total consumer costs and savings, for the time-series of costs and benefits using discount rates of three and seven percent for all costs and benefits except for the value of CO_2 reductions. For the latter, DOE used a range of discount rates, as shown in Table I.7. From the present value, DOE then calculated the fixed annual payment over a 30-year period (2020 through 2049) that yields the same present value. The fixed annual payment is the annualized value. Although DOE calculated annualized values, this does not imply that the time-series of cost and benefits from which the annualized values were determined is a steady stream of payments.

impacts resulting from the emission of one ton of carbon dioxide in each year. These impacts continue well beyond 2100.

Estimates of annualized benefits and costs of the proposed AFUE standards are shown in Table I.7. The results under the primary estimate are as follows. Using a 7-percent discount rate for benefits and costs other than CO_2 reduction (for which DOE used a 3-percent discount rate along with the average SCC series that uses a 3-percent discount rate ($40.5/t in 2015)), cost of the residential boiler standards proposed in today's rule is $32.3 million per year in increased equipment costs, while the estimated benefits are $73 million per year in reduced equipment operating costs, $21.8 million in CO_2 reductions, and $1.53 million in reduced NO_X emissions. In this case, the net benefit would amount to $64 million per year. Using a 3-percent discount rate for all benefits and costs and the average SCC series that uses a 3-percent discount rate ($40.5/t in 2015), the estimated cost of the residential boiler standards proposed in today's rule is $31.7 million per year in increased equipment costs, while the estimated benefits are $108 million per year in reduced equipment operating costs, $21.8 million in CO_2 reductions, and $2.10 million in reduced NO_X emissions. In this case, the net benefit would amount to $100 million per year.

Table I.8 Annualized Benefits and Costs of Proposed AFUE Energy Conservation Standards for Residential Boilers (TSL 3)

	Discount Rate %	Primary Estimate*	Low Net Benefits Estimate*	High Net Benefits Estimate*
		million 2013$/year		
Benefits				
Consumer Operating Cost Savings	7	73	71	75
	3	108	105	112
CO_2 Reduction Monetized Value ($12.0/t case)*	5	6.1	6.1	6.2
CO_2 Reduction Monetized Value ($40.5/t case)*	3	21.8	21.6	22.0
CO_2 Reduction Monetized Value ($62.4/t case)*	2.5	32.2	31.9	32.5
CO_2 Reduction Monetized Value ($119/t case)*	3	67.6	66.9	68.2
NO_X Reduction Monetized Value (at $2,684/ton)**	7	1.53	1.52	1.53
	3	2.10	2.08	2.12
Total Benefits†	7 plus CO_2 range	80 to 142	79 to 140	83 to 145
	7	96	94	99
	3 plus CO_2 range	116 to 177	113 to 174	121 to 183
	3	132	128	136
Costs				
Consumer Incremental Installed Costs	7	32.3	38.7	26.8
	3	31.7	38.9	25.6
Net Benefits				
Total†	7 plus CO_2 range	48 to 110	40 to 101	56 to 118
	7	64	56	72
	3 plus CO_2 range	84 to 146	74 to 135	95 to 157
	3	100	89	111

* This table presents the annualized costs and benefits associated with residential boilers shipped in 2020–2049. These results include benefits to consumers which accrue after 2049 from the products purchased in 2020–2049. The results account for the incremental variable and fixed costs incurred by manufacturers due to the standard, some of which may be incurred in preparation for the rule. The Primary, Low Benefits, and High Benefits Estimates utilize projections of energy prices from the AEO 2013 Reference case, Low Estimate, and High Estimate, respectively. In addition, incremental product costs reflect a medium decline rate for projected product price trends in the Primary Estimate, a low decline rate for projected product price trends in the Low Benefits Estimate, and a high decline rate for projected product price trends in the High Benefits Estimate. The methods used to derive projected price trends are explained in section IV.F.1.
** The CO_2 values represent global monetized values of the SCC, in 2013$, in 2015 under several scenarios of the updated SCC values. The first three cases use the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The fourth case represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The SCC time series used by DOE incorporate an escalation factor. The value for NO_X is the average of the low and high values used in DOE's analysis.
† Total Benefits for both the 3% and 7% cases are derived using the series corresponding to the average SCC with a 3-percent discount rate ($40.5/t in 2015). 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.

Estimates of annualized benefits and costs of the proposed standby mode and off mode standards are shown in Table I.8. The results under the primary estimate are as follows. Using a 7-percent discount rate for benefits and costs other than CO_2 reduction (for which DOE used a 3-percent discount rate along with the average SCC series that uses a 3-percent discount rate ($40.5/t in 2015)), the estimated cost of the residential boiler standby mode and off mode standards proposed in today's rule is $9.31 million per year in increased equipment costs, while the estimated benefits are $28 million per year in reduced equipment operating costs, $3 million in CO_2 reductions, and $0.09 million in reduced NO_X emissions. In this case, the net benefit would amount to $22 million per year. Using a 3-percent discount rate for all benefits and costs and the average SCC series that uses a 3-percent discount rate ($40.5/t in 2015), the estimated cost of the residential boiler standby mode and off mode standards proposed in today's rule is $9.35 million per year in increased equipment costs, while the estimated benefits are $35 million per year in reduced equipment operating costs, $3 million in CO_2 reductions, and

$0.12 million in reduced NO_X emissions. In this case, the net benefit would amount to $29 million per year.

Table I.9 Annualized Benefits and Costs of Proposed Standby Mode and Off Mode Energy Conservation Standards for Residential Boilers (TSL 3)

	Discount Rate %	Primary Estimate*	Low Net Benefits Estimate*	High Net Benefits Estimate*
		million 2013$/year		
Benefits				
Consumer Operating Cost Savings	7	28	27	29
	3	35	34	36
CO_2 Reduction Monetized Value ($12.0/t case)*	5	1	1	1
CO_2 Reduction Monetized Value ($40.5/t case)*	3	3	3	4
CO_2 Reduction Monetized Value ($62.4/t case)*	2.5	5	5	5
CO_2 Reduction Monetized Value ($119/t case)*	3	11	10	11
NO_X Reduction Monetized Value (at $2,684/ton)**	7	0.09	0.09	0.09
	3	0.12	0.12	0.13
Total Benefits†	7 plus CO_2 range	29 to 39	28 to 38	30 to 40
	7	32	30	33
	3 plus CO_2 range	36 to 46	35 to 44	38 to 47
	3	39	37	40
Costs				
Consumer Incremental Installed Costs	7	9.31	9.48	9.13
	3	9.35	9.55	9.15
Net Benefits				
Total†	7 plus CO_2 range	20 to 30	19 to 28	21 to 31
	7	22	21	24
	3 plus CO_2 range	27 to 37	25 to 35	28 to 38
	3	29	28	31

* This table presents the annualized costs and benefits associated with residential boilers shipped in 2020−2049. These results include benefits to consumers which accrue after 2049 from the products purchased in 2020−2049. The results account for the incremental variable and fixed costs incurred by manufacturers due to the standard, some of which may be incurred in preparation for the rule. The Primary, Low Benefits, and High Benefits Estimates utilize projections of energy prices from the AEO 2013 Reference case, Low Estimate, and High Estimate, respectively. In addition, incremental product costs reflect a medium decline rate for projected product price trends in the Primary Estimate, a low decline rate for projected product price trends in the Low Benefits Estimate, and a high decline rate for projected product price trends in the High Benefits Estimate. The methods used to derive projected price trends are explained in section IV.F.1.
** The CO_2 values represent global monetized values of the SCC, in 2013$, in 2015 under several scenarios of the updated SCC values. The first three cases use the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The fourth case represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The SCC time series used by DOE incorporate an escalation factor. The value for NO_X is the average of the low and high values used in DOE's analysis.
† Total Benefits for both the 3% and 7% cases are derived using the series corresponding to the average SCC with a 3-percent discount rate ($40.5/t in 2015). 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 has tentatively concluded that the proposed standards (for both AFUE, as well as standby mode and off mode) 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 products achieving these standard levels are already commercially available for all product classes covered by today's proposal. 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 trial standard levels, and is still 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 DOE receives in response to this notice and related information collected and analyzed during the course of this rulemaking effort, DOE may adopt energy efficiency levels presented in this notice that are either higher or lower than the proposed standards, or some combination of level(s) that incorporate the proposed standards in part.

DOE also added the annualized benefits and costs from the individual annualized tables to provide a combined benefit and cost estimate of the proposed AFUE and standby mode and off mode standards as shown in Table I.10[14]. The results under the primary estimate are as follows. Using a 7-percent discount rate for benefits and costs other than CO_2 reduction, for which DOE used a 3-percent discount rate along with the average SCC series that uses a 3-percent discount rate ($40.5/t in 2015), the estimated cost of the residential boilers AFUE and standby mode and off mode standards proposed in this rule is $41.7 million per year in increased equipment costs, while the estimated benefits are $101 million per year in reduced equipment operating costs, $25.3 million per year in CO_2 reductions, and $1.62 million per year in reduced NO_X emissions. In this case, the net benefit would amount to $86.3 million per year. Using a 3-percent discount rate for all benefits and costs and the average SCC series that uses a 3-percent discount rate ($40.5/t in 2015), the estimated cost of the residential boilers AFUE and standby mode and off mode standards proposed in this rule is $41.0 million per year in increased equipment costs, while the estimated benefits are $143 million per year in reduced equipment operating costs, $25.3 million per year in CO_2 reductions, and $2.22 million per year in reduced NO_X emissions. In this case, the net benefit would amount to $129 million per year.

[14] To obtain the combined results, DOE added the results for the AFUE standard in Table I.7 and for the standby standards in Table I.8.

Table I.10 Annualized Benefits and Costs of Proposed AFUE and Standby Mode and Off Mode Energy Conservation Standards for Residential Boilers (TSL 3)

	Discount Rate %	Primary Estimate*	Low Net Benefits Estimate*	High Net Benefits Estimate*
		million 2013$/year		
Benefits				
Consumer Operating Cost Savings	7	101	98	104
	3	143	138	149
CO_2 Reduction Monetized Value ($12.0/t case)*	5	7.11	7.04	7.18
CO_2 Reduction Monetized Value ($40.5/t case)*	3	25.3	25.0	25.6
CO_2 Reduction Monetized Value ($62.4/t case)*	2.5	37.3	36.8	37.7
CO_2 Reduction Monetized Value ($119/t case)*	3	78.2	77.3	79.1
NO_X Reduction Monetized Value (at $2,684/ton)**	7	1.62	1.61	1.63
	3	2.22	2.20	2.24
Total Benefits†	7 plus CO_2 range	110 to 181	107 to 177	113 to 185
	7	128	125	131
	3 plus CO_2 range	152 to 223	148 to 218	158 to 230
	3	170	165	177
Costs				
Consumer Incremental Installed Costs	7	41.7	48.2	35.9
	3	41.0	48.5	34.8
Net Benefits				
Total†	7 plus CO_2 range	68.1 to 139	58.8 to 129	77.0 to 149
	7	86.3	76.7	95.4
	3 plus CO_2 range	111 to 182	99 to 169	123 to 195
	3	129	117	142

* This table presents the annualized costs and benefits associated with residential boilers shipped in 2020−2049. These results include benefits to consumers which accrue after 2049 from the products purchased in 2020−2049. The results account for the incremental variable and fixed costs incurred by manufacturers due to the standard, some of which may be incurred in preparation for the rule. The Primary, Low Benefits, and High Benefits Estimates utilize projections of energy prices from the AEO 2013 Reference case, Low Estimate, and High Estimate, respectively.

** The CO_2 values represent global monetized values of the SCC, in 2013$, in 2015 under several scenarios of the updated SCC values. The first three cases use the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The fourth case represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The SCC time series used by DOE incorporate an escalation factor. The value for NO_X is the average of the low and high values used in DOE's analysis.
† Total Benefits for both the 3% and 7% cases are derived using the series corresponding to the average SCC with a 3-percent discount rate ($40.5/t in 2015). 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.

D. Standby Mode and Off Mode

As discussed in section II.A of this NOPR, any final rule for amended or new energy conservation standards that is published on or after July 1, 2010 must address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) As a result, DOE has analyzed and is proposing new energy conservation standards for the standby mode and off mode electrical energy consumption for residential boilers.

AFUE, the statutory metric for residential boilers, does not incorporate standby mode or off mode use of electricity, although it already fully addresses use in these modes of fossil fuels by gas-fired and oil-fired boilers. In the October 2010 test procedure final rule for residential furnaces and boilers, DOE determined that incorporating standby mode and off mode electricity consumption into a single standard for residential furnaces and boilers is not technically feasible. 75 FR 64621, 64626-64627 (Oct. 20, 2010). DOE concluded that a metric that integrates standby mode and off mode electricity consumption into AFUE is not technically feasible, because the standby mode and off mode energy usage, when measured, is essentially lost in practical terms due to rounding conventions for certifying furnace and boiler compliance with Federal energy conservation standards. Id. Therefore, in this notice, DOE is proposing amended boiler standards that are AFUE levels, which exclude standby mode and off mode electricity use, and DOE is also proposing separate standards that are maximum wattage (W) levels to address the standby mode ($P_{W,SB}$) and off mode ($P_{W,OFF}$) electrical energy use of boilers. DOE also presents corresponding trial standard levels (TSLs) for energy consumption in standby mode and off mode. DOE has tentatively decided to use a maximum wattage requirement to regulate standby mode and off mode for boilers. DOE believes using an annualized metric could add unnecessary complexities, such as trying to estimate an assumed number of hours that a boiler typically spends in standby mode. Instead, DOE believes that a maximum wattage standard is the most straightforward metric for regulating standby mode and off mode energy consumption of boilers and will result in the least amount of industry and consumer confusion.

DOE is using the metrics just described – AFUE, $P_{W,SB}$, and $P_{W,OFF}$ – in the amended energy conservation standards it proposes in this rulemaking for boilers. This approach satisfies the mandate of 42 U.S.C. 6295(gg)(3) that amended standards address standby mode and off mode energy use. The various analyses performed by DOE to evaluate minimum standards for standby mode and off mode electrical energy consumption for boilers are discussed further in section IV.E of this NOPR.

II. Introduction

The following section briefly discusses the statutory authority underlying today's proposal, as well as some of the relevant historical background related to the establishment of standards for residential boilers.

A. Authority

Title III, Part B[15] of the Energy Policy and Conservation Act of 1975 (EPCA or the Act), Pub. L. 94-163 (42 U.S.C. 6291-6309, as codified) established the Energy Conservation Program for Consumer Products Other Than Automobiles, a program covering most major household appliances (collectively referred to as "covered products").[16] These products include the residential boilers that are the subject of this rulemaking. (42 U.S.C. 6292(a)(5)) EPCA, as amended, prescribed energy conservation standards for these products (42 U.S.C. 6295(f)(1) and (3)), and directed DOE to conduct further rulemakings to determine whether to amend these standards (42 U.S.C. 6295(f)(4)). Under 42 U.S.C. 6295(m), the agency must periodically review established energy conservation standards for a covered product; under this requirement, such review must be conducted no later than 6 years from the issuance of any final rule establishing or amending a standard for a covered product. This rulemaking satisfies both statutory provisions (42 U.S.C. 6295(f)(4) and 42 U.S.C. 6295(m)).

Pursuant to EPCA, DOE's energy conservation program for covered products consists essentially of four parts: (1) testing; (2) labeling; (3) establishing Federal energy conservation standards; and (4) certification and enforcement procedures. The Federal Trade Commission (FTC) is primarily responsible for labeling, and DOE implements the remainder of the program. Subject to certain criteria and conditions, DOE is required to conduct a second round of rulemaking under 42 U.S.C. 6295(f)(4)(C) to consider

[15] For editorial reasons, upon codification in the U.S. Code, Part B was redesignated Part A.
[16] All references to EPCA in this document refer to the statute as amended through the American Energy Manufacturing Technical Corrections Act, Pub. L. 112-210 (enacted December 18, 2012).

amended energy conservation standards for residential boilers, and DOE is also required to consider amended standards under 42 U.S.C. 6295(m)(1) by July 15, 2014 (*i.e.*, with either: (1) a NOPR with proposed standards, or (2) a notice of determination not to amend the standards within six years of issuance of the last final rule for residential boilers). DOE is further required to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating cost of each covered product prior to the adoption of a new or amended energy conservation standard. (42 U.S.C. 6295(o)(3)(A) and (r)) Manufacturers of covered products must use the prescribed DOE test procedure as the basis for certifying to DOE that their products comply with the applicable energy conservation standards adopted under EPCA and when making representations to the public regarding the energy use or efficiency of those products. (42 U.S.C. 6293(c) and 6295(s)) Similarly, DOE must use these test procedures to determine whether the products comply with standards adopted pursuant to EPCA. (42 U.S.C. 6295(s)) The DOE test procedures for residential boilers appear at title 10 of the Code of Federal Regulations (CFR) part 430, subpart B, appendix N. In 2012, DOE initiated a rulemaking to review the residential furnace and boiler test procedure. In March 2015, DOE published a NOPR outlining the proposed changes to the test procedure. 80 FR 12876. Details regarding this rulemaking are discussed in section III.B.

DOE must follow specific statutory criteria for prescribing amended standards for covered products, including residential boilers. As indicated above, any amended standard for a covered product must be designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. (42

U.S.C. 6295(o)(2)(A) and (3)(B)) Furthermore, DOE may not adopt any standard that would not result in the significant conservation of energy. (42 U.S.C. 6295(o)(3)) Moreover, DOE may not prescribe a standard: (1) for certain products, including residential boilers, if no test procedure has been established for the product, or (2) if DOE determines by rule that the proposed standard is not technologically feasible or economically justified. (42 U.S.C. 6295(o)(3)(A)-(B)) In deciding whether a proposed standard is economically justified, after receiving comments on the proposed standard, DOE must determine whether the benefits of the standard exceed its burdens. (42 U.S.C. 6295(o)(2)(B)(i)) DOE must make this determination by, to the greatest extent practicable, considering the following seven statutory factors:

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

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

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

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

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

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

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

(42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII))

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

Further, EPCA, as codified, establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the energy savings during the first year that the consumer will receive as a result of the standard, as calculated under the applicable test procedure. (42 U.S.C. 6295(o)(2)(B)(iii))

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

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

Finally, pursuant to the amendments contained in the Energy Independence and Security Act of 2007 (EISA 2007), Pub. L. 110-140, any final rule for new or amended energy conservation standards promulgated after July 1, 2010, is required to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) Specifically, when DOE adopts a standard for a covered product after that date, it must, if justified by the criteria for adoption of standards under EPCA (42 U.S.C. 6295(o)), incorporate standby mode and off mode energy use into a single standard, or, if that is not feasible, adopt a separate standard for such energy use for that product. (42 U.S.C. 6295(gg)(3)(A)-(B)) DOE's current test procedures for residential boilers address standby mode and off mode energy use. In this rulemaking, DOE intends to adopt separate energy conservation standards to address standby mode and off mode energy use.

B. Background

1. Current Standards

In a final rule published on July 28, 2008 (2008 final rule), DOE prescribed energy conservation standards for residential boilers manufactured on or after September 1, 2012. 73 FR 43611. These standards are set forth in DOE's regulations at 10 CFR 430.32(e)(2)(ii) and are repeated in Table II.1 below.

Table II.1: Current Federal Energy Conservation Standards for Residential Boilers

Product Class	Minimum Annual Fuel Utilization Efficiency %	Design Requirements
Gas-fired Hot Water Boiler	82	No Constant-Burning Pilot, Automatic Means for Adjusting Water Temperature*
Gas-fired Steam Boiler	80	No Constant-Burning Pilot
Oil-fired Hot Water Boiler	84	Automatic Means for Adjusting Temperature*
Oil-fired Steam Boiler	82	None
Electric Hot Water Boiler	None	Automatic Means for Adjusting Temperature*

Electric Steam Boiler**	None	None

* Excluding boilers equipped with a tankless domestic water heating coil.
** Although the "Electric steam boiler" product class is not included in the table at 10 CFR 430.32(e)(2)(ii), according to 42 U.S.C. 6295(f), there are no minimum AFUE or design requirements for these products. DOE intends to clarify the standards for these products in this NOPR.

2. History of Standards Rulemaking for Residential Boilers

Given the somewhat complicated interplay of recent DOE rulemakings and statutory provisions related to residential boilers, DOE provides the following regulatory history as background leading to the present rulemaking. On November 19, 2007, DOE published a final rule in the Federal Register (November 2007 final rule) revising the energy conservation standards for furnaces and boilers, which addressed the first required review of standards for boilers under 42 U.S.C. 6295(f)(4)(B). 72 FR 65136. Compliance with the standards in the November 2007 final rule would have been required by November 19, 2015. However, on December 19, 2007, EISA 2007, Pub. L. No. 110-140, was signed into law, which further revised the energy conservation standards for residential boilers. More specifically, EISA 2007 amended EPCA to revise the AFUE requirements for residential boilers and set design requirements for most product classes. (42 U.S.C. 6295(f)(3)) EISA 2007 required compliance with the amended energy conservation standards for residential boilers beginning on September 1, 2012.

Only July 15, 2008, DOE issued a final rule technical amendment to the 2007 final rule, which was published in the Federal Register on July 28, 2008, to codify the energy conservation standard levels, the design requirements, and compliance dates for residential boilers outlined in EISA 2007. 73 FR 43611. For gas-fired hot water boilers, oil-fired hot water boilers, and electric hot water boilers, EISA 2007 requires that residential boilers manufactured after September 1, 2012 have an automatic means for adjusting water temperature. (42 U.S.C. 6295(f)(3)(A)-(C); 10 CFR 430.32(e)(2)(ii)-(iv)) The automatic means for adjusting water temperature must ensure that an incremental change in the inferred heat load produces a corresponding incremental change in the temperature of the water supplied by the boiler. EISA 2007 also disallows the use of constant-burning pilot lights in gas-fired hot water boilers and gas-fired steam boilers.

DOE initiated today's rulemaking pursuant to 42 U.S.C. 6295(f)(4)(C), which requires DOE to conduct a second round of amended standards rulemaking for residential boilers. EPCA, as amended by EISA 2007, also requires that not later than 6 years after issuance of any final rule establishing or amending a standard, DOE must publish either a notice of the determination that standards for the product do not need to be amended, or a notice of proposed rulemaking including proposed energy conservation standards. (42 U.S.C. 6295(m)(1)) As noted above, this rulemaking will satisfy both statutory provisions.

Furthermore, EISA 2007 amended EPCA to require that any new or amended energy conservation standard adopted after July 1, 2010, shall address standby mode and off mode energy consumption pursuant to 42 U.S.C. 6295(o). (42 U.S.C. 6295(gg)(3)) If feasible, the statute directs DOE to incorporate standby mode and off mode energy consumption into a single standard with the product's active mode energy use. If a single standard is not feasible, DOE may consider establishing a separate standard to regulate standby mode and off mode energy consumption. Consequently, DOE will consider standby mode and off mode energy use as part of this rulemaking for residential boilers.

DOE initiated this current rulemaking by issuing an analytical Framework Document, "Rulemaking Framework for Residential Boilers" (February 11, 2013). DOE published the notice of public meeting and availability of the Framework Document for residential boilers in the Federal Register on February 11, 2013. 78 FR 9631. The residential boiler energy conservation standards rulemaking docket is EERE-2012-BT-STD-0047. See: http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx?ruleid=112

The Framework Document explained the issues, analyses, and process that DOE anticipated using to develop energy conservation standards for residential boilers. DOE held a public meeting on March 13, 2013, to solicit comments from interested parties regarding DOE's analytical approach. The comment period for the Framework Document closed on March 28, 2013.

To further develop the energy conservation standards for residential boilers, DOE gathered additional information and performed an initial technical analysis. This process culminated in publication in the Federal Register on February 11, 2014, of the notice of data availability (NODA), which announced the availability of analytical results and modeling tools. 79 FR 8122. In that document, DOE presented its initial analysis of potential amended energy conservation standards for residential boilers, and requested comment on the following matters discussed in the analysis: (1) the product classes and scope of coverage; (2) the analytical framework, models, and tools that DOE is using to evaluate potential standards; and (3) the results of the preliminary analyses performed by DOE. Id. DOE also invited written comments on these subjects, as well as any other relevant issues, and announced the availability of supporting documentation on its website at

http://www.regulations.gov/#!documentDetail;D=EERE-2012-BT-STD-0047-0015.

A PDF copy of the supporting documentation is available at http://www.regulations.gov/#!documentDetail;D=EERE-2012-BT-STD-0047-0011. The comment period closed on March 13, 2014.

The supporting documentation in the NODA provided an overview of the activities DOE undertook in developing potential amended energy conservation standards for residential boilers, and discussed the comments DOE received in response to the Framework Document. It also described the analytical methodology that DOE used and each analysis DOE had performed up to that point. These analyses were as follows:

- A market and technology assessment addressed the scope of this rulemaking, identified the potential product classes of residential boilers, characterized the markets for these products, and reviewed techniques and approaches for improving their efficiency;

- A <u>screening analysis</u> reviewed technology options to improve the efficiency of residential boilers, and weighed these options against DOE's four prescribed screening criteria;
- An <u>engineering analysis</u> estimated the increase in manufacturer selling prices (MSPs) associated with more energy-efficient residential boilers;
- An <u>energy use analysis</u> estimated the annual energy use of residential boilers at various potential standard levels;
- A <u>markups analysis</u> converted estimated MSPs to consumer-installed prices.
- A <u>life-cycle cost (LCC) analysis</u> calculated, at the consumer level, the discounted savings in operating costs throughout the estimated average life of the product, compared to any increase in installed costs likely to result directly from the adoption of a given standard;
- A <u>payback period (PBP) analysis</u> estimated the amount of time it would take consumers to recover the higher expense of purchasing more-energy-efficient products through lower operating costs;
- A <u>shipments analysis</u> estimated shipments of residential boilers over the time period examined in the analysis (30 years), which were used in performing the national impact analysis;
- A <u>national impact analysis</u> assessed the aggregate impacts at the national level of potential energy conservation standards for residential boilers, as measured by the net present value of total consumer economic impacts and national energy savings;

The nature and function of the analyses in this rulemaking, including the engineering analysis, energy-use characterization, markups to determine installed prices, LCC and PBP analyses, and national impacts, are summarized in the February 2014 notice. 79 FR 8122, 8124-28 (Feb. 11, 2014).

Statements received after publication of the Framework Document, at the Framework public meeting, and comments received after the publication of the NODA have helped identify issues involved in this rulemaking and have provided information that has contributed to DOE's resolution of these issues. The Department considered these statements and comments in developing revised engineering and other analyses for this rulemaking.

DOE received 30 comments in response to the February 2014 NODA. These commenters include: a joint comment from the American Council for an Energy-Efficient Economy (ACEEE), the Appliance Standards Awareness Project (ASAP), the Alliance to Save Energy (ASE), the Natural Resources Defense Council (NRDC), and the Northeast Energy Efficiency Partnerships (NEEP); a comment from the Air-Conditioning, Heating, and Refrigeration Institute (AHRI); a comment from Edison Electric Institute (EEI); and a joint comment from the American Gas Association (AGA) and the American Public Gas Association (APGA). Manufacturers submitting written comments include: Energy Kinetics, Weil McLain, Weil McLain and various contractors and distributors (Weil McLain et al.), Crown Boiler, US Boiler, New Yorker Boiler, and HTP. Heating, ventilation, and air conditioning professionals and fuel companies who submitted written comments include: Belyea Brothers, Fire & Ice Heating &Cooling, Westmore Fuel Company, Maritime Energy, Brideau Oil Co., Hlavaty Plumb Heat and Cool, Rhoads Energy Corporation, Powers Energy Corporation, Sunshine Fuels & Energy Services, Petro Heating & Air Conditioning Services, OSI Comfort Specialists, Soundview Heating and Air Conditioning Corp, Aiello Home Services, Lombardi Oil, Boehm Heating Company, Kafin Oil Company, Wilkinson Oil Company, Santoro Oil Company, and Stocker Home Energy Services. This NOPR summarizes and responds to the issues raised in these comments. A parenthetical reference at the end of a comment quotation or paraphrase provides the location of the item in the public record.

III. General Discussion

DOE developed today's proposed rule after considering verbal and written comments, data, and information from interested parties that represent a variety of interests. The following discussion addresses issues raised by these commenters.

A. Product Classes and Scope of Coverage

When evaluating and establishing energy conservation standards, DOE divides covered products into product classes by the type of energy used or by capacity or other performance-related features that justify a different standard. In making a determination whether a performance-related feature justifies a different standard, DOE must consider such factors as the utility of the feature to the consumer and other factors DOE deems appropriate. (42 U.S.C. 6295(q))

Existing energy conservation standards divide residential boilers into six product classes based on the fuel type (*i.e.*, gas, oil, or electricity) and heating medium of the product (*i.e.*, hot water or steam). For this rulemaking, DOE proposes to maintain the scope of coverage defined by its current regulations for the analysis of standards, so as to include six product classes of boilers: (1) gas-fired hot water boilers; (2) gas-fired steam boilers; (3) oil-fired hot water boilers; (4) oil-fired steam boilers; (5) electric hot water boilers; and (6) electric steam boilers. DOE has not conducted an analysis of an AFUE standard level for electric boilers as the AFUE of these products already approaches 100 percent. DOE also did not conduct an analysis of a standard level for combination appliances as the DOE test procedure does not include a method with which to test these products. These reasons are explained in greater detail in section IV.A.1 of this NOPR. However, DOE did include electric boilers within the scope of its analysis of standby mode and off mode energy conservation standards.

The scope and product classes analyzed for today's NOPR are the same as those initially set forth proposed in the Framework Document and examined in DOE's initial analysis. Comments received relating to the scope of coverage are described in section IV.A of this proposed rule.

B. Test Procedure

DOE's current energy conservation standards for residential boilers are expressed in terms of annual fuel utilization efficiency (see 10 CFR 430.32(e)(2)(ii)). AFUE is an annualized fuel efficiency metric that fully accounts for fuel consumption in active, standby, and off modes. The existing DOE test procedure for determining the AFUE of residential boilers is located at 10 CFR part 430, subpart B, appendix N. The current DOE test procedure for residential boilers was originally established by a May 12, 1997 final rule, which incorporates by reference the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)/American National Standards Institute (ANSI) Standard 103-1993, Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers (1993). 62 FR 26140, 26157.

On October 20, 2010, DOE updated its test procedures for residential boilers in a final rule published in the Federal Register (October 2010 test procedure rule). 75 FR 64621. This rule amended DOE's test procedure for residential furnaces and boilers to establish a separate metric for measuring the electrical energy use in standby mode and off mode for gas-fired, oil-fired, and electric boilers pursuant to requirements established by EISA 2007. In the final rule, DOE determined that due to the magnitude of the electrical standby/off mode vs active mode, a single efficiency metric is technically infeasible. The test procedure amendments were primarily based on and incorporate by reference provisions of the International Electrotechnical Commission (IEC) Standard 62301 (First Edition), ''Household electrical appliances—Measurement of standby power." On December 31, 2012, DOE published a final rule in the Federal Register which updated the incorporation by reference of the standby mode and off mode test procedure provisions to refer to the latest edition of IEC Standard 62301 (Second Edition). 77 FR 76831.

On July 10, 2013, DOE published a final rule in the Federal Register (July 2013 final rule) that modified the existing testing procedures for residential furnaces and boilers. 78 FR 41265. The modification addressed the omission of equations needed to calculate AFUE for two-stage and modulating condensing furnaces and boilers that are tested using an optional procedure provided by section 9.10 of ASHRAE 103-1993 (incorporated by reference into DOE's test procedure), which allows the test engineer to omit the heat-up and cool-down tests if certain conditions are met. Specifically, the DOE test procedure allows condensing boilers and furnaces to omit the heat-up and cool-down tests provided that the units have no measurable airflow through the combustion chamber and heat exchanger (HX) during the burner off period and have post-purge period(s) of less than 5 seconds. For two-stage and modulating condensing furnaces and boilers, ASHRAE 103-1993 (and by extension the DOE test procedure) does not contain the necessary equations to calculate the heating seasonal efficiency (which contributes to the ultimate calculation of AFUE) when the option in section 9.10 is selected. The July 2013 final rule adopted two new equations needed to account for the use of section 9.10 for two-stage and modulating condensing furnaces and boilers. Id.

EPCA, as amended by EISA 2007, requires that DOE must review test procedures for all covered products at least once every 7 years. (42 U.S.C 6293(b)(1)(A)) Accordingly, DOE must complete the residential furnaces and boiler test procedure rulemaking no later than December 19, 2014 (i.e., 7 years after the enactment of EISA 2007), which is before the expected completion of this energy conservation standards rulemaking. On March 11, 2015, DOE published a notice of proposed rulemaking for the test procedure in the Federal Register (March 2015 Test Procedure NOPR), a necessary step toward fulfillment of the requirement under 42 U.S.C. 6293(b)(1)(A) for residential furnaces and boilers. 80 FR 12876. DOE must base the analysis of amended energy conservation standards on the most recent version of its test procedures, and accordingly, DOE will use any amended test procedure when considering product efficiencies, energy use, and efficiency improvements in its analyses. Major changes proposed in the March 2015 Test Procedure NOPR included proposals to:

- Adopt ANSI/ASHRAE 103-2007 by reference in place of the existing reference to ANSI/ASHRAE 103-1993;
- Modify the requirements for the measurement of condensate under steady-state conditions;
- Update references to installation manuals;
- Update the auxiliary electrical consumption calculation to include additional measurements of electrical consumption;
- Adopt a method for determining if the automatic means requirement has been met;
- Adopt a method for qualifying the use of the minimum draft factor, and
- Revising the required reporting precision for AFUE.

DOE received several comments from stakeholders relating to the residential furnace and boiler test procedure. These comments were considered and addressed in that rulemaking proceeding.

C. Technological Feasibility

1. General

In each energy conservation standards rulemaking, DOE conducts a screening analysis based on information gathered on all current technology and prototype designs that could improve the efficiency of the products or equipment that are the subject of the rulemaking. As the first step in such an analysis, DOE develops a list of technology options for consideration in consultation with manufacturers, design engineers, and other interested parties. DOE then determines which of those means for improving efficiency are technologically feasible. DOE considers technologies incorporated in commercially-available products or in working prototypes to be technologically feasible. 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)-(iv). Additionally, it is DOE policy not to include in its analysis any proprietary technology that is a unique pathway to achieving a certain efficiency level. Section IV.B of this notice discusses the results of the screening analysis for residential boilers, particularly the designs DOE considered, those it screened out, and those that are the basis for the trial standard levels (TSLs) in this rulemaking. For further details on the screening analysis for this rulemaking, see chapter 4 of the NOPR technical support document (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 product. (42 U.S.C. 6295(p)(1)) Accordingly, in the engineering analysis, DOE determined the maximum technologically feasible (max-tech) improvements in energy efficiency for residential boilers, using the design parameters for the most-efficient products available on the market or in working prototypes. The max-tech levels that DOE determined for this rulemaking include efficiency levels currently only achieved through the use of condensing technology for both the gas fired hot water and the oil fired hot water product classes. Details regarding the max-tech efficiency levels determined for this rulemaking are described in section IV.C of this proposed rule and in chapter 5 of the NOPR TSD.

D. Energy Savings

1. Determination of Savings

For each TSL, DOE projected energy savings from the products that are the subject of this rulemaking purchased in the 30-year period that begins in the year of compliance with amended standards (2020–2049).[17] The savings are measured over the entire lifetime of products purchased in the 30-year analysis period.[18] DOE quantified

[17] DOE also presents a sensitivity analysis that considers impacts for products shipped in a 9-year period.
[18] In the past, DOE presented energy savings results for only the 30-year period that begins in the year of compliance. In the calculation of economic impacts, however, DOE considered operating cost savings measured over the entire lifetime of products purchased in the 30-year period. DOE has chosen to modify

the energy savings attributable to each TSL as the difference in energy consumption between each standards case and the base case. The base case represents a projection of energy consumption in the absence of amended energy conservation standards, and it considers market forces and policies that affect demand for more-efficient products.

DOE used its national impact analysis (NIA) spreadsheet model to estimate energy savings from potential amended standards for the products that are the subject of this rulemaking. The NIA spreadsheet model (described in section IV.H of this NOPR) calculates energy savings in site energy, which is the energy directly consumed by products at the locations where they are used. For electricity, DOE reports national energy savings on an annual basis in terms of primary (source) energy savings, which is the savings in the energy that is used to generate and transmit the site electricity. To calculate this quantity (*i.e.*, converting site energy to primary energy), DOE derives annual conversion factors from the model used to prepare the Energy Information Administration's (EIA) most recent Annual Energy Outlook (AEO).

DOE also has begun to estimate full-fuel-cycle (FFC) energy savings, as discussed in DOE's statement of policy and notice of policy amendment. 76 FR 51282 (August 18, 2011), as amended at 77 FR 49701 (August 17, 2012). 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. DOE's evaluation of FFC savings is driven in

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its presentation of national energy savings to be consistent with the approach used for its national economic analysis.

part by the National Academy of Sciences' (NAS) report on FFC measurement approaches for DOE's Appliance Standards Program.[19] The NAS report discusses that the FFC metric was primarily intended for energy conservation standards rulemakings where multiple fuels may be used by a particular product. DOE's approach is based on the calculation of an FFC multiplier for each of the energy types used by covered products or equipment (oil, gas and electricity in the case of residential boilers). Although the addition of FFC energy savings in the rulemakings is consistent with the recommendations, the methodology for estimating FFC does not project how fuel markets would respond to this particular standards rulemaking. The FFC methodology simply estimates how much additional energy, and in turn how many tons of emissions, may be displaced if the estimated quantity of energy was not consumed by the residential boilers covered in this rulemaking. It is also important to note that inclusion of FFC savings did not affect DOE's choice of proposed standards. For more information on FFC energy savings, see section IV.H.1.

2. Significance of Savings

To adopt more-stringent standards for a covered product, DOE must determine that such action would result in "significant" energy savings. (42 U.S.C. 6295(o)(3)(B)) Although the term "significant" is not defined in the Act, the U.S. Court of Appeals for the District of Columbia Circuit, in Natural Resources Defense Council v. Herrington, 768 F.2d 1355, 1373 (D.C. Cir. 1985), opined that Congress intended "significant"

[19] "Review of Site (Point-of-Use) and Full-Fuel-Cycle Measurement Approaches to DOE/EERE Building Appliance Energy- Efficiency Standards,'' (Academy report) was completed in May 2009 and included five recommendations. A copy of the study can be downloaded at: http://www.nap.edu/catalog.php?record_id=12670.

energy savings in the context of EPCA to be savings that were not "genuinely trivial." The energy savings for all of the trial standard levels considered in this rulemaking, including the proposed standards, are nontrivial, and, therefore, DOE considers them "significant" within the meaning of section 325 of EPCA.

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. 6295(o)(2)(B)(i)(I)-(VII)) The following sections discuss how DOE has addressed each of those seven factors in this rulemaking.

a. Economic Impact on Manufacturers and Consumers

In determining the impacts of a potential amended standard on manufacturers, DOE conducts a manufacturer impact analysis (MIA), as discussed in section IV.J. 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) industry net present value (INPV), which values the industry on the basis of expected future cash flows; (2) cash flows by year; (3) changes in revenue and income; and (4) other measures of impact, as appropriate. Second, DOE analyzes and reports the impacts on different types of manufacturers, including impacts on small manufacturers. Third, DOE considers the impact of standards on domestic manufacturer employment and manufacturing capacity, as well as the potential for standards to result in plant closures and loss of capital investment. Finally, DOE takes into account cumulative impacts of various DOE regulations and other regulatory requirements on manufacturers.

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

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

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

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

The LCC savings and the PBP for the considered conservation levels are calculated relative to a base 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 analyses are discussed in further detail in section IV.F.

c. Energy Savings

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

d. Lessening of Utility or Performance of Products

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

e. Impact of Any Lessening of Competition

EPCA directs DOE to consider the impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from a proposed standard. (42 U.S.C. 6295(o)(2)(B)(i)(V)) It also directs the Attorney General to determine the impact, if any, of any lessening of competition likely to result from a proposed standard and to transmit such determination to the Secretary within 60 days of the publication of a proposed rule, together with an analysis of the nature and extent of the impact. (42 U.S.C. 6295(o)(2)(B)(ii)) DOE will transmit a copy of this 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 evaluating the need for national energy conservation, DOE expects that the energy savings from the proposed standards are likely to provide improvements to the security and reliability of the nation's energy system. (42 U.S.C. 6295(o)(2)(B)(i)(VI))

Reductions in the demand for electricity also may result in reduced costs for maintaining the reliability of the nation's electricity system. DOE conducts a utility impact analysis to estimate how standards may affect the nation's needed power generation capacity, as discussed in section IV.M.

The 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. DOE reports the emissions impacts from today's proposed standards and from each TSL it considered and discussed in sections IV.K and V.B.6 of this NOPR. DOE also reports estimates of the economic value of emissions reductions resulting from the considered TSLs, as discussed in section IV.L.

g. Other Factors

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

2. Rebuttable Presumption

As set forth in 42 U.S.C. 6295(o)(2)(B)(iii), EPCA creates a rebuttable presumption that an energy conservation standard is economically justified if the additional cost to the consumer of a product that meets the standard is less than three times the value of the first year's energy savings resulting from the standard, as calculated under the applicable DOE test procedure. DOE's LCC and PBP analyses generate values used to calculate the effects that proposed energy conservation standards would have on the payback period for consumers. These analyses include, but are not limited to, the 3-year payback period contemplated under the rebuttable-presumption test. In addition, DOE routinely conducts an economic analysis that considers the full range of impacts to consumers, manufacturers, the Nation, and the environment, as required under 42 U.S.C. 6295(o)(2)(B)(i). The results of this analysis serve as the basis for DOE's evaluation of the economic justification for a potential standard level (thereby supporting or rebutting the results of any preliminary determination of economic justification). The rebuttable presumption payback calculation is discussed in section V.B.1 of this proposed rule.

IV. Methodology and Discussion of Comments

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

DOE used three spreadsheet tools to estimate the impact of today's proposed standards. The first spreadsheet calculates LCCs and payback periods of potential standards. The second provides shipments forecasts, and then calculates national energy savings and net present value impacts of potential standards. Finally, DOE assessed manufacturer impacts, largely through use of the Government Regulatory Impact Model

(GRIM). All three spreadsheet tools are available online at the rulemaking portion of DOE's website:
http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx?ruleid=112

Additionally, DOE estimated the impacts on utilities and the environment that would be likely to result from potential amended standards for residential boilers. DOE used a version of EIA's National Energy Modeling System (NEMS) for the utility and environmental analyses.[20] The NEMS simulates the energy sector of the U.S. economy. EIA uses NEMS to prepare its Annual Energy Outlook, a widely-known energy forecast for the United States. NEMS 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

DOE develops information that provides an overall picture of the market for the products concerned, including the purpose of the products, the industry structure, manufacturers, market characteristics, and technologies used in the products. This activity includes both quantitative and qualitative assessments, based primarily on publicly-available information. The subjects addressed in the market and technology assessment for this residential boilers rulemaking include: (1) a determination of the scope of the rulemaking and product classes; (2) manufacturers and industry structure; (3)

[20] For more information on NEMS, refer to the U.S. Department of Energy, Energy Information Administration documentation. A useful summary is *National Energy Modeling System: An Overview 2009*, DOE/EIA-0581(2009) (October 2009) (Available at: http://www.eia.doe.gov/oiaf/aeo/overview/index.html).

quantities and types of products sold and offered for sale; (4) retail market trends; (5) regulatory and non-regulatory programs; and (6) technologies or design options that could improve the energy efficiency of the product(s) under examination. The key findings of DOE's market assessment are summarized below. See chapter 3 of the NOPR TSD for further discussion of the market and technology assessment.

1. Definition and Scope of Coverage

EPCA defines residential boilers as a type of furnace. Specifically, the term "furnace" is defined as "a product which utilizes only single-phase electric current, or single-phase electric current or DC current in conjunction with natural gas, propane, or home heating oil, and which–

(A) is designed to be the principal heating source for the living space of a residence;

(B) is not contained within the same cabinet with a central air conditioner whose rated cooling capacity is above 65,000 Btu [British thermal units] per hour;

(C) is an electric central furnace, electric boiler, forced- air central furnace, gravity central furnace, or low pressure steam or hot water boiler; and

(D) has a heat input rate of less than 300,000 Btu per hour for electric boilers and low pressure steam or hot water boilers and less than 225,000 Btu per hour for forced-air central furnaces, gravity central furnaces, and electric central furnaces."

(42 U.S.C. 6291(23))

DOE has incorporated this definition into its regulations in the Code of Federal Regulations (CFR) at 10 CFR 430.2. DOE has generally defined an electric boiler as an electrically powered furnace designed to supply low pressure steam or hot water for space heating applications, including a low pressure steam boiler that operates at or below 15 pounds per square inch gauge (psig) steam pressure and a hot water boiler that operates at or below 160 psig water pressure and 250 °F water temperature. DOE has generally defined a low pressure steam or hot water boiler as an electric, gas or oil burning furnace designed to supply low pressure steam or hot water for space heating applications, including a low pressure steam boiler that operates at or below 15 psig steam pressure; a hot water boiler operates at or below 160 psig water pressure and 250 °F water temperature. See 10 CFR Part 430.2.

For this rulemaking, DOE proposes to maintain the scope of coverage as defined by its current regulations for this analysis of new and amended standards, which includes six product classes of boilers (gas-fired hot water boilers, gas-fired steam boilers, oil-fired hot water boilers, oil-fired steam boilers, electric hot water boilers, and electric steam boilers). DOE has not conducted an analysis of an AFUE standard level for electric boilers or combination appliance for the reasons explained below.

Combination appliances provide both space heating and domestic hot water to a residence. These products are available on the market in two major configurations, including a water heater fan-coil combination unit and a boiler tankless coil combination unit. Currently, manufacturers certify combination appliances by rating the efficiency of the unit when performing their primary function (i.e., space heating for boiler tankless coil combination units or water heating for water heater fan-coil units). In the March 2015 residential furnaces and boilers test procedure NOPR, DOE did not propose a method for which to calculate AFUE for combination appliances, because DOE chose not to delay or complicate the test procedure rulemaking. Rather, DOE plans to continue to seek input about the development of a test procedure for combination appliances and may consider a separate rulemaking devoted specifically to those products in the future. 80 FR 12876. Without a Federal test procedure for combination appliances, DOE was not able to perform an AFUE standards analysis for such products.

DOE did not include electric boilers in the analysis of amended AFUE standards. Electric boilers do not have an AFUE requirement under 10 CFR 430.32(e)(2)(ii). Electric boilers typically use electric resistance coils as their heating elements, which are highly efficient. Furthermore, the current DOE test procedure for determining AFUE classifies boilers as indoor units and, thus, considers jacket losses to be usable heat, because those losses would go to the conditioned space. The efficiency of these products already approaches 100 percent AFUE. Therefore, there are no options for increasing the rated AFUE of this product, and the impact of setting AFUE energy conservation standards for these products would be negligible. However, DOE has considered standby mode and off mode standards for electric boilers.

The proposed scope used for the analysis for this NOPR is the same as the scope used for the NODA analysis. In response to the NODA analysis, AGA and AGPA filed a joint comment which stated that DOE should clarify that gas-fired boilers that do not have an electrical supply requirement are not subject to this regulation. (AGA and AGPA, No. 21 at p. 2) DOE agrees that under EPCA, an exception already exists for boilers which are manufactured to operate without any need for electricity. (42 U.S.C. 6295(f)(3)(C); 10 CFR 430.32(e)(2)(iv)) Thus, DOE did not consider such products in the course of this analysis, and such products would not be covered by amended standards resulting from this process.

2. Product Classes

When evaluating and establishing energy conservation standards, DOE divides covered products into product classes by the type of energy used or by capacity or other performance-related features that justify a different standard. In making a determination whether a performance-related feature justifies a different standard, DOE must consider such factors as the utility to the consumer of the feature and other factors DOE determines are appropriate. (42 U.S.C. 6295(q)) For this rulemaking, DOE proposes to maintain the scope of coverage as defined by its current regulations for this analysis of standards, which includes six product classes of boilers. Table IV.1 lists the six proposed product classes.

Table IV.1: Proposed Product Classes for Residential Boilers

Boiler by Fuel Type	Heat Transfer Medium
Gas-fired Boiler	Steam
	Hot Water
Oil-fired Boiler	Steam
	Hot Water
Electric Boiler	Steam
	Hot Water

Several interested parties suggested that the product classes should be further subdivided into condensing and non-condensing products for gas-fired hot water boilers. (Weil McLain No. 20 at p. 2, AGA and APGA No.21 at p. 2, HTP No. 31 at p. 2)

Weil McLain commented that condensing and noncondensing boilers should be in separate product classes because each presents significant options to have available for different applications. Weil McLain added that each type of boiler can provide a good solution to a residential boiler need, but the solution requires the correct application of the boiler to a particular home. In particular, Weil McLain commented that there are important differences between new installations and replacement installations for these products. (Weil McLain No. 20 at p. 2)

Similarly, AGA and APGA suggested that the gas-fired hot water boiler product class should be subdivided into condensing and non-condensing subclasses, such that DOE may consider establishing separate standards for Category I and Category IV gas boilers based on their different venting and condensing characteristics. Category I gas boilers are those that operate with a non-positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent. Category IV gas boilers are those that operate with a positive vent static pressure with a vent gas temperature that is capable of causing excessive condensation.[21] AGA and APGA

[21] See ANSI Z223.1-2009/NFPA 54, National Fuel Gas Code, 3.3.6.11.1 and 3.3.6.11.4 (2009). See also 2012 International Fuel Gas Code, at p. 16 (2011).

commented that in the past, DOE has established separate standards for clothes dryers based on venting characteristics. (AGA and APGA No.21 at p. 2-3)

In response to these comments, DOE notes that, in evaluating and establishing energy conservation standards, EPCA directs DOE to divide covered products into classes based on differences including the type of energy used, capacity, or other performance-related feature that justifies a different standard for products having such feature. (42 U.S.C. 6295(q)) In deciding whether a feature justifies a different standard, DOE must consider factors such as the utility of the features to users. In evaluating Weil McLain's, AGA's, and AGPA's suggestion to consider separate product classes for non-condensing and condensing boilers (and specifically in AGA's and APGA's comments for boilers using Category I and Category IV venting), DOE considered the utility to consumers of condensing and non-condensing boilers, including the ability to use one venting type versus another. The utility derived by consumers from boilers is in the form of the space heating function that a boiler performs. Condensing and non-condensing boilers perform equally well in providing this function. Likewise, a boiler requiring Category I venting and a boiler requiring Category IV venting are capable of providing the same heating function to the consumer, and, thus, provide virtually the same utility with respect to their primary function. AGA and AGPA contend that the ability to vent a boiler with Category I venting provides boiler consumers with a special utility due to the cost-saving benefits compared to having to retrofit a venting system to accommodate a Category IV boiler. DOE does not agree with the characterization of reduced costs associated with Category I venting in certain installations as a special utility, but rather, it is an economic impact on consumers that must be considered in the rulemaking's cost-benefit analysis. Rather, the average installation cost by efficiency level for gas-fired hot water boilers ranges from $3,301 to $3,599; for gas-fired steam boilers, from $3,037 to $3,061; for oil-fired hot water boilers, from $3,069 to $3,662; and for oil-fired steam boilers, from $3,074 to $3,081. Information related to installation costs can be found in section IV.F.1 of this NOPR and Chapter 8 of the NOPR TSD. DOE also recognizes the merit in Weil McLain's comments regarding the important operational differences between condensing and non-condensing systems. However, DOE believes this issue is also analytical and best addressed in the analyses as DOE considers these operational differences. Accordingly, DOE is not proposing to establish separate product classes for condensing and non-condensing boilers, or for boilers utilizing Category I and Category IV venting systems. Rather, DOE considered the impacts of these characteristics in the relevant analyses performed for the NOPR. DOE requests comment on the installation costs cited above.

HTP suggested that the Department should consider separate residential boiler standards for new construction and retrofits. (HTP, No. 31 at p.2)

In response, as set forth in the statutory definition for "energy conservation standard," DOE notes that EPCA directs the Department to establish performance standards that prescribe minimum levels of energy efficiency or maximum levels of energy use for covered products. (42 U.S.C. 6291(6)(A)) EPCA does not authorize setting multiple levels of efficiency for a given covered product, depending on where the product is installed in terms of home type (i.e., new or existing). The Department does not have the authority to set separate standards for residential boilers for new homes and for existing homes and, therefore, must reject the suggestion that it consider separate standards for new construction and retrofits.

3. Technology Options

In the NODA analysis, DOE identified 10 technology options that would be expected to improve the AFUE of residential boilers, as measured by the DOE test procedure: (1) heat exchanger improvements; (2) modulating operation; (3) dampers; (4) direct vent; (5) pulse combustion; (6) premix burners; (7) burner derating; (8) low-pressure air-atomized oil burner; (9) delayed-action oil pump solenoid valve; and (10) electronic ignition.[22] In addition, DOE identified three technologies that would reduce the standby mode and off mode energy consumption of residential boilers: (1) transformer improvements; (2) control relay for models with brushless permanent magnet motors; and (3) switching mode power supply.

DOE received no comments suggesting additional technology options in response to the NODA analysis, and thus, DOE has maintained the same list of technology options in the NOPR analysis. After identifying all potential technology options for improving the efficiency of residential boilers, DOE performed the screening analysis (see section

[22] Although DOE has identified vent dampers and electronic ignition as technologies that improve residential boiler efficiency, DOE did not consider these technologies further in the analysis as options for improving efficiency of baseline units, because they are already included in baseline residential boilers.

IV.B of this NOPR or chapter 4 of the TSD) on these technologies to determine which could be considered further in the analysis and which should be eliminated.

B. Screening Analysis

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

1. Technological feasibility. Technologies that are not incorporated in commercial products or in working prototypes will not be considered further.
2. Practicability to manufacture, install, and service. If it is determined that mass production and reliable installation and servicing of a technology in commercial products could not be achieved on the scale necessary to serve the relevant market at the time of the compliance date of the standard, then that technology will not be considered further.
3. Impacts on product utility or product availability. If it is determined that a technology would have significant adverse impact on the utility of the product to significant subgroups of consumers or would result in the unavailability of any covered product type with performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as products generally available in the United States at the time, it will not be considered further.

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

(10 CFR part 430, subpart C, appendix A, 4(a)(4) and 5(b))

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

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

1. Screened-Out Technologies

During the NODA phase, DOE screened out pulse combustion as a technology option for improving AFUE and screened out control relay for boiler models with brushless permanent magnet motors as a technology option for reducing standby electric losses. DOE decided to screen out pulse combustion based on manufacturer feedback during the Framework public meeting indicating that pulse combustion boilers have had reliability issues in the past, and therefore, manufacturers do not consider this a viable option to improve efficiency. Further, manufacturers indicated that similar or greater efficiencies than those of pulse combustion boilers can be achieved using alternative technologies. For this reason, DOE is not including pulse combustion as a technology option, as it could reduce consumer utility (reliability). DOE decided to screen out using a control relay to depower BPM motors due to feedback received during the residential furnace rulemaking (which was reconfirmed during manufacturer interviews for the residential boiler rulemaking), which indicated that using a control relay to depower brushless permanent magnet motors could reduce the lifetime of the motors, which would lead to a reduction in utility of the product. For this reason, DOE is not including control relays for models with brushless permanent magnet motors as a technology option, as it could reduce consumer utility. DOE did not receive any comments relating to the screening out of these two technologies.

AHRI stated that neither direct vent nor burner derating should be included in the analysis since they are not currently practical ways to achieve higher levels of efficiency. (AHRI, No. 16 at p. 1)

In response, DOE agrees that burner derating should be screened out, and has done so for the NOPR analysis. Burner derating reduces the burner firing rate while keeping heat exchanger geometry and surface area and the fuel-air ratio the same, which increases the ratio of heat transfer surface area to energy input, and increases efficiency. However, the lower energy input means that less heat is provided to the user than with conventional burner firing rates. As a result of the decreased heat output of boilers with derated burners, DOE has screened out burner derating as a technology option, as it could reduce consumer utility.

For direct vent, DOE has found that boilers using this technology can improve AFUE by reducing the heat loss through draft, because direct vent systems are sealed systems in which combustion air is brought in from outside, rather than from the space surrounding the boiler. This reduces infiltration losses, and would improve AFUE. In addition, this technology has been demonstrated as technologically feasible and practicable to manufacture, install, and service, as it is currently offered in boiler models available on the market. In addition, DOE is not aware of any impacts on product utility or adverse impacts on safety that would result from the use of this technology. Thus, DOE has maintained direct vent as a technology option. However, it should be noted that this technology option was not considered to be a primary driver of increased efficiency in the engineering analysis (see section IV.C).

2. Remaining Technologies

Through a review of each technology, DOE found that all of the other identified technologies met all four screening criteria and consequently, are suitable for further examination in DOE's analysis. In summary, DOE did not screen out the following technology options to improve AFUE: (1) heat exchanger improvements; (2) modulating operation; (3) direct vent; (4) premix burners; (5) low-pressure air-atomized oil burner; and (6) delayed-action oil pump solenoid valve. DOE also maintained the following technology options to improve standby mode and off mode energy consumption: (1)

transformer improvements; and (2) switching mode power supply. All of these technology options are technologically feasible, given that the evaluated technologies are being used (or have been used) in commercially-available products or working prototypes. Therefore, all of the trial standard levels evaluated in this notice are technologically feasible. DOE also finds that all of the remaining technology options also meet the other screening criteria (i.e., practicable to manufacture, install, and service, and do not result in adverse impacts on consumer utility, product availability, health, or safety). For additional details, please see chapter 4 of the NOPR TSD. DOE requests further comment from interested parties regarding whether there are any technologies which have passed the screening analysis that should be screened out based on the four screening criteria (i.e., technological feasibility; practicability to manufacture, install, and service; impacts on product utility or product availability; and adverse impacts on health or safety).

C. Engineering Analysis

In the engineering analysis (corresponding to chapter 5 of the NOPR TSD), DOE establishes the relationship between the manufacturer selling price (MSP) and improved residential boiler efficiency. This relationship serves as the basis for cost-benefit calculations for individual consumers, manufacturers, and the Nation. DOE typically structures the engineering analysis using one of three approaches: (1) design option; (2) efficiency level; or (3) reverse engineering (or cost-assessment). The design-option approach involves adding the estimated cost and efficiency of various efficiency-improving design changes to the baseline to model different levels of efficiency. The efficiency-level approach uses estimates of cost and efficiency at distinct levels of efficiency from publicly-available information, and information gathered in manufacturer interviews that is supplemented and verified through technology reviews. The reverse-engineering approach involves testing products for efficiency and determining cost from a detailed bill of materials (BOM) derived from reverse engineering representative products. The efficiency values range from that of a least-efficient boiler sold today (i.e., the baseline) to the maximum technologically feasible efficiency level. At each efficiency level examined, DOE determines the manufacture production cost (MPC) and MSP; this relationship is referred to as a cost-efficiency curve.

As noted in section III.B, the active mode AFUE metric fully accounts for the fuel use consumption in active, standby and off modes whereas the standby and off mode metric (maximum wattage) only accounts for the electrical energy use in standby and off mode. In analyzing the technologies that would be likely to be employed to effect changes in these metrics, DOE found that the efficiency changes were mostly independent. For example, the primary means of improving AFUE is to improve the heat exchanger design, which would likely have little or no impact on standby and off mode electrical consumption. Similarly, the design options considered likely to be implemented for reducing standby mode and off mode electrical consumption are not expected to impact the AFUE. Therefore, DOE conducted separate engineering and cost-benefit analyses for each of these two metrics and their associated systems (fuel and electrical). In order to account for the total impacts of both proposed standards, DOE added the monetized impacts from these two separate analyses in the NIA, LCC, and MIA as a means of providing a cumulative impact on residential boilers. For the PBP, to estimate the cumulative impact for both standards, DOE determined the combined installed cost to the consumer and the first-year operating costs for each household. DOE requests comment on this approach and whether it is reasonable to assume that the design changes implemented by manufacturers in order to comply with the standby and off mode would be independent of those implemented to comply with AFUE standards.

DOE also requests comment on employing an alternative methodology to inform the selection of the appropriate technologically feasible and economically justified standard level, which would occur as follows: (1) first the agency would first consider the technological feasibility and economic justification of one standard (e.g., standby and off mode) in the engineering cost model and downstream cost-benefit analysis to select a proposed level; and (2) DOE would then incorporate the estimated impacts of the proposed level into the baseline of the engineering cost model and downstream cost-benefit analysis prior to conducting the analysis for the second standard (e.g. active mode). DOE recognizes that this methodology would yield the exact same incremental costs since the cost and savings are truly independent of one another – that is the cost to achieve the savings from the AFUE standard are not impacted by the compliance to the proposed sand-by and off mode standard.

For the NODA analysis of AFUE efficiency levels, DOE conducted the engineering analysis for residential boilers using a combination of the efficiency level and cost-assessment approaches. More specifically, DOE identified the efficiency levels for analysis and then used the cost-assessment approach to determine the technologies used and the associated manufacturing costs at those levels.

For the standby mode and off mode analyses, DOE adopted a design option approach, which allowed for the calculation of incremental costs through the addition of specific design options to a baseline model. DOE decided on this approach because it did not have sufficient data to execute an efficiency-level analysis, as manufacturers typically do not rate or publish data on the standby mode and or off mode energy consumption of their products.

DOE continued to use the same analytical approaches for the NOPR phase of this rulemaking as used in the NODA. In response to the NODA, DOE received specific comments from interested parties on certain aspects of the engineering analysis. A brief overview of the methodology, a discussion of the comments DOE received, DOE's response to those comments, and any adjustments made to the engineering analysis methodology or assumptions as a result of those comments is presented in the sections below. See chapter 5 of the NOPR TSD for additional details about the engineering analysis.

1. Efficiency Levels

As noted above, for analysis of amended AFUE standards, DOE used an efficiency-level approach to identify incremental improvements in efficiency for each product class. An efficiency-level approach enabled DOE to identify incremental improvements in efficiency for efficiency-improving technologies that boiler manufacturers already incorporate in commercially-available models. After identifying efficiency levels for analysis, DOE used a cost-assessment approach (section IV.C.2) to determine the MPC at each efficiency level identified for analysis. This method estimates the incremental cost of increasing product efficiency. For the analysis of amended standby mode and off mode energy conservation standards, DOE used a design-option approach and identified efficiency levels that would result from implementing certain design options for reducing power consumption in standby mode and off mode.

a. Baseline Efficiency Level and Product Characteristics

In the analysis presented in the NODA, DOE selected baseline units typical of the least-efficient commercially-available residential boilers. DOE selected baseline units as reference points for each product class, against which it measured changes resulting from potential amended energy conservation standards. The baseline efficiency level in each product class represents the basic characteristics of products in that class. A baseline unit is a unit that just meets current Federal energy conservation standards and provides basic consumer utility.

DOE uses the baseline unit for comparison in several phases of the analyses, including the engineering analysis, LCC analysis, PBP analysis, and the NIA. To determine energy savings that will result from an amended energy conservation standard, DOE compares energy use at each of the higher energy efficiency levels to the energy consumption of the baseline unit. Similarly, to determine the changes in price to the consumer that will result from an amended energy conservation standard, DOE compares the price of a baseline unit to the price of a unit at each higher efficiency level.

DOE received no comments regarding the baseline efficiency levels and characteristics chosen for the NODA analysis of amended AFUE standards. Thus, DOE has maintained these baseline efficiency levels, which are equal to the current federal minimum standards for each product class in the NOPR analysis. Table IV.2 presents the baseline AFUE levels identified for each product class. Additional details on the selection of baseline efficiency levels may be found in chapter 5 of the NOPR TSD.

Table IV.2 Baseline AFUE Efficiency Levels

Product Class	AFUE %
Gas-Fired Hot Water Boilers	82
Gas-Fired Steam Boilers	80
Oil-Fired Hot Water Boilers	84
Oil-Fired Steam Boilers	82

AHRI commented that the baseline efficiency levels shown in the engineering analysis are assumed to have dampers. AHRI asked for clarification as to the type of damper the baseline gas-fired hot water boilers are assumed to have in the analysis. (AHRI No. 22 at p.3) In the engineering analysis, DOE assumed baseline gas-fired hot water boilers to have stack dampers, as described in chapter 5 of the TSD.

For the standby mode and off mode analysis, DOE identified baseline components as those that consume the most electricity during the operation of those modes. Since it would not be practical for DOE to test every boiler on the market to determine the baseline and since manufacturers do not currently report standby mode and off mode energy consumption, DOE "assembled" the most consumptive baseline components from the models tested to model the electrical system of a boiler with the expected maximum system standby mode and off mode power consumption observed during testing of boilers and similar equipment. Additional boiler standby mode and off mode testing was performed for the NOPR analysis and has led DOE to lower the standby mode and off mode baseline consumption level for each product class as compared to the NODA analysis. The baseline standby mode and off mode consumption levels used in the NOPR analysis are presented in Table IV.3.

Table IV.3: Baseline Standby Mode and Off Mode Power Consumption Used in the NOPR Analyses

Component	**Standby Mode and Off Mode Power Consumption (watts)**					
	Gas-Fired Hot Water	**Oil-Fired Hot Water**	**Gas-Fired Steam**	**Oil-Fired Steam**	**Electric Hot Water**	**Electric Steam**
Transformer	4	4	4	4	4	4
ECM Burner Motor	1	N/A	N/A	N/A	N/A	N/A
Controls	2.5	2.5	2.5	2.5	2.5	2.5
Display	4	4	4	4	4	4
Oil Burner	N/A	3	N/A	3	N/A	N/A
Total (watts)	**11.5**	**13.5**	**10.5**	**13.5**	**10.5**	**10.5**

b. Other Energy Efficiency Levels

Table IV.4 through Table IV.7 shows the efficiency levels DOE selected for the NOPR analysis of amended AFUE standards, along with a description of the typical technological change at each level. DOE seeks comment from interested parties regarding the typical technological change associated with each efficiency level.

HTP commented that it does not support an incremental increase in AFUE for gas hot water boilers. The commenter stated that appliances utilizing combustion technology that operates at efficiencies above 82 percent and below 90 percent AFUE will likely experience cyclic condensation within their venting and periods of high vent temperatures. HTP added that the safety and installation cost implications of operating within this range should be seriously considered. (HTP, No. 31 at p. 1)

The Department recognizes that efficiency levels within the non-condensing to condensing range could pose health or safety concerns under certain conditions, but the concerns can be resolved with proper product installations and venting system design. This is evidenced by the high number of models of products that are currently commercially available at these efficiency levels, as well as the lack of restrictions on the installation of these units (in terms of location) in installation manuals. Therefore, due to the significant product availability, DOE considered efficiency levels above 82 percent and below 90 percent in its analysis. However, DOE requests further comment from interested parties on non-condensing levels above 82 percent, as well as the appropriateness of considering such levels for amended energy conservation standards.

Table IV.4: AFUE Efficiency Levels for Gas-Fired Hot Water Boilers

Efficiency Level	AFUE %	Technology Options
0 – Baseline	82	Baseline
1	83	EL0 + Increased Heat Exchanger (HX) Area, Baffles
2	84	EL1 + Increased HX Area
3	85	EL2 + Increased HX Area
4	90	Condensing HX

5	92	EL4 + Improved HX
6 – Max-Tech	96	EL5 + Improved HX

Table IV.5: AFUE Efficiency Levels for Gas-Fired Steam Boilers

Efficiency Level	**AFUE %**	**Technology Options**
0 – Baseline	80	Baseline
1	82	EL0 + Increased HX Area
2 – Max-Tech	83	EL1+ Increased HX Area

Table IV.6: AFUE Efficiency Levels for Oil-Fired Hot Water Boilers

Efficiency Level	**AFUE %**	**Technology Options**
0 – Baseline	84	Baseline
1	85	EL0 + Increased HX Area
2	86	EL1 + Increased HX Area
3 – Max-Tech	91	EL2 + Improved HX, baffles and Secondary Condensing HX

Table IV.7: AFUE Efficiency Levels for Oil-Fired Steam Boilers

Efficiency Level	**AFUE %**	**Technology Options**
0 – Baseline	82	Baseline
1	84	EL0 + Increased HX Area
2	85	EL1 + Increased HX Area
3 – Max-Tech	86	EL2 + Improved HX

In addition, DOE considered whether changes to the residential furnaces and boilers test procedure, as proposed by the March 2015 test procedure NOPR would necessitate changes to the AFUE levels being analyzed. The primary change proposed in the test procedure included updating the incorporation by reference to ASHRAE 103-2007. As discussed in the March 2015 test procedure NOPR, adopting ASHRAE 103-2007 would not be expected to change the AFUE rating for single-stage products and would result in a *de minimis* increase in the AFUE ratings for two-stage and modulating non-condensing products. Adopting ASHRAE 103-2007 provisions was assessed to have no statistically significant impact on the AFUE for condensing products. 80 FR 12876. DOE has found that single-stage (rather than two-stage or modulating) cast iron products make up the majority of non-condensing residential boilers and, therefore, has tentatively determined that this amendment to the test procedure would not be substantial enough to merit a revision of the proposed AFUE efficiency levels for residential boilers. Consequently, DOE used the same AFUE efficiency levels in the NOPR analysis as were used in the NODA analysis.

Table IV.8 through Table IV.13 show the efficiency levels DOE selected for the NOPR analysis of standby mode and off mode standards, along with a description of the typical technological change at each level. For the NOPR analysis, DOE has modified the baseline standby mode and off mode efficiency levels, as discussed in section IV.C.1.a. However, DOE has assumed the same impacts from the design options in the NOPR analysis, as was assumed for the NODA analysis. As a result, the change to the baseline standby mode and off mode power consumption have resulted in corresponding changes to the standby mode and off mode power consumption at each efficiency level.

"Standby mode" and "off mode" power consumption are defined in the DOE test procedure for residential furnaces and boilers. DOE defines "standby mode" as "the condition during the heating season in which the furnace or boiler is connected to the power source, and neither the burner, electric resistance elements, nor any electrical auxiliaries such as blowers or pumps, are activated." 10 CFR part 430, subpart B, appendix N, section 2.8. "Off mode" is defined as "the condition during the non-heating season in which the furnace or boiler is connected to the power source, and neither the burner, electric resistance elements, nor any electrical auxiliaries such as the blowers or pumps, are activated." 10 CFR part 430, subpart B, appendix N, section 2.6. A "seasonal off switch" is defined as "the switch on the furnace or boiler that, when activated, results in a measurable change in energy consumption between the standby and off modes." 10 CFR part 430, subpart B, appendix N, section 2.7.

Through review of product literature and discussions with manufacturers, DOE has found that boilers generally do not have a seasonal off switch. Manufactures stated that if a switch is included with a product, it is primarily used as a service/repair switch, not for turning off the product during the off season. Therefore, DOE assumed that the standby mode and the off mode power consumption are equal. DOE requests comment on the efficiency levels analyzed for standby mode and off mode, and on the assumption that standby mode and off mode energy consumption (as defined by DOE) would be equal.

Table IV.8 Standby Mode and Off Mode Efficiency Levels for Gas-Fired Hot Water Boilers

Efficiency Level	Standby Mode and Off Mode Power Consumption (W)	Technology Options
0 – Baseline	11.5	Linear Power Supply*
1	10.0	Linear Power Supply with Low-Loss Transformer (LLTX)
2	9.7	Switching Mode Power Supply**
3 – Max-Tech	9.0	Switching Mode Power Supply with LLTX

*A linear power supply regulates voltage with a series element.
**A switching mode power supply regulates voltage with power handling electronics.

Table IV.9 Standby Mode and Off Mode Efficiency Levels for Gas-Fired Steam Boilers

Efficiency Level	Standby Mode and Off Mode Power Consumption (W)	Technology Options
0 – Baseline	10.5	Linear Power Supply
1	9.0	Linear Power Supply with LLTX
2	8.7	Switching Mode Power Supply
3 – Max-Tech	8.0	Switching Mode Power Supply with LLTX

Table IV.10 Standby Mode and Off Mode Efficiency Levels for Oil-Fired Hot Water Boilers

Efficiency Level	Standby Mode and Off Mode Power Consumption (W)	Technology Options
0 – Baseline	13.5	Linear Power Supply
1	12.0	Linear Power Supply with LLTX
2	11.7	Switching Mode Power Supply
3 – Max-Tech	11.0	Switching Mode Power Supply with LLTX

Table IV.11 Standby Mode and Off Mode Efficiency Levels for Oil-Fired Steam Boilers

Efficiency Level	Standby Mode and Off Mode Power Consumption (W)	Technology Options
0 – Baseline	13.5	Linear Power Supply
1	12.0	Linear Power Supply with LLTX
2	11.7	Switching Mode Power Supply
3 – Max-Tech	11.0	Switching Mode Power Supply with LLTX

Table IV.12 Standby Mode and Off Mode Efficiency Levels for Electric Hot Water Boilers

Efficiency Level	Standby Mode and Off Mode Power Consumption (W)	Technology Options
0 – Baseline	10.5	Linear Power Supply
1	9.0	Linear Power Supply with LLTX
2	8.7	Switching Mode Power Supply
3 – Max-Tech	8.0	Switching Mode Power Supply with LLTX

Table IV.13 Standby Mode and Off Mode Efficiency Levels for Electric Steam Boilers

Efficiency Level	Standby Mode and Off Mode Power Consumption (W)	Technology Options
0 – Baseline	10.5	Linear Power Supply
1	9.0	Linear Power Supply with LLTX
2	8.7	Switching Mode Power Supply
3 – Max-Tech	8.0	Switching Mode Power Supply with LLTX

2. Cost-Assessment Methodology

At the start of the engineering analysis, DOE identified the energy efficiency levels associated with residential boilers on the market using data gathered in the market assessment. DOE also identified the technologies and features that are typically incorporated into products at the baseline level and at the various energy efficiency levels analyzed above the baseline. Next, DOE selected products for the physical teardown analysis having characteristics of typical products on the market at the representative input capacity. DOE gathered information by performing a physical teardown analysis (see section IV.C.2.a) to create detailed BOMs, which included all components and processes used to manufacture the products. DOE used the BOMs from the teardowns as an input to a cost model, which was then used to calculate the manufacturing production cost (MPC) for products at various efficiency levels spanning the full range of efficiencies from the baseline to the maximum technology available ("max-tech"). DOE reexamined and revised its cost assessment performed for the NODA analysis based on additional teardowns and in response to comments received on the NODA analysis.

During the development of the engineering analysis for the NOPR, DOE held interviews with manufacturers to gain insight into the residential boiler industry, and to request feedback on the engineering analysis and assumptions that DOE used. DOE used the information gathered from these interviews, along with the information obtained through the teardown analysis and public comments, to refine the assumptions and data in the cost model. Next, DOE derived manufacturer markups using publicly-available residential boiler industry financial data in conjunction with manufacturers' feedback. The markups were used to convert the MPCs into MSPs. Further information on comments received and the analytical methodology is presented in the subsections below. For additional detail, see chapter 5 of the NOPR TSD.

a. Teardown Analysis

To assemble BOMs and to calculate the manufacturing costs for the different components in residential boilers, DOE disassembled multiple units into their base components and estimated the materials, processes, and labor required for the manufacture of each individual component, a process referred to as a "physical teardown." Using the data gathered from the physical teardowns, DOE characterized each component according to its weight, dimensions, material, quantity, and the manufacturing processes used to fabricate and assemble it.

DOE also used a supplementary method, called a "virtual teardown," which examines published manufacturer catalogs and supplementary component data to estimate the major physical differences between a product that was physically disassembled and a similar product that was not. For supplementary virtual teardowns, DOE gathered product data such as dimensions, weight, and design features from publicly-available information, such as manufacturer catalogs. The initial teardown analysis for the NODA included 6 physical and 5 virtual teardowns of residential boilers. The NOPR teardown analysis included 16 physical and 4 virtual teardowns of residential boilers. The additional teardowns performed for the NOPR analysis allowed DOE to further refine the assumptions used to develop the MPCs.

DOE selected the majority of the physical teardown units in the gas hot water product class because it has the largest number of shipments. DOE conducted physical teardowns of twelve gas hot water boilers, five of which were non-condensing cast iron boilers, two were non-condensing copper boilers, and the remaining five were condensing boilers. DOE performed an additional two virtual teardowns of gas hot water boilers.

DOE also performed physical teardowns on two gas-fired steam boilers as well as two oil-fired hot water boilers. DOE conducted one virtual teardown of an oil steam boiler as well as a virtual teardown of an oil hot water boiler.

The teardown analysis allowed DOE to identify the technologies that manufacturers typically incorporate into their products, along with the efficiency levels associated with each technology or combination of technologies. The end result of each teardown is a structured BOM, which DOE developed for each of the physical and virtual teardowns. The BOMs incorporate all materials, components, and fasteners (classified as either raw materials or purchased parts and assemblies), and characterize the materials and components by weight, manufacturing processes used, dimensions, material, and quantity. The BOMs from the teardown analysis were then used as inputs to the cost model to calculate the MPC for each product that was torn down. The MPCs resulting from the teardowns were then used to develop an industry average MPC for each product class analyzed.

In response to the teardown analysis performed for the NODA, AHRI stated that it is not appropriate to perform a virtual teardown of a baseline 82-percent AFUE gas hot water boiler based on information developed by physically tearing down an 85-percent AFUE gas hot water boiler. (AHRI, No. 22 at p. 3) AHRI explained that the designs to achieve an 85-percent AFUE model are significantly different than that to build an 82-percent AFUE model, so it is not appropriate to do a virtual teardown of a baseline 82-percent AFUE model, as this approach assumes a commonality of design between an 85-

percent AFUE model and an 82-percent AFUE model that is greater than it actually is. In response, DOE agrees that it is preferable to conduct a physical teardown at the baseline level as to not overstate the similarities between the baseline and higher efficiency levels. Accordingly, DOE has supplemented the virtual teardown conducted at the 82-percent AFUE baseline level for the gas-fired hot water boiler product class during the initial analysis with two physical teardowns at the baseline level for the NOPR analysis.

AHRI also stated that conducting a single teardown for the oil-fired hot water boiler product class is inadequate for this analysis. (AHRI, No. 22 at p. 3) In response to this comment, DOE has conducted an additional physical teardown for the oil-fired hot water boiler product class.

More information regarding details on the teardown analysis can be found in chapter 5 of the NOPR TSD.

b. Cost Model

The cost model is a spreadsheet that converts the materials and components in the BOMs into dollar values based on the price of materials, average labor rates associated with manufacturing and assembling, and the cost of overhead and depreciation, as determined based on manufacturer interviews and DOE expertise. To convert the information in the BOMs to dollar values, DOE collected information on labor rates, tooling costs, raw material prices, and other factors. For purchased parts, the cost model estimates the purchase price based on volume-variable price quotations and detailed discussions with manufacturers and component suppliers. For fabricated parts, the prices of raw metal materials[23] (e.g., tube, sheet metal) are estimated on the basis of 5-year averages (from 2009 to 2014). The cost of transforming the intermediate materials into finished parts is estimated based on current industry pricing.[24]

Burnham subsidiaries Crown Boiler, US Boiler, and New Yorker all commented that the material price for cast iron was not shown in chapter 5 of the TSD. (Crown Boiler, No. 24 at p. 1; US Boiler, No. 25 at p.1; New Yorker, No. 26 at p. 1) DOE acknowledges that a large portion of the manufacturer production cost can typically be attributed to raw materials and the omission of the cost used for cast iron may make it difficult to review how DOE arrived at the MSPs. The omission of this value from chapter 5 of the NODA TSD was in error, and chapter 5 of the NOPR TSD corrects this deficiency.

c. Manufacturing Production Costs

Once the cost estimates for all the components in each teardown unit were finalized, DOE totaled the cost of materials, labor, and direct overhead used to manufacture a product in order to calculate the manufacturer production cost. The total cost of the product was broken down into two main costs: (1) the full manufacturer production cost, referred to as MPC; and (2) the non-production cost, which includes selling, general, and administration (SG&A) expenses; the cost of research and

[23] American Metals Market (Available at: http://www.amm.com (Last accessed January, 2014).
[24] U.S. Department of Labor, Bureau of Labor Statistics, Produce Price Indices (Available at: http://www.bls.gov/ppi/) (Last accessed January, 2014).

development; and interest from borrowing for operations or capital expenditures. DOE estimated the MPC at each efficiency level considered for each product class, from the baseline through the max-tech. After incorporating all of the assumptions into the cost model, DOE calculated the percentages attributable to each element of total production cost (i.e., materials, labor, depreciation, and overhead). These percentages are used to validate the assumptions by comparing them to manufacturers' actual financial data published in annual reports, along with feedback obtained from manufacturers during interviews. DOE uses these production cost percentages in the manufacturer impact analysis (MIA) (see section IV.J).

In developing the MPCs for the NODA analysis, DOE considered the draft type (*i.e.*, natural draft or fan-assisted draft) and whether the model would have fan-assisted draft at a given efficiency level. Some boilers utilize natural draft, in which the natural buoyancy of the combustion gases is sufficient to vent those gases. Other boilers employ fan-assisted draft to help vent the products of combustion. As product efficiency increases, more heat is extracted from the flue gases, thereby resulting in less natural buoyancy that can be used to vent the flue gases. DOE surveyed the market to determine the percentage of models at each efficiency level that currently utilize fan-assisted draft, and DOE assumed that under an amended standard, that percentage would remain unchanged. DOE received various comments in response to the MPCs presented in its NODA analysis, as discussed below.

AHRI stated that it disagrees with the assumption that if the minimum efficiency level were to change, the percentage of models using inducer fans (*i.e.*, a fan-assisted boiler design) at each efficiency level would remain unchanged. AHRI stated that, at higher efficiency levels that are non-condensing (such as 84 percent and 85 percent for gas-fired hot water boilers), the manufacturer would consider anew the question of whether to use a fan-assisted design, if that higher level were to become the minimum standard. AHRI added that manufacturers face challenges in trying to address the wide range of venting systems that are connected to existing residential boiler installations. The commenter argued that models developed by manufacturers must be able to work safely and properly with existing venting systems that vary widely relative to an ideally-sized and configured vent system. AHRI stated that today, the models that are available at 84-percent AFUE or 85-percent AFUE are offered by the manufacturer with the knowledge that in cases where such models are not compatible with the existing vent system, lower efficiency models are available. Those lower efficiency models are more likely to be designed in a manner compatible with the existing vent system. If the minimum standard is raised to 84 percent or 85 percent, this current market equilibrium would be eliminated, and manufacturers would need to reconsider the mix of models they offer. For these reasons, AHRI recommended that DOE should increase the percentage of fan-assisted models at these levels. (AHRI No. 22 at p.3-4)

In response to AHRI's comment, DOE notes that AHRI did not provide any information as to how the mix of products with and without inducers might change in response to amended energy conservation standards. As mentioned above, for the NODA analysis, DOE used information gathered from a survey of models currently on the market to determine the percentages of units with and without inducer fans. DOE was unable to identify any better source of data or methodology for estimating the percentage of products which would have inducer fans under amended standards, so DOE maintained this methodology for the NOPR. DOE requests comments regarding how the mix of products with and without inducers would change under amended energy conservation standards, and how to best estimate and account for such changes in this analysis.

Crown Boiler stated that the incremental MPCs for EL1 and EL2 for gas-fired hot water and gas-fired steam boilers are optimistic and cannot be analyzed for accuracy. In addition, Crown Boiler stated that the incremental costs for the gas-fired product classes imply that DOE is assuming simple changes to the heat pin size to increase heat exchanger area, but that in reality, this change would be more complicated. Crown Boiler added that this is contradicted by the assumption of heat exchanger cost increase in non-condensing oil-fired boilers. The commenter stated that the use of larger heat transfer pins would likely require a wider heat exchanger to avoid excessive flue gas pressure drop. In addition, atmospheric boilers would probably require a taller draft hood to overcome the increased pressure drop caused by larger heat transfer pins. Crown Boiler also stated that the cost of sheet metal is not accounted for in the analysis. (Crown Boiler, No. 24 at p. 1)

As noted previously, DOE determined the incremental MPC at various efficiency levels for each product class by conducting physical and virtual teardowns. DOE determined the incremental cost between EL1 and EL2 for gas-fired hot water boilers in the NODA analysis using virtual teardowns, which are based on physical teardowns of similar units and then supplemented with catalog data. For the NOPR, DOE acquired additional data by conducting physical teardowns, which confirmed its observations from catalog data at the NODA analysis stage. Based on the observations from physical teardowns and manufacturer product literature and parts list, DOE found that many manufactures are able to increase the efficiency of their baseline gas-fired hot water boilers through the addition of baffles and/or a modest increase in heat transfer surface. Through product literature review, DOE has found it is common for manufacturers of non-condensing oil-fired boilers to derate the burner input (thereby increasing the ratio of heat transfer area to input rating) rather than create new cast iron patterns. However, as discussed previously, derating was screened out as a design option because it reduces the heating capability of the boiler. Therefore, DOE estimated the cost of improving efficiency as an increase in heat exchanger size, using information observed to model the appropriate amount of heat exchanger increase that would be required to improve efficiency. Based upon the different observed methods for improving efficiency, DOE's NODA and NOPR analyses reflect the different designs and different costs of achieving incremental AFUE increases in gas-fired and oil-fired boilers. The differential cost in efficiency improvement between gas-fired and oil-fired non-condensing boilers is also due in part to the larger representative input capacity of oil-fired boilers, as well as the larger heat exchanger design for oil-fired boilers (*i.e.*, wet-based rather than dry-based). DOE has also accounted for the additional sheet metal cost of increasing the cabinet to accommodate an increase in heat exchanger size. Because DOE's analysis is based upon observations from teardowns of actual products available on the market, DOE did not change its assumptions for how EL1 and EL2 are achieved in gas-fired or oil-fired boilers, as suggested by Crown Boiler.

In the NOPR analysis, DOE revised the cost model assumptions it used for the NODA analysis based on additional teardown analysis, updated pricing information (for raw materials and purchased parts), and additional manufacturer feedback. These changes resulted in refined MPCs and production cost percentages. Table IV.14 through Table IV.17 present DOE's estimates of the MPCs by AFUE efficiency level for this rulemaking.

Table IV.14 Manufacturing Cost for Gas-Fired Hot Water Boilers

Efficiency Level	Efficiency Level (AFUE) %	MPC* $	Incremental Cost $
Baseline	82	624	-
EL1	83	631	7
EL2	84	637	13
EL3	85	675	51
EL4	90	1,023	399
EL5	92	1,158	534
EL6	96	1,522	898

*Non-condensing boilers (< 90 percent AFUE) are available with or without an inducer. The costs shown reflect the MPC for a boiler without an inducer.

Table IV.15 Manufacturing Cost for Gas-Fired Steam Boilers

Efficiency Level	Efficiency Level (AFUE) %	MPC* $	Incremental Cost $
Baseline	80	798	-
EL1	82	812	13
EL2	83	952	154

*Non-condensing boilers (< 90 percent AFUE) are available with or without an inducer. The costs shown reflect the MPC for a boiler without an inducer.

Table IV.16 Manufacturing Cost for Oil-Fired Hot Water Boilers

Efficiency Level	Efficiency Level (AFUE) %	MPC* $	Incremental Cost $
Baseline	84	1,247	-
EL1	85	1,319	73
EL2	86	1,392	146
EL3	91	2,204	957

*Non-condensing boilers (< 90 percent AFUE) are available with or without an inducer. The costs shown reflect the MPC for a boiler without an inducer.

Table IV.17 Manufacturing Cost for Oil-Fired Steam Boilers

Efficiency Level	Efficiency Level (AFUE) %	MPC* $	Incremental Cost $
Baseline	82	1,270	-
EL1	84	1,416	146
EL2	85	1,489	218
EL3	86	1,634	364

*Non-condensing boilers (< 90 percent AFUE) are available with or without an inducer. The costs shown reflect the MPC for a boiler without an inducer.

Table IV.18 through Table IV.23 present's DOE's estimate estimates of the MPCs at each standby mode and off mode efficiency level for this rulemaking.

Table IV.18 Manufacturing Cost for Gas-Fired Hot Water Boilers Standby Mode and Off Mode

Efficiency Level	Standby Mode and Off Mode Power Consumption (W)	MPC $	Incremental Cost $
Baseline	11.5	9.56	-
EL1	10.0	10.56	1.00
EL2	9.7	20.03	10.47
EL3	9.0	20.68	11.12

Table IV.19 Manufacturing Cost for Gas-Fired Steam Boilers Standby Mode and Off Mode

Efficiency Level	Standby Mode and Off Mode Power Consumption (W)	MPC $	Incremental Cost $
Baseline	10.5	9.56	-
EL1	9.0	10.56	1.00
EL2	8.7	20.03	10.47
EL 3	8.0	20.68	11.12

Table IV.20 Manufacturing Cost for Oil-Fired Hot Water Boilers Standby Mode and Off Mode

Efficiency Level	Standby Mode and Off Mode Power Consumption (W)	MPC $	Incremental Cost $
Baseline	13.5	9.56	-
EL1	12.0	10.56	1.00
EL2	11.7	20.03	10.47
EL3	11.0	20.68	11.12

Table IV.21 Manufacturing Cost for Oil-Fired Steam Boilers Standby Mode and Off Mode

Efficiency Level	Standby Mode and Off Mode Power Consumption (W)	MPC $	Incremental Cost $
Baseline	13.5	9.56	-
EL1	12.0	10.56	1.00
EL2	11.7	20.03	10.47
EL3	11.0	20.68	11.12

Table IV.22 Manufacturing Cost for Electric Hot Water Boilers Standby Mode and Off Mode

Efficiency Level	Standby Mode and Off Mode Power Consumption (W)	MPC $	Incremental Cost $
Baseline	10.5	9.56	-
EL1	9.0	10.56	1.00
EL2	8.7	20.03	10.47
EL3	8.0	20.68	11.12

Table IV.23 Manufacturing Cost for Electric Steam Boilers Standby Mode and Off Mode

Efficiency Level	Standby Mode and Off Mode Power Consumption (W)	MPC $	Incremental Cost $
Baseline	10.5	9.56	-
EL1	9.0	10.56	1.00
EL2	8.7	20.03	10.47
EL3	8.0	20.68	11.12

Chapter 5 of the NOPR TSD presents more information regarding the development of DOE's estimates of the MPCs for this rulemaking.

d. Cost-Efficiency Relationship

The result of the engineering analysis is a cost-efficiency relationship. DOE created cost-efficiency curves representing the cost-efficiency relationship for each product class that it examined. To develop the cost-efficiency relationships for residential boilers, DOE examined the cost differential to move from one efficiency level to the next for each manufacturer. DOE used the results of teardowns on a market-share-weighted average basis to determine the industry average cost increase to move from one efficiency level to the next. Additional details on how DOE developed the cost-efficiency relationships and related results are available in chapter 5 of the NOPR TSD, which also presents these cost-efficiency curves in the form of energy efficiency versus MPC.

The results indicate that cost-efficiency relationships are nonlinear. In other words, as efficiency increases, manufacturing becomes more difficult and more costly. A large cost increase is evident between non-condensing and condensing efficiency levels due to the requirement for a heat exchanger that can withstand corrosive condensate.

e. Manufacturer Markup

To account for manufacturers' non-production costs and profit margin, DOE applies a non-production cost multiplier (the manufacturer markup) to the full MPC. The resulting MSP is the price at which the manufacturer can recover all production and non-production costs and earn a profit. To meet new or amended energy conservation standards, manufacturers typically introduce design changes to their product lines that increase manufacturer production costs. Depending on the competitive environment for these particular products, some or all of the increased production costs may be passed from manufacturers to retailers and eventually to consumers in the form of higher purchase prices. As production costs increase, manufacturers typically incur additional overhead. The MSP should be high enough to recover the full cost of the product (i.e., full production and non-production costs) and yield a profit. The manufacturer markup has an important bearing on profitability. A high markup under a standards scenario suggests manufacturers can readily pass along the increased variable costs and some of the capital and product conversion costs (the one-time expenditures) to consumers. A low markup suggests that manufacturers will not be able to recover as much of the necessary investment in plant and equipment.

To calculate the manufacturer markups, DOE used 10-K reports[25] submitted to the U.S. Securities and Exchange Commission (SEC) by the three publicly-owned residential boiler companies. The financial figures necessary for calculating the manufacturer markup are net sales, costs of sales, and gross profit. For boilers, DOE averaged the financial figures spanning the years 2008 to 2012 in order to calculate the markups. DOE used this approach because amended standards may transform high-efficiency products (which currently are considered premium products) into typical

[25] U.S. Securities and Exchange Commission, Annual 10-K Reports (Various Years) (Available at: http://sec.gov).

products. DOE acknowledges that there are numerous manufacturers of residential boilers that are privately-held companies, which do not file SEC 10-K reports. In addition, while the publicly-owned companies file SEC 10-K reports, the financial information summarized may not be exclusively for the residential boiler portion of their business and can also include financial information from other product sectors, whose margins could be quite different from the residential boiler industries. DOE discussed the manufacturer markup with manufacturers during interviews, and used the feedback to validate the markup calculated through review of SEC 10-K reports. DOE received no comments regarding the manufacturer markup used in the NODA analysis. See chapter 5 of the NOPR TSD for more details about the manufacturer markup calculation.

f. Shipping Costs

In response to the NODA analysis, Crown Boiler, US Boiler, and New Yorker commented that the shipping costs were not discussed in chapter 5 of the TSD nor is it apparent that they were used to calculate MPC in the manufacturer markup. These commenters stated that depending on the situation, shipping costs may be borne by either the manufacturer or by the wholesaler, but either way, the shipping costs eventually become part of the installed cost of the boiler and, therefore, need to be taken into account. The commenters added that almost all condensing gas-fired boiler heat exchangers and burner systems are imported from Europe or Asia, and therefore, there are importation costs associated with condensing boilers. (Crown Boiler, No. 24 at p. 1; US Boiler, No. 25 at p.1; New Yorker, No. 26 at p. 1)

For residential boilers, the Department has included transportation costs in its calculation of manufacturer selling price in both the NODA and the NOPR. Outbound freight is normally considered a sales expense and not a production cost. As discussed in section IV.C.2.e, when translating MPCs to MSPs, DOE applies a manufacturer mark-up to the MPC. This mark-up, based on an analysis of manufacturer SEC 10-K reports, includes outbound freight costs. Inbound freight costs are included in MPCs as a component of costs for purchased parts and raw materials. Chapter 5 of the NOPR TSD contains additional details about DOE's shipping cost assumptions.

g. Manufacturer Interviews

Throughout the rulemaking process, DOE has sought and continues to seek feedback and insight from interested parties that would improve the information used in its analyses. DOE interviewed manufacturers as a part of the NOPR manufacturer impact analysis (see section IV.J.3). During the interviews, DOE sought feedback on all aspects of its analyses for residential boilers. For the engineering analysis, DOE discussed the analytical assumptions and estimates, cost model, and cost-efficiency curves with residential boiler manufacturers. DOE considered all the information manufacturers provided when refining the cost model and assumptions. However, DOE incorporated equipment and manufacturing process figures into the analysis as averages in order to avoid disclosing sensitive information about individual manufacturers’ products or manufacturing processes. More details about the manufacturer interviews are contained in chapter 12 of the NOPR TSD.

D. Markups Analysis

DOE uses appropriate markups (e.g., manufacturer markups, retailer markups, distributors markups, contractor markups), and sales taxes to convert the manufacturer selling price (MSP) estimates from the engineering analysis to consumer prices, 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 product markups at each step in the distribution chain. The markups are multipliers that represent increases above the MSP for residential boilers. The incremental markup relates the change in the manufacturer sales price of higher-efficiency models (the incremental cost increase) to the change in the consumer price. Before developing markups, DOE defines key market participants and identifies distribution channels.

In the NODA, DOE characterized three distribution channels to describe how residential boiler products pass from the manufacturer to residential and commercial consumers: (1) replacement market; (2) new construction, and (3) national accounts.[26] 79 FR 8122, 8124 (Feb. 11, 2014). The replacement market distribution channel is characterized as follows:

Manufacturer → Wholesaler → Mechanical contractor → Consumer

[26] The national accounts channel is an exception to the usual distribution channel that is only applicable to those residential boilers installed in the small to mid-size commercial buildings where the on-site contractor staff purchase equipment directly from the wholesalers at lower prices due to the large volume of equipment purchased, and perform the installation themselves.

The new construction distribution channel is characterized as follows:

Manufacturer → Wholesaler → Mechanical contractor → General contractor → Consumer

In the third distribution channel, the manufacturer sells the product to a wholesaler and then to the commercial consumer through a national account:

Manufacturer → Wholesaler → Consumer (National Account)

To develop markups for the parties involved in the distribution of the product, DOE utilized several sources, including: (1) the Heating, Air-Conditioning & Refrigeration Distributors International (HARDI) 2012 Profit Report[27] 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[28] to develop mechanical contractor markups, and (3) U.S. Census Bureau's 2007 Economic Census data[29] for the commercial and institutional building construction industry to develop general contractor markups.

[27] Heating, Air Conditioning & Refrigeration Distributors International 2012 Profit Report (Available at: http://www.hardinet.org/Profit-Report) (Last accessed April 10, 2013).
[28] Air Conditioning Contractors of America (ACCA), Financial Analysis for the HVACR Contracting Industry: 2005 (Available at: http://www.acca.org/store/) (Last accessed April 10, 2013).
[29] U.S. Census Bureau, 2007 Economic Census Data (2007) (Available at: http://www.census.gov/econ/)(Last accessed April 10, 2013).

In addition to the markups, DOE derived State and local taxes from data provided by the Sales Tax Clearinghouse.[30] 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.

DOE did not receive comments on the markups analysis, and consequently, it retained the same approach for today's NOPR. Chapter 6 of the NOPR TSD provides further detail on the estimation of markups.

E. Energy Use Analysis

1. Energy Use Methodology

The purpose of the energy use analysis is to determine the annual energy consumption of residential boilers at different efficiencies in representative U.S. single-family homes, multi-family residences, and commercial buildings, and to assess the energy savings potential of increased boiler efficiency. DOE estimated the annual energy consumption of residential boilers at specified energy efficiency levels across a range of climate zones, building characteristics, and heating applications. The annual energy consumption includes the natural gas, liquid petroleum gas (LPG), oil, and/or electricity use by the boiler for space and water heating. The annual energy consumption of residential boilers is used in subsequent analyses, including the LCC and PBP analysis and the national impacts analysis.

[30] Sales Tax Clearinghouse Inc., State Sales Tax Rates Along with Combined Average City and County Rates, 2013 (Available at: http://thestc.com/STrates.stm) (Last accessed Sept. 11, 2013).

For the residential sector, DOE consulted the Energy Information Administration's (EIA) 2009 Residential Energy Consumption Survey (RECS 2009) to establish a sample of households using residential boilers for each boiler product class.[31] The RECS data provide information on the vintage of the home, as well as heating energy use in each household. The survey also included household characteristics such as the physical characteristics of housing units, household demographics, information about other heating and cooling products, fuels used, energy consumption and expenditures, and other relevant data. DOE used the household samples not only to determine boiler annual energy consumption, but also as the basis for conducting the LCC and PBP analysis. DOE used data from RECS 2009[32] and CBECS 2003[33] to project household weights and household characteristics in 2020, the expected compliance date of any amended energy conservation standards for residential boilers.

DOE accounted for applications of residential boilers in commercial buildings because the intent of the analysis of consumer impacts is to capture the full range of usage conditions for these products. DOE considers the definition of "residential boiler"

[31] U.S. Department of Energy: Energy Information Administration, Residential Energy Consumption Survey: 2009 RECS Survey Data (2013) (Available at: <http://www.eia.gov/consumption/residential/data/2009/>) (Last accessed March, 2013).
[32] U.S. Department of Energy: Energy Information Administration, Residential Energy Consumption Survey: 2009 RECS Survey Data (2013) (Available at: http://www.eia.gov/consumption/residential/data/2009/) (Last accessed March, 2014).
[33] U.S. Department of Energy: Energy Information Administration, Commercial Buildings Energy Consumption Survey (2003) (Available at: http://www.eia.gov/consumption/commercial/data/2003/index.cfm?view=microdata) (Last accessed November, 2013).

to be limited only by its capacity.[34] DOE determined that these applications represent about 7 percent of the residential boiler market.

For the commercial building sample, DOE used the EIA's 2003 Commercial Building Energy Consumption Survey[35] (CBECS 2003) to establish a sample of commercial buildings using residential boilers for each boiler product class. Criteria were developed to help size these boilers using several variables, including building square footage and estimated supply water temperature. For boilers used in multi-family housing, DOE used the RECS 2009 sample discussed above, accounting for situations where more than one residential boiler is used to heat a building.

To estimate the annual energy consumption of boilers meeting higher efficiency levels, DOE first calculated the heating load based on the RECS and CBECS estimates of the annual energy consumption of the boiler for each household. DOE estimated the house heating load by reference to the existing boiler's characteristics, specifically its capacity and efficiency (AFUE), as well as by the heat generated from the electrical components. The AFUE of the existing boilers was determined using the boiler vintage (the year of installation of the product) from RECS and historical data on the market share of boilers by AFUE. DOE then used the house heating load to determine the burner operating hours, which are needed to calculate the fossil fuel consumption and electricity

[34] 42 U.S.C. 6291(23)
[35] U.S. Department of Energy: Energy Information Administration, Commercial Buildings Energy Consumption Survey (2003) (Available at: <http://www.eia.gov/consumption/commercial/data/2003/index.cfm?view=microdata>) (Last accessed November, 2013).

consumption based on the DOE residential furnace and boiler test procedure. To calculate pump and other auxiliary components' electricity consumption, DOE utilized data from manufacturer product literature.

Additionally, DOE adjusted the energy use to normalize for weather by using long-term heating degree-day (HDD) data for each geographical region.[36] DOE also accounted for change in building shell characteristics between 2009 and 2020 by applying the building shell efficiency indexes in the National Energy Modeling System (NEMS) based on EIA's Annual Energy Outlook 2013 (AEO 2013).[37] DOE also accounted for future climate trends based on AEO 2013 HDD projections

DOE is aware that some residential boilers have the ability to provide both space heating and domestic water heating, and that these products are widely available and may vary greatly in design. For these applications, DOE accounted for the boiler energy used for domestic water heating, which is part of the total annual boiler energy use. To accomplish this, DOE used the RECS 2009 and/or CBECS data to identify households or buildings with boilers that use the same fuel type for space and water heating, and then assumed that a fraction of these identified households/buildings use the boiler for both applications.

[36] National Oceanic and Atmospheric Administration, NNDC Climate Data Online (Available at: http://www7.ncdc.noaa.gov/CDO/CDODivisionalSelect.jsp) (Last accessed March 15, 2013).
[37] U.S. Department of Energy-Energy Information Administration, Annual Energy Outlook 2013 with Projections to 2040 (Available at: <http://www.eia.gov/forecasts/aeo/>).

To calculate the annual water-heating energy use for each boiler efficiency level, DOE first calculated the water-heating load by multiplying the annual fuel consumption for water heating (derived from RECS or CBECS) by the AFUE of the existing boiler, adjusted for the difference between AFUE and recovery efficiency for water heating. DOE then calculated the boiler energy use for each efficiency level by multiplying the water-heating load by the AFUE of the selected efficiency level, adjusted for the difference between AFUE and recovery efficiency for water heating.

The Department calculated boiler electricity consumption for the circulating pump, the draft inducer,[38] and the ignition system. If a household required a condensate pump, which is sometimes installed with higher-efficiency products, DOE assumed that the pump consumes 60 watts and operated at the same time as the burner. For single-stage boilers, the Department calculated the electricity consumption as the sum of the electrical energy used during boiler operation for space heating, water heating, and standby energy consumption. For two-stage and modulating products, this formula includes parameters for the operation at full, modulating, and reduced load.

2. Standby Mode and Off Mode

The Department calculated boiler standby mode and off mode electricity consumption for times when the boiler is not in use for each efficiency level identified in the engineering analysis. DOE calculated boiler standby mode and off mode electricity

[38] In the case of modulating condensing boilers, to accommodate lower firing rates, the inducer will provide lower combustion airflow to regulate the excess air in the combustion process. DOE assumed that modulating condensing boilers are equipped with inducer fans with PSC motors and two-stage controls. The inducers are assumed to run at a 70-percent airflow rate when the modulating unit operates at low-fire.

consumption by multiplying the power consumption at each efficiency level by the number of standby mode and off mode hours. To calculate the annual number of standby mode and off mode hours for each sample household, DOE subtracted the estimated total burner operating hours (both for space heating and water heating) from the total hours in a year (8,760). Details of the method are provided in chapter 7 of the NOPR TSD.

AHRI disagreed with DOE's assumption that a residential boiler is in standby mode throughout the year. AHRI stated that the time when the boiler is in standby should be limited to the heating season; the remainder of the year the boiler is “off.” (AHRI, No. 22 at p. 5) DOE is not aware of any information on the extent to which consumers shut off the boiler when the heating season is over. For the NOPR, DOE estimated that 25 percent of consumers shut the boiler off.

See chapter 7 in the NOPR TSD for additional detail on the energy analysis and results for standby mode and off mode operation.

3. Comments on Boiler Energy Use Calculation

Commenting on the NODA, AHRI stated that, in basing the estimated energy consumption on RECS 2009 and CBECS 2003 data, the estimated energy use must be recalculated to account for the benefit of the automatic temperature reset means both for the baseline unit and the higher efficiency levels. For residential applications, AHRI suggested that an average of 10 percent savings would be a reasonable estimate. AHRI predicted that this revised analysis will show a smaller incremental energy savings resulting from an increased AFUE rating. (AHRI, No. 22 at pp. 5-6)

For the NOPR, DOE incorporated the impact of automatic temperature reset means on boiler energy use by adjusting AFUE based on a reduction in average return water temperature (RWT). DOE calculated the reduction in average RWT for single-stage boilers based on the duration of burner operating hours at reduced RWT. For modulating boilers, DOE used the average relationship[39] between RWT and thermal efficiency to establish the magnitude of the efficiency adjustment required for the high- and low-temperature applications. See appendix 7B for details on how DOE calculated the adjustment for automatic means.

Energy Kinetics stated that the average oversizing factor of between three and four used in the NODA exceeds the 0.7 oversizing factor indicated in the AFUE standard. It argued that this oversizing has a clear and direct impact on annual efficiency due to idle losses, which are virtually ignored in AFUE. (Energy Kinetics, No. 19 at p. 1)

In the NODA analysis, DOE did not use an average oversizing factor of between three and four, but applied an oversize factor of 0.7 as specified in the existing DOE test procedure. The oversize factor was applied directly to the calculated input capacity of the boiler. DOE calculated the input capacity for the existing boiler of each

[39] Appendix 7B includes a list of references used to derive the relationship. No information is available about the relationship between AFUE and RWT, while manufacturers publish data on the relationship between boiler thermal efficiency and the RWT. DOE assumed that AFUE scales according to the relationship reported for the thermal efficiency.

housing/building unit based on information derived from the RECS and CBECs data. The equipment sizing approach determines the heating load of the sampled household/building by accounting for building characteristics impacting heat load. Following determination of the building heating load, equipment efficiency is applied to the heat load to calculate the boiler input capacity. Input capacity was then multiplied by an oversize factor of 0.7 as specified in the existing DOE test procedure. Using the oversized input capacity, DOE then rounded the input capacity up to the nearest typical equipment size, which in some cases resulted in oversize factors slightly more or less than 1.7. See appendix 7B for additional details of the boiler sizing methodology.

Energy Kinetics stated that temperature reset controls would be highly ineffective without accounting for idle loss. Energy Kinetics stated that idle loss or energy wasted at the end of the heating cycle (not during the burner operation), greatly impacts annual energy efficiency. (Energy Kinetics, No. 19 at p. 2)

Idle loss, as the term applies to residential heating boilers, is heat wasted when the burner is not firing. The idle losses are the heat from combustion that is not transferred to the heating water, including the products of combustion up the flue, the loss out of the heat exchanger walls and boiler's jacket (in the form of radiant, conductive, or convective transfer), and the loss down the drain as a condensate. Since no fuel is being consumed in the off-cycle, off-cycle losses, therefore, are important only to the extent that they must be replaced during the on-cycle by the burning of extra fuel (i.e., longer burner on times or higher firing rates). The DOE test procedure accounts for idle losses associated with space heating in the heating season efficiency value, but the idle losses during non-space heating operation (i.e., domestic water heating) are not captured in the existing DOE test procedure. For the NOPR analysis, DOE accounted for idle losses based on the installation location of the boiler (conditioned or unconditioned space) and whether or not the boiler served domestic hot water loads (summer hot water use only). For boilers that serve only space heating loads, the idle losses are accounted for in the heating season efficiency. For boilers that provided domestic hot water heating, idle losses occur in both heating and non-heating seasons. These idle losses were accounted for by applying heat loss values to the boiler and storage tank (when necessary) for a fraction of the off-cycle time. DOE also accounted for the losses for boilers that are installed with indirect tanks or tankless coils. See appendix 7B for additional details on the consideration of idle losses.

Energy Kinetics also stated that AFUE assumes that the boiler is in the conditioned space and heat lost is gained in the conditioned space, but in practice, much of this heat energy is wasted in basements, up chimneys, and out draft hoods and draft regulators. (Energy Kinetics, No. 19 at p. 2)

The AFUE metric incorporates sensible and latent heat lost up chimneys and out draft hoods and draft regulators. Regarding losses in basements, for the NOPR analysis, DOE accounted for boiler jacket losses based on the installation location. For boilers installed in unconditioned basements and garages, DOE adjusted AFUE using a jacket loss factor, which was derived from the values provided by the existing DOE test procedure. For high-mass boilers, DOE used a jacket loss factor of 2.4 percent. For low-mass boilers, DOE assumed that the jacket losses were only 10 percent of those of a high-mass boiler (i.e., 0.24 percent).[40] See appendix 7B for details of the jacket loss factors applied.

Energy Kinetics stated that if combined heat and hot water boilers are considered to be in the conditioned space, then heat lost in summertime while heating domestic water should have an impact on air conditioning cooling loads. (Energy Kinetics, No. 19 at p. 2) For the NOPR, DOE estimated the share of combined heat and hot water boilers that are installed in the conditioned space, and estimated the impact of heat lost in summertime on air conditioning cooling loads. Details of the method are given in chapter 7 of the NOPR TSD.

Fire & Ice and Weil McLain *et al*. stated that installing high-efficiency condensing boilers in older replacement applications may not actually achieve the expected energy savings because the homeowners may not be able to afford to make extensive and expensive changes to the heat distribution system in an older home that may be needed to achieve the rated efficiency. (Fire & Ice, No. 18 at pp. 1-2; Weil McLain *et al*., No. 20-2 at pp. 1-2) Weil McLain stated that if a condensing boiler is installed in a heat distribution system that is not appropriate for that product (i.e., the return water temperature is too high), then the condensing boiler will not be able to operate in the "condensing" mode, but will instead operate in the non-condensing mode,

[40] DOE estimated that 75 percent of condensing boilers, and 25 percent of non-condensing boilers are low-mass. The remainder are high-mass.

achieving much lower efficiencies. (Weil McLain, No. 20-1 at p. 5) Crown Boiler, U.S. Boiler, and New Yorker Boiler agree with the AFUE adjustment for condensing boilers that recognizes 150°F average return water temperature and resulting operation in a non-condensing mode during a significant portion of the heating season. (Crown Boiler, No. 24 at p. 2; U.S. Boiler, No. 25 at p. 2; New Yorker Boiler, No. 26 at p. 2)

DOE accounts for boiler operational efficiency in specific installations by adjusting the AFUE of the sampled boiler based on an average system return water temperature. The criteria used to determine the return water temperature of the boiler system included consideration of building vintage, product type (condensing or non-condensing, single-stage or modulating), and whether the boiler employed an automatic means for adjusting water temperature. Using product type and system return water temperature, DOE developed and applied the AFUE adjustments based on average heating season return water temperatures. See appendix 7B for additional details.

F. Life-Cycle Cost and Payback Period Analysis

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

- LCC (life-cycle cost) is the total consumer cost of an appliance or product, generally over the life of the appliance or product. 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), product lifetime, and discount rate. Future operating costs are discounted to the time of purchase and summed over the lifetime of the appliance or product.
- PBP (payback period) measures the amount of time it takes consumers to recover the assumed higher purchase price of a more energy-efficient product through reduced operating costs. Inputs to the payback period calculation include the installed cost to the consumer and first-year operating costs.

For any given efficiency level, DOE measures the PBP and the change in LCC relative to an estimate of the base-case efficiency level. The base-case estimate reflects the market in the absence of amended energy conservation standards, including market trends for products that exceed the current energy conservation standards.

DOE analyzed the net effect of potential amended residential boiler standards on consumers by calculating the LCC and PBP for each efficiency level of each sample household 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). It uses weighting factors to account for distributions of shipments to different building types and 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 household samples or characterized with single point values. The analytical results include a distribution of 10,000 data points showing the range of LCC savings and PBPs for a given efficiency level relative to the base-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 who already purchase more-efficient products, DOE avoids overstating the potential benefits from increasing product efficiency.

EPCA establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the energy (and, as applicable, water) savings during the first year that the consumer will receive as a result of the standard, as calculated under the test procedure in place for that standard. (42 U.S.C. 6295(o)(2)(B)(iii)) 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.

DOE calculated the LCC and PBP for all consumers of residential boilers as if each were to purchase new product in the year that compliance with amended standards is required. As discussed above, DOE is conducting this rulemaking pursuant to 42 U.S.C. 6295(f)(4)(C), and consistent with that provision, DOE is applying a 5-year lead time for compliance with amended standards. (This rulemaking also satisfies DOE's 6-year-lookback review requirement under 42 U.S.C. 6295(m), a provision which calls for the same 5-year lead time for residential boilers.) At the time of preparation of the NOPR analysis, the expected issuance date was spring 2014, leading to an anticipated final rule publication in 2015. Accordingly, the projected compliance date for amended standards is early 2020. Therefore, for purposes of its analysis, DOE used January 1, 2020 as the beginning of compliance with potential amended standards for residential boilers.

As noted above, DOE's LCC and PBP analyses generate values that calculate the payback period for consumers of potential energy conservation standards, which includes, but is not limited to, the three-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, as required under 42 U.S.C. 6295(o)(2)(B)(i). The results of this 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).

1. Inputs to Installed Cost

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

Weil McLain stated that lumping all condensing and non-condensing boilers together to determine the average or median cost of a type of boiler does not provide the correct basis for making a decision. (Weil McLain, No. 20-1 at p. 3) In response, DOE's product cost analysis considers condensing and non-condensing boilers as separate efficiency levels and accounts for the specific characteristics of these designs. Details of the method are provided in chapter 8 of the NOPR TSD.

For the NODA, DOE projected future prices of residential boilers using inflation-adjusted producer price index (PPI) data for "heating equipment" from the Bureau of Labor Statistics.[41] AHRI stated that the analysis conducted for the residential furnace rulemaking and the PPI data for heating equipment from the Bureau of Labor Statistics

[41] Series ID PCU333414333414 (Available at: http://www.bls.gov/ppi/)

are not directly transferable to residential boilers. AHRI stated that the unique factors of the relatively small size of the residential boiler market and the relatively higher cost of residential boilers minimize the applicability of the general PPI data in this analysis. (AHRI, No. 22 at p. 5)

DOE agrees that the broad category "heating equipment" may not be the best measure to apply to residential boilers. For the NOPR, DOE examined the PPI for cast iron heating boilers from 1987 to 2013 and for steel heating boilers from 1980 to 2013.[42] The inflation-adjusted PPI shows a strongly rising trend over this period. DOE has concerns about using this trend, however. During much of the period, the inflation-adjusted PPI for iron and steel mills (which indicates the price of the primary materials that go into cast iron heating boilers) was also sharply rising. This rise mirrors the increase in prices of various industrial commodities, which resulted from rapid industrialization in China, India, and other emerging economies. Prior to 2004, the inflation-adjusted PPI for iron and steel mills was in a long downtrend that began in the early 1980s. In the recent global economic environment of slower growth, iron ore prices have been declining since the beginning of 2011. Given the past trend and the current situation, DOE is not confident that extrapolating the trend in the PPI for cast iron heating boilers in 1999-2013 would provide a sound projection. Nor is DOE confident that the recent downward trend in iron ore prices will continue in the future. Given the uncertainty in commodities pricing and other factors, DOE concluded that including a

[42] Cast iron heating boiler PPI series ID: PCU 3334143334141; Steel heating boiler PPI series ID: PCU 3334143334145 (Available at: www.bls.gov/ppi/).

price trend in the main analysis cases would not be justified by the data, instead choosing to maintain a constant manufacturer selling price (in real dollars) for residential boilers.

The Joint Commenters stated that it is expected that the installed cost of condensing boilers would decline between now and the compliance date of amended standards (2020). The Joint Commenters stated that the new ENERGY STAR specification, which requires condensing levels from gas-fired boilers, are expected to increase the market share of condensing gas boilers, resulting in a decline in equipment costs. Furthermore, the Joint Commenters encouraged DOE to explore ways to estimate learning rates for condensing technology. The Joint Commenters stated that analyzing price trends of whole categories of equipment fails to capture the price trends of the actual technologies that are employed to improve efficiency. The Joint Commenters would expect the price of condensing boilers to decline much faster than the price of all boilers. The Joint Commenters stated that the use of historic price trends of heating equipment to estimate learning rates for boilers implicitly assumes that prices of non-condensing and condensing boilers will change at the same rate, and will likely significantly underestimate future declines in the incremental cost of condensing boilers. (Joint Commenters, No. 27 at pp. 2-3)

DOE acknowledges that the product cost of condensing boilers may decline between now and the compliance date of amended standards as production increases and the technology matures. It also recognizes that experience in the manufacturing sector generally indicates that the price of new products declines in the early years of adoption.

However, DOE could not find data that would allow a projection of the magnitude of likely decline for condensing boilers. Thus, for the NOPR, it used the same price trend projection for condensing and non-condensing boilers. Currently, information about price trends related to different boiler technologies is not available, but DOE is exploring ways to estimate learning rates for different technologies.[43]

DOE estimated the costs associated with installing a boiler in a new housing unit or as a replacement for an existing boiler. Installation costs account for labor and material costs and any additional costs, such as venting and piping modifications and condensate disposal that might be required when installing products at various efficiency levels.

For replacement installations, DOE included a number of additional costs ("adders") for a fraction of the sample households. For non-condensing boilers, these additional costs may account for updating of flue vent connectors, vent resizing, chimney relining, and, for a fraction of installations, the costs for a stainless steel vent. For condensing boilers, these additional costs included adding a new polyvinylchloride (PVC) flue vent, combustion air venting for direct vent installations (PVC), concealing vent pipes for indoor installations, addressing an orphaned water heater (by updating flue vent connectors, vent resizing, or chimney relining), and condensate removal.

[43] Taylor, M. and K. S. Fujita, Accounting for Technological Change in Regulatory Impact Analyses: The Learning Curve Technique, Lawrence Berkeley National Laboratory, Report No. LBNL-6195E (2013) (Available at: http://efficiency.lbl.gov/sites/all/files/accounting_for_tech_change_in_rias_-_learning_curves_lbnl.pdf).

Weil McLain stated that changes to the heat distribution system in an older home can include: installing new piping and venting; lining the existing chimney; installing a more powerful circulating pump; installing a different, larger electrical service; and/or installing a condensate neutralizer to prevent damage to a cast iron drain or installing a condensate pump. Weil McLain stated that quotations from qualified contractors for the complete installation of a condensing boiler in a replacement application are generally at least 30-60 percent higher than the installation cost of a non-condensing boiler in the same application. (Weil McLain, No. 20-1 at pp. 3-4)

In response, DOE's analysis does account for venting, condensate, and electrical related costs to determine the overall installation cost for condensing boilers. According to the available data, the total installed cost, which is the sum of the installation cost and the product price, is on average 23 percent higher for condensing boilers compared to baseline products. See appendix 8D of the NOPR TSD for details on how DOE calculated the installation costs.

Crown Boiler, U.S. Boiler, and New Yorker Boiler stated that the LCC spreadsheet does not include the total cost of masonry chimneys, chimney relining, vent resizing, and orphaned water heaters (except for condensing boiler venting cost). They also suggested that DOE should consider vent system changes based on input from building inspectors and code officials. (Crown Boiler, No. 24 at p. 2; U.S. Boiler, No. 25 at p. 2; New Yorker Boiler, No. 26 at p. 2)

Gathering input from a representative sample of building inspectors and code officials was not possible in the time frame of the NOPR preparation. However, for the NOPR, DOE included disaggregated costs associated with different installation scenarios and requirements. These costs included the cost of chimney relining, vent resizing, orphaned water heaters, and condensate withdrawal. These costs can be found in appendix 8D of the NOPR TSD.

Crown Boiler, U.S. Boiler, and New Yorker Boiler stated that a 100 Mbh gas boiler would use a 5" vent, not a 4" Type B vent as shown in the LCC spreadsheet. They also stated that a 140 Mbh oil boiler would use a 6" vent and cannot use a 4" Type B vent as shown in the LCC spreadsheet. (Crown Boiler, No. 24 at p. 2; U.S. Boiler, No. 25 at p. 2; New Yorker Boiler, No. 26 at p. 2) DOE agrees that the vent size is correlated with boiler capacity. For the NOPR, DOE included a methodology that sized vent material based on the capacity of the boiler to be installed and accounted for the subsequent change in installation cost. Specifically, DOE modified the analysis to include the costs of 5" and 6" vent material where appropriate. Appendix 8D of the NOPR TSD contains more details on the installation cost methodology.

Crown Boiler, U.S. Boiler, and New Yorker Boiler stated that the National Fuel Gas Code (ANSI Z223.l/INFPA 54, 2012 Edition, paragraph 12.6.4.3) suggests EL0 gas boilers can be installed without vent modification. (Crown Boiler, No. 24 at p. 2; U.S. Boiler, No. 25 at p. 2; New Yorker Boiler, No. 26 at p. 2) DOE's LCC analysis accounts for an estimated fraction of 81 percent of boiler replacement installations that do not require vent modifications for EL 0 (baseline) for hot water gas boilers. The baseline may require chimney relining or vent resizing for boilers installed before 1995. See appendix 8D of the NOPR TSD for more details.

The Joint Commenters stated that the installation costs for condensing boilers will decline as contractors gain more experience installing condensing boilers, competition increases, and new venting systems for retrofits (including flexible polypropylene) are introduced to the market. The Joint Commenters encouraged DOE to evaluate whether polypropylene venting systems, which are designed for easy retrofit installations, would represent the lowest-cost venting option for some portion of installations. (Joint Commenters, No. 27 at pp. 2-3)

In response, DOE notes that condensing boilers already comprise more than one-third of boiler installations, so it is not clear that costs will decline due to experience and competition. DOE conducted a literature review to assess the polypropylene venting market in the U.S. For this rulemaking, DOE applied polypropylene venting as a venting option for the fraction of installations involving models or applications for which PVC piping is not recommended.

DOE also included installation adders for new construction installations related to potential amended standards. For non-condensing boilers, the only adder is a new metal flue vent (including a fraction with stainless steel venting). For condensing gas boilers, the adders include a new flue vent, combustion air venting for direct vent installations, accounting for a commonly-vented water heater, and condensate removal.

Crown Boiler, U.S. Boiler, and New Yorker Boiler stated that the only difference in residential boiler installation cost between retrofit and new construction applications in terms of placement and set-up should be the cost of removing the old boiler; trip charge, unit startup, check, and cleanup should apply equally to both types of installation. (Crown Boiler, No. 24 at p. 2; U.S. Boiler, No. 25 at p. 2; New Yorker Boiler, No. 26 at p. 2)

For the NOPR analysis, DOE assumes that boiler placement, set-up, start-up, check, trip charge, and cleanup costs are included in labor hours based on RS Means data for both new construction and replacements. The cost of removing the old boiler was only applied for replacement installations and not applied to new construction.

With regards to near-condensing boiler installations, for the NODA, DOE accounted for the installation costs of the near-condensing products by considering the additional cost of using stainless steel venting. AHRI stated that boilers with AFUE ratings in the range of 83.5 percent to 87 percent should be considered near-condensing products from an installation perspective (in terms of vent requirements). AHRI stated that DOE has underestimated the increased installation cost for vent system rework or upgrade at the 84-percent and 85-percent AFUE levels for gas-fired hot water boiler models. (AHRI, No. 22 at pp. 1-2) HTP stated that the safety and installation cost implications of operating at efficiencies between 82-percent and 90-percent AFUE should be seriously considered. (HTP, No. 31 at p. 1)

For the NOPR, DOE included additional venting cost associated with stainless steel venting for a fraction of installations between 82-percent AFUE and 86-percent AFUE that require such venting. Such inclusion addresses potential safety concerns by preventing the corrosive impacts of condensation in the venting system. Because use of an inducer or forced draft fan creates conditions under which stainless steel venting is necessary to avoid condensation in some cases, DOE based the fraction requiring stainless steel venting on the percentage of models with inducer or forced draft fans and manufacturer literature.[44] The fraction of stainless steel venting installations ranged from 11 percent for the baseline efficiency models to 32 percent for the 85-percent AFUE models. See appendix 8D of the NOPR TSD for more details.

2. Inputs to Operating Costs

The primary inputs for calculating the operating costs are product energy consumption, product efficiency, energy prices and forecasts, maintenance and repair costs, product lifetime, and discount rates. DOE uses discount rates to determine the present value of lifetime operating expenses. The discount rate used in the LCC analysis represents the rate from an individual consumer's perspective. Much of the data used for

[44] DOE did not consider any efficiency levels above 86-percent AFUE and below 90-percent AFUE.

determining consumer discount rates comes from the Federal Reserve Board's triennial Survey of Consumer Finances.[45]

a. Energy Consumption

The product energy consumption is the site energy use associated with providing space heating (and water heating in some cases) to the building. DOE utilized the methodology described in section IV.E to establish product energy use.

DOE considered whether boiler energy use would likely be impacted by a direct rebound effect, which occurs when a product that is made more efficient is used more intensively, such that the expected energy savings from the efficiency improvement may not fully materialize. For the NODA, DOE conducted a review of information that included a 2009 study examining empirical estimates of the rebound effect for various energy-using products.[46] Based on this review, DOE tentatively concluded that the inclusion of a rebound effect of 20 percent for residential boilers is warranted.

The Joint Commenters stated that a 20-percent rebound effect is too high. The Joint Commenters stated that a 2012 ACEEE paper concluded that the most widely applicable estimates of rebound rates in the studies reviewed by Sorrell (referenced above) range from 1-12 percent. The Joint Commenters stated that a similar range is

[45] Available at www.federalreserve.gov/econresdata/scf/scfindex.htm.
[46] S. Sorrell, J. D., and M. Sommerville, "Empirical estimates of the direct rebound effect: a review," Energy Policy (2009) 37: pp. 1356–71.

provided in a 2013 paper by Thomas and Azevedo which lists five space-heating studies with rebound rates ranging from 1-15 percent. (Joint Commenters, No. 27 at p. 4)

For the NOPR, DOE reviewed the 2012 ACEEE paper[47] and the article by Thomas and Azevedo.[48] Both of these publications examined the same studies that were reviewed by Sorrell, as well as by Greening *et al*,[49] and identified methodological problems with some of the studies. The studies believed to be most reliable by Thomas and Azevedo show a direct rebound effect for heating products in the 1-percent to 15-percent range, while Nadel concludes that a more likely range is 1 to 12 percent, with rebound effects sometimes higher than this range for low-income households who could not afford to adequately heat their homes prior to weatherization. These assessments are described in further detail in chapter 10 of the NOPR TSD. Based on DOE's review of these recent assessments, DOE reduced the rebound effect for residential boilers to 15 percent for the NOPR. Although a lower value might be warranted, DOE prefers to be conservative and not risk understating the rebound effect.

AHRI recommended that the LCC and PBP analysis should incorporate the energy savings reduction attributable to the rebound effect. AHRI stated that the TSD does not provide information to explain what the increase in the consumer's utility is that offsets the 20-percent rebound effect identified in the analysis. Additionally, AHRI

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[47] Steven Nadel, "The Rebound Effect: Large or Small?" ACEEE White Paper (August 2012) (Available at: http://www.aceee.org/white-paper/rebound-effect-large-or-small).

[48] Brinda Thomas and Ines Azevedo, "Estimating direct and indirect rebound effects for U.S. households with input–output analysis Part 1: Theoretical framework," Ecological Economics Vol. 86, pp. 199-201 (Feb. 2013) (Available at: http://www.sciencedirect.com/science/article/pii/S0921800912004764).

[49] Greening, L.A., Greene, D.L., Difiglio, C., Energy efficiency and consumption-the rebound effect—a survey, (2002) Energy Policy 28(6–7), 389–401.

stated that the consumer's utility is not a quantifiable, monetary value, and it does not affect the cost of operation of the boiler. (AHRI, No. 22 at p. 5)

In response, the most likely reason for a direct rebound effect associated with higher-efficiency boilers is that the consumer would maintain a higher indoor temperature than before, or extend the heating season for longer periods. It is reasonable to presume that such a consumer receives greater indoor comfort than before. The increased comfort has a cost that is equal to the monetary value of the higher energy use. DOE could reduce the energy cost savings to account for the rebound effect, but then it would have to add the value of increased comfort in order to conduct a proper economic analysis. The approach that DOE uses – not reducing the energy cost savings to account for the rebound effect and not adding the value of increased comfort – assumes that the value of increased comfort is equal to the monetary value of the higher energy use. Although DOE cannot measure the actual value to the consumers of increased comfort, the monetary value of the higher energy use represents a lower bound for this quantity.

b. Energy Prices

Using the most current data from the Energy Information Administration[50,51,52] (described in chapter 8 of the NOPR TSD), DOE assigned an appropriate energy price to each household or commercial building in the sample, depending on its location. For

[50] U.S. Department of Energy-Energy Information Administration, Form EIA-826 Database Monthly Electric Utility Sales and Revenue Data (2013) (Available at: http://www.eia.doe.gov/cneaf/electricity/page/eia826.html).
[51] U.S. Department of Energy-Energy Information Administration, Natural Gas Navigator (2013) (Available at: http://tonto.eia.doe.gov/dnav/ng/ng_pri_sum_dcu_nus_m.htm).
[52] U.S. Department of Energy-Energy Information Administration, 2012 State Energy Consumption, Price, and Expenditure Estimates (SEDS) (2013) (Available at: http://www.eia.doe.gov/emeu/states/_seds.html).

future prices, DOE used the projected annual changes in average residential and commercial natural gas, LPG, electricity, and fuel oil prices in the Reference case projection in AEO 2013.[53]

AGA and APGA contended that the Department should use a marginal price analysis, which reflects the incremental gas costs most closely associated with changes in the amount of gas consumed by appliances of different efficiencies, when evaluating the impact of natural gas prices on the life-cycle-cost savings associated with standards. (AGA, APGA, No. 21 at p. 5) In response, in the analyses performed for the NODA and for the NOPR, average electricity and natural gas prices from the EIA data were adjusted using seasonal marginal price factors to derive monthly marginal electricity and natural gas prices. For a detailed discussion of the development of marginal energy price factors, see appendix 8C of the NOPR TSD.

c. Maintenance and Repair Costs

The maintenance cost is the routine annual cost to the consumer of general maintenance for product operation. The frequency with which the maintenance occurs was derived from a consumer survey[54] that provided the frequency with which owners of different types of boilers perform maintenance. For oil-fired boilers, the high quantity of sulfur in the fuel in States without regulation of sulfur content results in frequent cleaning of the heat exchanger, which DOE included in its analysis.

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[53] DOE plans to use AEO 2014 when it becomes available.
[54] Decision Analysts, *2008 American Home Comfort Study: Online Database Tool* (2009) (Available at: <http://www.decisionanalyst.com/Syndicated/HomeComfort.dai>).

The repair cost is the cost to the consumer for replacing or repairing components in the boiler that have failed. DOE estimated repair costs at each considered efficiency level using a variety of sources, including 2013 RS Means Facility Repair and Maintenance Data, [55] manufacturer literature, and information from expert consultants.

Weil McLain, Crown Boiler, U.S. Boiler, and New Yorker Boiler stated that condensing boilers generally cost more to maintain and repair than non-condensing boilers because condensing boilers have more complex and costly component parts that need more frequent service, adjustment, and repair. (Weil McLain, No. 20-1 at p. 3; Crown Boiler, No. 24 at p. 2; U.S. Boiler, No. 25 at p. 2; New Yorker Boiler, No. 26 at p. 2) In response, DOE's analysis does account for additional maintenance and repair costs for condensing boilers. Maintenance costs include checking the condensate withdrawal system, replacing the neutralizer filter, and flushing the secondary heat exchanger for condensing oil boilers in high-sulfur oil-fuel regions. In addition, higher repair costs for ignition, controls, gas valve, and inducer fan are included. For more details on DOE's methodology for calculating maintenance and repair costs, see appendix 8E of the NOPR TSD.

[55] RS Means Company Inc., RS Means Facilities Maintenance & Repair Cost Data (2013) (Available at http://www.rsmeans.com/).

d. Product Lifetime

Product lifetime is the age at which an appliance is retired from service. DOE conducted an analysis of boiler lifetimes using a combination of historical boiler shipments (see section IV.G), American Housing Survey data on historical stock of boilers,[56] and RECS data[57] on the age of the boilers in homes. The data allowed DOE to develop a Weibull lifetime distribution function, which results in a lifetime ranging from 2 to 55 years. The resulting average and median lifetimes for the NOPR analysis are 25 years for all boiler product classes. In addition, DOE reviewed a number of sources to validate the derived boiler lifetime, including research studies (from the U.S. and Europe) and field data reports (see appendix 8F of the NOPR TSD for details).

A number of commenters stated that condensing boilers generally have a shorter lifespan than non-condensing boilers. Weil McLain stated that condensing boilers generally have a shorter lifespan than non-condensing boilers because the condensing boilers are exposed to the corrosive effects of condensation, and because there are many more component parts to wear out. (Weil McLain, No. 20-1 at p. 3) Crown Boiler, U.S. Boiler, and New Yorker Boiler believe that there is a significant difference between expected lifetimes for non-condensing and condensing boilers, with the latter typically lasting less than 15 years. (Crown Boiler, No. 24 at p. 2; U.S. Boiler, No. 25 at p. 2; New Yorker Boiler, No. 26 at p. 2) Weil McLain, Crown Boiler, U.S. Boiler, and New Yorker

[56] U.S. Census Bureau: Housing and Household Economic Statistics Division, American Housing Survey, Multiple Years (1974, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1983, 1985, 1987, 1989, 1991, 1993, 1995, 1997, 1999, 2001, 2003, 2005, 2007, 2009, and 2011). (Available at: www.census.gov/programs-surveys/ahs/) (Last accessed January, 2014).
[57] U.S. Department of Energy: Energy Information Administration, Residential Energy Consumption Survey: 2009 RECS Survey Data (2013) (Available at: <http://www.eia.gov/consumption/residential/data/2009/>) (Last accessed March, 2013).

Boiler stated that manufacturers generally offer shorter warranties for condensing boilers than for non-condensing boilers, indicating that manufacturers have found that condensing boilers have a shorter life expectancy than non-condensing boilers. (Weil McLain, No. 20-1 at pp. 4; Crown Boiler, No. 24 at p. 2; U.S. Boiler, No. 25 at p. 2; New Yorker Boiler, No. 26 at p. 2) AHRI stated that the 22-year median lifetime used for all boilers in the analysis is an invalid assumption for condensing gas boilers. AHRI stated that deriving lifetimes from a combination of shipment data, boiler stock, and RECS data assumes that there is an established population of units in the field that reflect the full range of lifetimes that apply to the product. AHRI stated that this is not the case, as condensing gas hot water boilers were just beginning to be introduced 22 years ago. AHRI stated that it is not possible to conclude from field data that condensing gas boilers have a median lifetime of 22 years when the number of such units installed 22 years ago likely accounts for 1 percent or less of all residential gas boilers currently in use. (AHRI, No. 22 at p. 2)

In response, DOE notes that in developing 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 non-condensing boilers.[58] EPA also

[58] See: http://www.energystar.gov/products/specs/sites/products/files/Stakeholder%20Comment%20Response%20Summary%20Boilers%20Draft%201%20Version%203%200_0.pdf

discussed boiler life expectancy with the Department for Environment, Food & Rural Affairs (DEFRA) in the UK, 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.[59] The commenters provided no data to support their opinion regarding a lower condensing boiler lifetime vis-à-vis non-condensing boilers. Therefore, for the NOPR, DOE did not apply different lifetimes for non-condensing and condensing boilers. However, DOE did conduct a sensitivity analysis to investigate the impact of different lifetime values on consumer impacts. For more details on how DOE derived the boiler lifetime and on the lifetime sensitivity analysis, see appendix 8F of the NOPR TSD.

e. Base-Case Efficiency

To estimate the share of consumers affected by a potential energy conservation standard at a particular efficiency level, DOE's LCC and PBP analysis considers the projected distribution (i.e., market shares) of product efficiencies that consumers will purchase in the first compliance year under the base case (*i.e.*, the case without amended energy conservation standards).

For residential boilers, DOE first developed data on the current share of models in each product class that are of the different efficiencies based on the latest AHRI

[59] 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) (Last accessed April 16, 2014).

certification directory.[60] To estimate shares in 2020, DOE took into account the potential impacts of the ENERGY STAR program, which is working on new performance criteria: 90-percent AFUE for gas-fired boilers and 87-percent AFUE for oil-fired boilers.[61]

For the boiler standby mode and off mode, DOE assumed that 50 percent of shipments would be at the baseline efficiency level and 50 percent would be at the max-tech efficiency level (EL 3) for all product classes, based on characteristics of available models.[62]

No comments were received on the base-case efficiency distributions, and DOE retained the same approach for the NOPR.

G. Shipments Analysis

DOE uses forecasts of product shipments 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 historical data and an analysis of key market drivers for each product. DOE estimated boiler shipments by projecting shipments in three market segments: (1) replacements; (2) new housing; and (3) new owners in buildings that did not previously have a boiler. DOE also

[60] Air Conditioning, Heating, and Refrigeration Institute, Consumer's Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment (AHRI Directory) (September 2013) (Available at: http://www.ahridirectory.org/ahridirectory/pages/home.aspx) (Last accessed September, 2013).
[61] Energy Star, Boiler Specification Version 3.0 (Last accessed September, 2013) (Available at: https://www.energystar.gov/products/specs/boilers_specification_version_3_0_pd).
[62] Air Conditioning, Heating, and Refrigeration Institute, Consumer's Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment (AHRI Directory) (September 2013) (Available at: http://www.ahridirectory.org/ahridirectory/pages/home.aspx) (Last accessed September, 2013).

considered whether standards that require more-efficient boilers would have an impact on boiler shipments.

To project boiler replacement shipments, DOE developed retirement functions from the boiler lifetime estimates and applied them to the existing products in the housing stock. The existing stock of products is tracked by vintage and developed from historical shipments data.[63,64] The shipments analysis uses a distribution of residential boiler lifetimes to estimate boiler replacement shipments.

To project shipments to the new housing market, DOE utilized a forecast of new housing construction and historic saturation rates of various boiler product types in new housing. DOE used AEO 2013 for forecasts of new housing. Boiler saturation rates in new housing were estimated based on a weighted-average of values in 1990−2013 presented in the U.S. Census Bureau's Characteristics of New Housing.[65]

To estimate future shipments to new owners, DOE determined the fraction of residential boiler shipments that are to new owners with no previous boiler, based on a proprietary consumer survey.[66] The new owners primarily consist of households that during a major remodel add hydronic heating using a gas-fired hot water boiler and households that choose to install a boiler for a hydronic air handler to replace a gas

[63] U.S. Appliance Industry Statistical Review, *Appliance Magazine*, various years.
[64] Air-Conditioning, Heating, and Refrigeration Institute (AHRI), Confidential Shipment data for 2003-2012.
[65] Available at: http://www.census.gov/const/www/charindex.html.
[66] Decision Analysts, 2008 American Home Comfort Study: Online Database Tool (2009) (Available at: <http://www.decisionanalyst.com/Syndicated/HomeComfort.dai>).

furnace. New owners also include households switching between different boiler product classes (i.e., from the steam to hot water boiler product classes and from the oil-fired to gas-fired boiler product classes).

Commenting on the NODA, AHRI stated that DOE's estimate that 80 percent of all gas-fired hot water boiler installations are replacements may be too low. (AHRI, No. 22 at p. 4) Based on this comment, DOE reexamined the available shipments data, and for the NOPR, DOE estimated that 93 percent of gas-fired hot water boiler installations are replacements or new owners, with the remaining 7 percent installed in new homes.

To estimate the impact of the projected price increase for the considered efficiency levels, DOE used a relative price elasticity approach. This approach gives some weight to the operating cost savings from higher-efficiency products. As is typical, the impact of higher boiler prices (at higher efficiency levels) is expressed as a percentage drop in market share for each year during the analysis period.

Weil McLain stated that a typical homeowner facing the prospect of installing a condensing high-efficiency boiler at a much higher product and installation cost (plus the cost of upgrading the heat distribution system) may decide to repair an older system instead. (Weil McLain, No. 20-1 at p. 5) In response, DOE acknowledges that if the amended standard were to require purchase of a condensing boiler, some consumers would choose to repair and thereby extend the life of their existing system. Because the proposed standards would not require the use of a condensing boiler, DOE concludes that any incremental shift towards repair instead of replacement would be minimal. DOE applied a relative price elasticity in the shipments model to estimate the change in shipments under potential amended standards at different efficiency (and installed cost) levels.

AGA and APGA stated that the Department should include a fuel switching analysis as part of the process of evaluating possible amended standards for residential boilers to help ensure that when evaluating different levels of efficiency for gas-fired hot water boilers, fuel switching to other energy sources that produce higher emissions and use more overall energy is not encouraged. (AGA, APGA, No. 21 at p. 5)

For the NOPR, DOE evaluated the potential for switching from gas-fired hot water boilers to other heating systems. Incentive for such switching would only exist if the amended standards were to require efficiency for gas-fired hot water boilers that would entail a significantly higher installed cost than the other heating options. Because DOE is not proposing an amended standard that would require condensing technology, DOE has tentatively concluded that consumer switching from gas-fired hot water boilers would be rare. Even if DOE were to adopt an amended standard that would require condensing technology for gas-fired hot water boilers, it is likely that switching would be minimal for the following reasons. First, although electric boilers may have a much lower product cost, they would be expected to have far higher operating costs (especially in the Northeast). Moreover, electric boiler installation would require upgrading the electrical system in the house. Finally, switching from a hydronic heating system using a gas-fired boiler to an air-distribution heating system using a furnace would be expensive, and would likely only be done as part of a major renovation.

The details and results of the shipments analysis can be found in chapter 9 of the NOPR TSD.

H. National Impact Analysis

The NIA assesses the national energy savings (NES) and the net present value (NPV) from a national perspective of total consumer costs and savings expected to result from new or amended energy conservation standards at specific efficiency levels. DOE determined the NPV and NES for the potential standard levels considered for the residential boiler product classes analyzed.

To make the analysis more accessible and transparent to all interested parties, DOE used a computer spreadsheet model (as opposed to probability distributions) to calculate the energy savings and the national consumer costs and savings at each TSL.[67] The NIA calculations are based on the annual energy consumption and total installed cost data from the energy use analysis and the LCC analysis. To assess the effect of input uncertainty on NES and NPV results, DOE developed its spreadsheet model to conduct sensitivity analyses by running scenarios on specific input variables. In the NIA, DOE forecasted the lifetime energy savings, energy cost savings, product costs, and NPV of

[67] DOE's use of spreadsheet models provides interested parties with access to the models within a familiar context. In addition, the TSD and other documentation that DOE provides during the rulemaking help explain the models and how to use them, and interested parties can review DOE's analyses by changing various input quantities within the spreadsheet.

consumer benefits for each product class over the lifetime of products sold from 2020 through 2049.

To develop the NES, DOE calculates annual energy consumption for the base case and the standards cases. DOE calculates the annual energy consumption using per-unit annual energy use data multiplied by projected shipments. As explained in section IV.E, DOE incorporated a rebound effect for residential boilers, which is implemented by reducing the NES in each year.

To develop the national NPV of consumer benefits from potential energy conservation standards, DOE calculates annual energy expenditures and annual product expenditures for the base case and the standards cases. DOE calculates annual energy expenditures from annual energy consumption by incorporating forecasted energy prices, using shipment projections and average energy efficiency projections. DOE calculates annual product expenditures by multiplying the price per unit times the projected shipments. The aggregate difference each year between energy bill savings and increased product expenditures is the net savings or net costs. As discussed in section IV.F, DOE chose to not apply a trend to the manufacturer selling price (in real dollars) of residential boilers. For the NIA, DOE developed a sensitivity analysis that considered one scenario with a lower rate of price decline than the reference case and one scenario with a higher rate of price decline than the reference case. These scenarios are described in appendix 10C of the NOPR TSD.

A key component of the NIA is the energy efficiency forecasted over time for the base case (without new standards) and each of the standards cases. As discussed in section IV.F, DOE developed a distribution of efficiencies in the base case for 2020 (the year of anticipated compliance with an amended standard) for each residential boiler product class. Regarding the efficiency trend in the years after compliance, for the base case, DOE estimated that the overall market share of condensing gas-fired hot water boilers would grow from 44 percent to 63 percent by 2049, and the overall market share of condensing oil-fired hot water boilers would grow from 7 percent to 13 percent. DOE estimated that the base-case market shares of condensing gas-fired and oil-fired steam boilers will be negligible during the period of analysis. DOE assumed similar trends for the standards cases (albeit starting from a higher point). Details on how these efficiency trends were developed are provided in appendix 8H of the NOPR TSD.

To estimate the impact that amended energy conservation standards may have in the year compliance becomes required, DOE uses "roll-up" or "shift" scenarios in its standards rulemakings. Under the "roll-up" scenario, DOE assumes: (1) product efficiencies in the base case that do not meet the new or amended standard level under consideration would "roll up" to meet that standard level; and (2) products at efficiencies above the standard level under consideration would not be affected. Under the "shift" scenario, DOE retains the pattern of the base-case efficiency distribution but re-orients the distribution at and above the new or amended minimum energy conservation standard. Because there is no reason to expect a shift, DOE used the “roll-up” scenario for the standards cases.

1. National Energy Savings Analysis

The national energy savings analysis involves a comparison of national energy consumption of the considered products in each potential standards case (TSL) with consumption in the base case with no new or amended energy conservation standards. DOE calculated the national energy consumption by multiplying the number of units (stock) of each product (by vintage or age) by the unit energy consumption (also by vintage). Vintage represents the age of the product. DOE calculated annual NES based on the difference in national energy consumption for the base case (without amended efficiency standards) and for each higher efficiency standard. DOE estimated energy consumption and savings based on site energy and converted the electricity consumption and savings to primary energy using annual conversion factors derived from the AEO 2013 version of NEMS. Cumulative energy savings are the sum of the NES for each year over the timeframe of the analysis.

a. Full-Fuel-Cycle Energy Savings

DOE has historically presented NES in terms of primary energy savings. In the case of electricity use and savings, this quantity includes the energy consumed by power plants to generate delivered (site) electricity.

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). After evaluating the approaches discussed in the August 18, 2011 notice, DOE published a statement of amended policy in the Federal Register in which DOE explained its determination that NEMS is the most appropriate tool for its FFC analysis and its intention to use NEMS for that purpose. 77 FR 49701 (August 17, 2012).

AGA and APGA stated that it is not clear if the NEMS-based methodology provides the most complete and accurate methodology for incorporating the full-fuel-cycle analysis in energy conservation standards because all the assumptions used in the program are not fully disclosed. AGA and APGA urged the Department to hold a public workshop to provide all stakeholders the opportunity to review and discuss the assumptions and analyses included in the model, and to make the model publically available for anyone who wishes to run the analysis. (AGA, APGA, No. 21 at p. 4)

In response, DOE notes that its Notice of Policy Amendment Regarding Full-Fuel-Cycle Analyses explains in some detail the reasoning for DOE's determination that NEMS is the most appropriate tool to calculate FFC measures of energy use and greenhouse gas and other emissions. 77 FR 49701 (August 17, 2012). The method and assumptions used to develop the FFC analysis are described in appendix 10B of the NOPR TSD, and are discussed in detail in the report referenced in that appendix. DOE does not have a separate FFC model, as it utilizes NEMS to derive multipliers that allow estimation of the FFC impacts of the energy savings identified for a given product. The methods and assumptions used in NEMS are fully described in the documentation provided by EIA.[68] DOE has used the FFC measures in several recent rulemakings, thereby providing interested parties with opportunities to review the approach and the associated documentation. Furthermore, the August 17, 2012 notice stated that the public is free to send in comments on this policy amendment at any time. 77 FR 49701, 49702 (August 17, 2012).

In the case of natural gas, the FFC measure includes losses in transmission and distribution, as well as energy use and losses (including methane leakage) in natural gas production.

AHRI stated that the FFC NES values do not seem to reflect the greater FFC consumption of electricity because the primary and FFC energy savings in standby mode, which only uses electricity, are nearly the same. (AHRI, No. 22 at p. 5) In response, the primary energy savings for site use of electricity include the primary energy consumption by the electric generation sector. The FFC measure adds in energy that is used "upstream" in the production and transport of the primary fuels. This quantity, expressed as a percentage of the primary energy consumption, is relatively small. Hence, the FFC energy savings are only slightly larger than the primary energy savings.

[68] See http://www.eia.gov/oiaf/aeo/overview/.

2. Net Present Value Analysis

The inputs for determining NPV are: (1) total annual installed cost; (2) total annual savings in operating costs; (3) a discount factor to calculate the present value of costs and savings; (4) present value of costs; and (5) present value of savings. DOE calculated net savings each year as the difference between the base case and each standards case in terms of total savings in operating costs versus total increases in installed costs. DOE calculated savings over the lifetime of products shipped in the forecast period. DOE calculated NPV as the difference between the present value of operating cost savings and the present value of total installed costs. DOE used a discount factor based on real discount rates of 3 percent and 7 percent to discount future costs and savings to present values.

For the NPV analysis, DOE calculates increases in total installed costs as the difference in total installed cost between the base case and standards case (i.e., once the new or amended standards take effect).

DOE expresses savings in operating costs as decreases associated with the lower energy consumption of products bought in the standards case compared to the base efficiency case. Total savings in operating costs are the product of savings per unit and the number of units of each vintage that survive in a given year.

a. Discount Rates for Net Present Value

DOE estimates the NPV of consumer benefits using both a 3-percent and a 7-percent real discount rate. DOE uses these discount rates in accordance with guidance provided by the Office of Management and Budget (OMB) to Federal agencies on the development of regulatory analysis.[69]

The Joint Commenters stated that in recent rulemakings for other products, it appears that DOE has placed significant emphasis on NPV at a 7-percent discount rate. They stated that DOE must consider NPV at both 3 percent and 7 percent as directed in OMB guidance, and it should weigh the NPV at a 3-percent discount rate more heavily. As noted in the Joint Comment, NRDC has explained why a 3-percent discount rate is more appropriate to use when considering national economic benefits in comments on previous rulemakings. NRDC stated in a previous comment that investments in energy efficiency reduce overall societal risk, and that the average rate of return on all investments is far below 7 percent.[70] (Joint Commenters, No. 27 at pp. 3-4)

OMB Circular A-4 states that the 7-percent discount rate is an estimate of the average before-tax rate of return to private capital in the U.S. economy. It approximates the opportunity cost of capital, and it is the appropriate discount rate whenever the main effect of a regulation is to displace or alter the use of capital in the private sector. Circular A-4 also states that when regulation primarily and directly affects private

[69] OMB Circular A-4 (Sept. 17, 2003), section E, "Identifying and Measuring Benefits and Costs."
[70] See comment submitted by NRDC to docket EE-RM/STD-01-350 on January 15, 2007, Comment 131, pp. 16-17.

consumption, a lower discount rate is appropriate. The alternative most often used is sometimes called the "social rate of time preference," which means the rate at which "society" discounts future consumption flows to their present value. If one takes the rate that the average saver uses to discount future consumption as a measure of the social rate of time preference, then the real rate of return on long-term government debt may provide a fair approximation. Over the last thirty years, this rate has averaged around 3 percent in real terms on a pre-tax basis. Energy conservation standards for appliances and equipment affect both the use of capital and private consumption. Accordingly, DOE believes that it would be inappropriate to weight the NPV at either discount rate more heavily than the other.

I. Consumer Subgroup Analysis

In the NOPR stage of a rulemaking, DOE conducts a consumer subgroup analysis. A consumer subgroup comprises a subset of the population that may be affected disproportionately by new or revised energy conservation standards (*e.g.*, low-income consumers, seniors). The purpose of a subgroup analysis is to determine the extent of any such disproportional impacts.

For today's NOPR, DOE evaluated impacts of potential standards on two subgroups: (1) senior-only households and (2) low-income households. DOE identified these households in the RECS sample and used the LCC and PBP spreadsheet model to estimate the impacts of the considered efficiency levels on these subgroups. To the extent possible, it utilized inputs appropriate for these subgroups. The consumer subgroup results for the residential boilers TSLs are presented in section V.B.1.b of this notice and chapter 11 of the NOPR TSD.

J. Manufacturer Impact Analysis

1. Overview

DOE performed an MIA to determine the financial impact of amended energy conservation standards on manufacturers of residential 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 base case and various TSLs (the standards case). The difference in INPV between the base case and standards cases represents the financial impact of amended energy conservation standards on residential boiler 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 sub-group 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 the first phase 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,[71] corporate annual reports, the U.S. Census Bureau's Economic Census,[72] and Hoover's reports[73] to conduct this analysis.

In the second phase 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

[71] U.S. Securities and Exchange Commission, Annual 10-K Reports (Various Years) (Available at: http://www.sec.gov/edgar/searchedgar/companysearch.html).
[72] U.S. Census Bureau, Annual Survey of Manufacturers: General Statistics: Statistics for Industry Groups and Industries (2011) (Available at: http://factfinder2.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t).
[73] Hoovers Inc. Company Profiles, Various Companies (Available at: http://www.hoovers.com).

standard levels using industry financial parameters derived in the first phase and the shipment scenario used in the NIA. The GRIM modeled both impacts from the AFUE energy conservation standards and impacts from standby mode and off mode energy conservation standards (*i.e.,* standards based on standby mode and off mode wattage). The GRIM results from the two standards were evaluated independent of one another.

In the third phase of the MIA, DOE conducted structured, detailed interviews with a variety of manufacturers that represent approximately 46 percent of domestic residential boiler sales 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 the third phase, 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 at least 13 residential boiler companies that qualify as small businesses. The residential boiler small manufacturer subgroup is discussed in section VI.B of this notice and in chapter 12 of the NOPR TSD.

2. Government Regulatory Impact Model

DOE uses the GRIM to quantify the potential changes in cash flow due to amended standards that result in a higher or lower industry value. The GRIM was designed to conduct an annual cash-flow analysis using standard accounting principles that incorporates manufacturer costs, markups, shipments, and industry financial information as inputs. DOE thereby calculated a series of annual cash flows, beginning in 2014 (the base year of the analysis) and continuing to 2049. DOE summed the stream of annual discounted cash flows during this period to calculate INPVs at each TSL. For residential boiler manufacturers, DOE used a real discount rate of 8.0 percent, which was derived from industry financial information 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 base case and each standards case. The difference in INPV between the base case and a standards case represents the financial impact of the amended energy conservation standard on manufacturers at a particular TSL. As discussed previously, DOE collected this information on GRIM inputs from a number of sources, including publicly-available data and confidential interviews with a number of manufacturers. GRIM inputs are discussed in more detail in the next section. The GRIM results are discussed in section V.B.2. Additional details about the GRIM, the discount rate, and other financial parameters can be found in chapter 12 of the NOPR TSD.

For consideration of standby mode and off mode regulations, DOE modeled the impacts of the technology options for reducing electricity usage discussed in the engineering analysis (chapter 5 of the TSD). The GRIM analysis incorporates the incremental additions to the MPC of standby mode and off mode features and the resulting impacts on markups.

Due to the small cost of standby mode and off mode components relative to the overall cost of a residential boiler, DOE assumes that standards regarding standby mode and off mode features alone would not impact product shipment numbers. Additionally, DOE has tentatively concluded that the incremental cost of standby mode and off mode features would not have a differentiated impact on manufacturers of different product classes. Consequently, DOE models the impact of standby mode and off mode for the industry as a whole.

The electric boiler product classes were not analyzed in the GRIM for AFUE energy conservation standards. As a result, quantitative numbers for those product classes are not available in the GRIM analyzing standby mode and off mode standards. However, the standby mode and off mode technology options considered for electric boilers are identical to the technology options for all other residential boiler product classes. As a result, DOE expects the standby mode and off mode impacts on electric boilers to be of the same order of magnitude as the impacts on all other residential boiler product classes.

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 MPCs 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 calculated 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 calculate the MPCs for products at and above the baseline, DOE performed teardowns and cost modeling that allowed DOE to estimate the incremental material, labor, and overhead costs for products above the baseline. 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 2014 (the base year) to 2049 (the end year of the analysis period). The shipments model divides the shipments of residential 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 base 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 base case that does not meet the standard under consideration would “roll up” to meet the amended standard beginning in the compliance year of 2020. See section IV.G and chapter 9 of the NOPR TSD for additional details.

Product and Capital Conversion Costs

Amended energy conservation standards would cause manufacturers to incur one-time conversion costs to bring their production facilities and 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 manufacturer feedback, DOE developed a market-share-weighted manufacturer average capital expenditure which it then applied to the entire industry. DOE also made assumptions about which manufacturers would develop their own condensing heat exchanger production lines, in the event that efficiency levels using condensing technology were proposed. DOE supplemented manufacturer comments and tailored its analyses with estimates of capital expenditure requirements derived from the product teardown analysis and 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) and validated those numbers against engineering estimates of redesign efforts. 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 were 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.a of this notice. For additional information on the estimated product and capital conversion costs, see chapter 12 of the NOPR TSD.

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 residential 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 all product classes. This markup scenario represents the upper bound of the residential boiler 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 residential boiler 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 base 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 base case. Therefore, operating margin in percentage terms is reduced between the base 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 base 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 residential boiler standards, as they are able to do in the preservation of gross margin percentage markup scenario.

3. Manufacturer Interviews

DOE interviewed manufacturers representing approximately 55 percent of the residential boiler 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 residential boilers 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 residential boiler industry. The information gathered during these interviews enabled DOE to tailor the GRIM to reflect the unique financial characteristics of the residential boiler 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 residential 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 of 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. (DOE also considered all other concerns expressed by manufacturers in this analysis.) Below, DOE summarizes these issues, which were raised in manufacturer interviews, in order to obtain public comment and related data.

Diminished Ability to Serve the Replacement Market

In interviews, several manufacturers pointed out that over 90 percent of residential boiler sales are transacted in the replacement channel, rather than the new construction channel. They stated that the current residential boiler market is structured around the legacy venting infrastructures that exist in the vast majority of homes and that any regulation that eliminated 82 to 83-percent efficient products would be very disruptive to the market. Manufacturers argued that under this scenario, consumers would face much higher installation costs, as well as complex challenges in changing the layout of the boiler room and upgrading their venting and heat distribution systems. Manufacturers argued that these considerations may induce consumers to explore other HVAC options and may cause them to leave the boiler market entirely. Manufacturers also asserted that the elimination of 82 to 83-percent efficient products could be disruptive to the market because several manufacturers would have to eliminate commodity products that generate a majority of their sales and be forced to sell products for which they are less vertically integrated, which may cause them to exit the market entirely. Some manufacturers speculated that if this scenario were to play out, it could result in the loss of a substantial number of American manufacturing jobs.

Accordingly, DOE has considered this feedback when developing its analysis of installation costs (see section IV.F.1), shipments analysis (see section IV.G), and employment impacts analysis (see section (V.B.2.b).

Condensing Boilers May Not Perform As Rated Without System Improvements

Several manufacturers argued out that condensing boilers may have overstated efficiencies in terms of actual results in the field if they are installed as replacements in legacy distribution systems that were designed to maintain hot water supply temperatures of 180-200°F. Manufacturers stated that in these systems, return water temperatures will often be too high for condensing boilers to operate in condensing mode, thereby causing the boiler to be less efficient than its express rating. Manufacturers also stated that because condensing boilers are designed for lower maximum supply water temperatures, the heat distribution output of the heating system as a whole is often reduced, and the boiler may not be able to meet heat distribution requirements. This may require the implementation of additional heat distribution equipment within a particular system. Some manufacturers pointed out that reducing the supply water temperature also reduces the radiation component of some heat distribution units, which is essential for comfort and allows consumers to maintain a lower thermostat setting. Reducing the radiation component may require a higher thermostat setting to maintain comfort, thereby reducing overall system efficiency.

DOE recognizes this issue and considered it in the energy use analysis for residential boilers. See chapter 7 of the NOPR TSD for additional details.

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.

DOE considered these comments when developing its estimates of repair and maintenance costs for residential boilers (see section IV.F.2.c) and product lifetime (IV.F.2.d).

K. Emissions Analysis

In the emissions analysis, DOE estimated the reduction in power sector emissions of carbon dioxide (CO_2), nitrogen oxides (NO_X), sulfur dioxide (SO_2), and mercury (Hg) from potential amended energy conservation standards for residential boilers. In addition to estimating impacts of standards on power sector emissions, DOE estimated emissions impacts in production activities (extracting, processing, and transporting fuels) that provide the energy inputs to power plants. These are referred to as "upstream" emissions. Together, these emissions account for the full-fuel-cycle (FFC). In accordance with DOE's FFC Statement of Policy (76 FR 51281 (Aug. 18, 2011) as amended at 77 FR 49701 (August 17, 2012)), the FFC analysis also includes impacts on emissions of methane (CH_4) and nitrous oxide (N_2O), both of which are recognized as greenhouse gases. The combustion emissions factors and the method that DOE used to derive upstream emissions factors are described in chapter 13 of the NOPR TSD. The cumulative emissions reduction estimated for residential boilers is presented in section V.B.6.

Today's proposed standards would reduce use of fuel at the site and slightly reduce electricity use, thereby reducing power sector emissions. However, the highest efficiency levels (i.e., the max-tech levels) considered for residential boilers would increase the use of electricity by the furnace. For the considered TSLs, DOE estimated the change in power sector and upstream emissions of CO_2, NO_X, SO_2, and Hg.[74]

DOE primarily conducted the emissions analysis using emissions factors for CO_2 and most of the other gases derived from data in AEO 2013. Combustion emissions of CH_4 and N_2O were estimated using emissions intensity factors published by the

[74] Note that in these cases, the reduction in site emissions of CO_2, NO_X, and SO_2 is larger than the increase in power sector emissions.

Environmental Protection Agency (EPA) in its GHG Emissions Factors Hub.[75] Site emissions of CO_2 and NO_X were estimated using emissions intensity factors from a separate EPA publication.[76] DOE developed separate emissions factors for power sector emissions and upstream emissions. The method that DOE used to derive emissions factors is described in chapter 13 of the NOPR TSD.

For CH_4 and N_2O, DOE calculated emissions reduction in tons and also in terms of units of carbon dioxide equivalent (CO_2eq). Gases are converted to CO_2eq by multiplying each ton of the greenhouse gas by the gas's global warming potential (GWP) over a 100-year time horizon. Based on the Fifth Assessment Report of the Intergovernmental Panel on Climate Change,[77] DOE used GWP values of 28 for CH_4 and 265 for N_2O.

EIA prepares the Annual Energy Outlook using the National Energy Modeling System (NEMS). Each annual version of NEMS incorporates the projected impacts of existing air quality regulations on emissions. AEO 2013 generally represents current legislation and environmental regulations, including recent government actions, for which implementing regulations were available as of December 31, 2012.

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[75] See http://www.epa.gov/climateleadership/inventory/ghg-emissions.html.

[76] 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).

[77] IPCC, 2013: 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 (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Chapter 8.

Because the on-site operation of residential 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.

SO_2 emissions from affected electric generating units (EGUs) are subject to nationwide and regional emissions cap-and-trade programs. Title IV of the Clean Air Act sets an annual emissions cap on SO_2 for affected EGUs in the 48 contiguous States and the District of Columbia (D.C.). (42 U.S.C. 7651 et seq.) SO_2 emissions from 28 eastern States and D.C. were also limited under the Clean Air Interstate Rule (CAIR; 70 FR 25162 (May 12, 2005)), which created an allowance-based trading program that operates along with the Title IV program. CAIR was remanded to the U.S. Environmental Protection Agency (EPA) by the U.S. Court of Appeals for the District of Columbia Circuit, but it remained in effect.[78] In 2011, EPA issued a replacement for CAIR, the Cross-State Air Pollution Rule (CSAPR). 76 FR 48208 (August 8, 2011). On August 21, 2012, the D.C. Circuit issued a decision to vacate CSAPR.[79] The court ordered EPA to continue administering CAIR. The emissions factors used for today's NOPR, which are based on AEO 2013, assume that CAIR remains a binding regulation through 2040.[80]

[78] 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).
[79] 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).
[80] On April 29, 2014, the U.S. Supreme Court reversed the judgment of the D.C. Circuit and remanded the case for further proceedings consistent with the Supreme Court's opinion. 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. See EPA v. EME Homer City Generation, No 12-1182, slip op. at 32 (U.S. April 29, 2014). Because DOE is using emissions factors

The attainment of emissions caps is typically flexible among EGUs and is enforced through the use of emissions allowances and tradable permits. Beginning in 2016, however, SO_2 emissions will decline significantly as a result of the Mercury and Air Toxics Standards (MATS) for power plants. 77 FR 9304 (Feb. 16, 2012). In the final MATS rule, EPA established a standard for hydrogen chloride as a surrogate for acid gas hazardous air pollutants (HAP), and also established a standard for SO_2 (a non-HAP acid gas) as an alternative equivalent surrogate standard for acid gas HAP. The same controls are used to reduce HAP and non-HAP acid gas; thus, SO_2 emissions will be reduced as a result of the control technologies installed on coal-fired power plants to comply with the MATS requirements for acid gas. AEO 2013 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 likely that the increase in electricity demand associated with the highest residential boiler efficiency levels would increase SO_2 emissions.

CAIR established a cap on NO_X emissions in 28 eastern States and the District of Columbia.[81] Thus, it is unlikely that the increase in electricity demand associated with the highest residential boiler efficiency levels would increase NO_X emissions in those

based on AEO 2013 for today's NOPR, the NOPR assumes that CAIR, not CSAPR, is the regulation in force. The difference between CAIR and CSAPR is not relevant for the purpose of DOE's analysis of SO_2 emissions.

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

States covered by CAIR. However, these levels would be expected to increase NO_X emissions in the States not affected by the caps, so DOE estimated NO_X emissions increases for these States.

The MATS limit mercury emissions from power plants, but they do not include emissions caps and, as such, the increase in electricity demand associated with the highest residential boiler efficiency levels would be expected to increase Hg emissions. DOE estimated mercury emissions using emissions factors based on AEO 2013, which incorporates the MATS.

L. Monetizing Carbon Dioxide and Other Emissions Impacts

As part of the development of this proposed rule, DOE considered the estimated monetary benefits from the reduced emissions of CO_2 and NO_X that are expected to result from each of the TSLs considered. In order to make this calculation similar to the calculation of the NPV of consumer benefit, DOE considered the reduced emissions expected to result over the lifetime of 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 rulemaking.

For today's NOPR, DOE is relying on a set of values for the social cost of carbon (SCC) that was developed by a Federal interagency process. A summary of the basis for these values is provided below, and a more detailed description of the methodologies used is provided as an appendix to chapter 14 of the NOPR TSD.

1. Social Cost of Carbon

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

Under section 1(b)(6) of Executive Order 12866, "Regulatory Planning and Review," 58 FR 51735 (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 carbon dioxide emissions, the analyst faces a number of challenges. A recent report from the National Research Council[82] points out that any assessment will suffer from uncertainty, speculation, and lack of information about: (1) future emissions of greenhouse gases; (2) the effects of past and future emissions on the climate system; (3) the impact of changes in climate on the physical and biological environment; and (4) the translation of these environmental impacts into economic damages. As a result, any effort to quantify and monetize the harms associated with climate change will raise questions of science, economics, and ethics and should be viewed as provisional.

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

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

each of these future benefits by an appropriate discount factor and summing across all affected years.

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

b. Development of Social Cost of Carbon Values

In 2009, an interagency process was initiated to offer a preliminary assessment of how best to quantify the benefits from reducing carbon dioxide 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 Approach 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 were used in the last assessment of the Intergovernmental Panel on Climate Change (IPCC). Each model was given equal weight in the SCC values that were developed.

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

In 2010, the interagency group selected four sets of SCC values for use in regulatory analyses. Three sets of values are based on the average SCC from three integrated assessment models, at discount rates of 2.5 percent, 3 percent, and 5 percent. The fourth set, which represents the 95th-percentile SCC estimate across all three models at a 3-percent discount rate, is included to represent higher-than-expected impacts from climate change further out in the tails of the SCC distribution. The values grow in real terms over time. Additionally, the interagency group determined that a range of values from 7 percent to 23 percent should be used to adjust the global SCC to calculate domestic effects, although preference is given to consideration of the global benefits of reducing CO_2 emissions.[83] Table IV.24 presents the values in the 2010 interagency group report,[84] which is reproduced in appendix 14A of the NOPR TSD.

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

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

Table IV.24. Annual SCC Values from 2010 Interagency Report, 2010–2050 (in 2007 dollars per metric ton CO_2)

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

The SCC values used for today's notice were generated using the most recent versions of the three integrated assessment models that have been published in the peer-reviewed literature. Table IV.25 shows the updated sets of SCC estimates from the 2013 interagency update[85] in five-year increments from 2010 to 2050. Appendix 14B of the NOPR TSD provides the full set of values. The central value that emerges is the average SCC across models at a 3-percent discount rate. However, for purposes of capturing the uncertainties involved in regulatory impact analysis, the interagency group emphasizes the importance of including all four sets of SCC values.

Table IV.25. Annual SCC Values from 2013 Interagency Update, 2010–2050 (in 2007 dollars per metric ton CO_2)

[85] 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 November 2013) (Available at: http://www.whitehouse.gov/sites/default/files/omb/assets/inforeg/technical-update-social-cost-of-carbon-for-regulator-impact-analysis.pdf).

Year	Discount Rate			
	5%	**3%**	**2.5%**	**3%**
	Average	**Average**	**Average**	**95th Percentile**
2010	11	32	51	89
2015	11	37	57	109
2020	12	43	64	128
2025	14	47	69	143
2030	16	52	75	159
2035	19	56	80	175
2040	21	61	86	191
2045	24	66	92	206
2050	26	71	97	220

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 analytical challenges that are being addressed by the research community, including research programs housed in many of the Federal agencies participating in the interagency process to estimate the SCC. The interagency group intends to periodically review and reconsider those estimates to reflect increasing knowledge of the science and economics of climate impacts, as well as improvements in modeling.

In summary, in considering the potential global benefits resulting from reduced CO_2 emissions, DOE used the values from the 2013 interagency report, adjusted to 2013$

using the Gross Domestic Product price deflator. For each of the four SCC cases specified, the values used for emissions in 2015 were $12.0, $40.5, $62.4, and $119 per metric ton avoided (values expressed in 2013$). 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. Valuation of Other Emissions Reductions

As noted above, DOE has taken into account how amended energy conservation standards would reduce site NO_X emissions nationwide and increase power sector NO_X emissions in those 22 States not affected by the CAIR. DOE estimated the monetized value of net NO_X emissions reductions resulting from each of the TSLs considered for today's NOPR based on estimates found in the relevant scientific literature. Estimates of monetary value for reducing NO_X from stationary sources range from $476 to $4,893 per ton in 2013$.[86] DOE calculated monetary benefits using a medium value for NO_X emissions of $2,684 per short ton (in 2013$), and real discount rates of 3 percent and 7 percent.

[86] U.S. Office of Management and Budget, Office of Information and Regulatory Affairs, 2006 Report to Congress on the Costs and Benefits of Federal Regulations and Unfunded Mandates on State, Local, and Tribal Entities (2006) (Available at: http://www.whitehouse.gov/sites/default/files/omb/assets/omb/inforeg/2006_cb/2006_cb_final_report.pdf).

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 power generation industry that would result from the adoption of new or amended energy conservation standards. In the utility impact analysis, DOE analyzes the changes in installed electrical capacity and generation that would result for each trial standard level. The utility impact analysis uses a variant of NEMS,[87] which is a public domain, multi-sectored, partial equilibrium model of the U.S. energy sector. DOE uses a variant of this model, referred to as NEMS-BT,[88] to account for selected utility impacts of new or amended energy conservation standards. DOE's analysis consists of a comparison between model results for the most recent AEO Reference Case and for cases in which energy use is decremented to reflect the impact of potential standards. The energy savings inputs associated with each TSL come from the NIA. Chapter 15 of the NOPR TSD describes the utility impact analysis in further detail.

[87] For more information on NEMS, refer to the U.S. Department of Energy, Energy Information Administration documentation. A useful summary is *National Energy Modeling System: An Overview 2003*, DOE/EIA-0581(2003) (March 2003).
[88] DOE/EIA approves use of the name NEMS to describe only an official version of the model without any modification to code or data. Because this analysis entails some minor code modifications and the model is run under various policy scenarios that are variations on DOE/EIA assumptions, DOE refers to it by the name "NEMS-BT" ("BT" is DOE's Building Technologies Program, under whose aegis this work has been performed).

N. Employment Impact Analysis

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

One method for assessing the possible effects on the demand for labor of such shifts in economic activity is to compare sector employment statistics developed by the Labor Department's Bureau of Labor Statistics (BLS). BLS regularly publishes its estimates of the number of jobs per million dollars of economic activity in different sectors of the economy, as well as the jobs created elsewhere in the economy by this same economic activity. Data from BLS indicate that expenditures in the utility sector generally create fewer jobs (both directly and indirectly) than expenditures in other sectors of the economy.[89] There are many reasons for these differences, including wage differences and the fact that the utility sector is more capital-intensive and less labor-

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

intensive than other sectors. Energy conservation standards have the effect of reducing consumer utility bills. Because reduced consumer expenditures for energy likely lead to increased expenditures in other sectors of the economy, the general effect of efficiency standards is to shift economic activity from a less labor-intensive sector (i.e., the utility sector) to more labor-intensive sectors (e.g., the retail and service sectors). Thus, based on the BLS data alone, DOE believes net national employment may increase because of shifts in economic activity resulting from amended standards for residential boilers.

For the amended standard levels considered in this NOPR, 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).[90] 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-

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

estimate actual job impacts over the long run. For the NOPR, DOE used ImSET only to estimate short-term (through 2023) employment impacts.

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

<u>O.</u> <u>General Comments on Residential Boiler Standards</u>

Fire & Ice, Weil McLain, and Weil McLain *et al.* stated that amended energy conservation standards for residential boilers would not achieve significant additional conservation of energy, would not be technologically feasible, and would not be economically justified. (Fire & Ice, No. 18 at p. 1; Weil McLain, No. 20-1 at pp. 1-2; Weil McLain *et al.*, No. 20-2 at p. 1) Crown Boiler, U.S. Boiler, and New Yorker Boiler do not believe that DOE can economically justify a minimum efficiency level for gas-fired hot water boilers any higher than the current 82-percent AFUE level. (Crown Boiler, No. 24 at p. 3; U.S. Boiler, No. 25 at p. 2; New Yorker Boiler, No. 26 at p. 2) Fire & Ice and Weil McLain *et al.* stated that amending the standards would reduce the choices available to consumers that will properly operate in the field. (Fire & Ice, No. 18 at pp. 1-2; Weil McLain *et al.*, No. 20-2 at pp. 1-2) Weil McLain stated that for replacement installations where a condensing boiler would not present an economically and technologically feasible method of actually achieving greater energy conservation, the non-condensing boilers allowed under the current standards can achieve significant energy savings when older, low-efficiency boilers are replaced. (Weil McLain, No. 20-1 at p. 5)

HTP stated that it does not support an incremental increase in the allowable minimum efficiency of residential boilers, because appliances which operate at efficiencies between 82-percent and 90-percent AFUE are very likely to experience cyclic condensation within their venting and periods of high vent temperatures. (HTP, No. 31 at p. 1) Condensation in the venting system causes corrosion that may lead to safety concerns.

The Joint Commenters urged DOE to strongly consider condensing-level standards for both gas-fired and oil-fired hot water boilers, as the analysis found that such standards would yield positive average LCC savings for consumers. The Joint Commenters stated that the LCC savings for consumers at condensing levels may be higher than indicated in the analysis for the NODA, in part because of lower installation costs due to the introduction of advanced venting systems and declining equipment costs. (Joint Commenters, No. 27 at p. 1) Belyea Bros. stated that all furnaces sold and installed in Canada must have an AFUE of 90 or above, and it is illogical to not treat boilers the same as furnaces. (Belyea Bros., No. 17 at p. 1)

DOE examined the impacts of condensing-level standards for both gas-fired and oil-fired hot water boilers. Its analysis accounted for applicable venting system technology and expected product costs for condensing boilers. Although condensing-level standards would save a substantial amount of energy, DOE concluded that such standards are likely not economically justified. DOE has tentatively concluded that, at the TSLs that include condensing efficiency levels (TSL 4 and TSL 5), the benefits would be outweighed by the large reduction in industry value and the high number of consumers experiencing a net LCC cost for gas-fired hot water boilers and oil-fired hot water boilers, as well as the negative NPV at a 7-percent discount rate (TSL 5 only). See section V.C for further details.

A number of parties stated that much greater savings than indicated with AFUE or combustion efficiency tests are seen when replacing conventional heating equipment with integrated heat and hot water systems. (Breda, No. 29 at p. 1; Hlavaty Plumb Heat Cool, No. 29 at p. 1; Maritime Energy, No. 29 at p. 1; OSI Comfort Specialists, No. 29 at p. 1; Petro Heating & Air Conditioning Services, No. 29 at p. 1; Sunshine Fuels & Energy Services, No. 29 at p. 1; Aiello Home Services, No. 29 at p. 1; Lombardi Oil, No. 29 at p. 1; Soundview Heating and Air Conditioning, No. 29 at p. 1; Stocker Home Energy Services, No. 29 at p. 1) DOE agrees that integrated heat and hot water systems can provide significant overall energy savings compared to use of separate heat and hot water systems, but DOE does not have authority to adopt standards that would require the use of integrated heat and hot water systems.

V. Analytical Results and Conclusions

A. Trial Standard Levels

DOE developed trial standard levels (TSLs) that combine efficiency levels for each product class of residential boilers. The following section addresses the trial standard levels examined by DOE, the projected impacts of each of these levels if adopted as energy conservation standards for residential boilers, and the standards levels that DOE is proposing in today's NOPR. Additional details regarding the analyses conducted by DOE are contained in the publicly-available NOPR TSD supporting this notice.

1. TSLs for Energy Efficiency

Table V.1 presents the efficiency levels for each product class in each TSL that DOE has identified for residential boilers. TSL 5 consists of the max-tech efficiency levels. TSL 4 consists of those efficiency levels that provide the maximum NES with an NPV greater than zero at a 7-percent discount rate (see section V.B.3 for NPV results). TSL 3 consists of the efficiency levels that provide the highest NPV using a 7-percent discount rate, and that also result in a higher percentage of consumers that receive an LCC benefit than experience an LCC loss (see section V.B.1 for LCC results). TSL 2 consists of the intermediate efficiency levels. TSL 1 consists of the most common efficiency levels in the current market. Table V.1 and Table V.2 present the TSLs and the corresponding product class efficiency levels and AFUE levels that DOE considered for residential boilers.

Table V.1 Trial Standard Levels for Residential Boilers by Efficiency Level

	Trial Standard Levels				
Product Class*	**1**	**2**	**3**	**4**	**5**
Gas-Fired Hot Water Boiler	1	2	3	5	6
Gas-Fired Steam Boiler	1	1	1	1	2
Oil-Fired Hot Water Boiler	1	2	2	3	3
Oil-Fired Steam Boiler	1	3	3	3	3

*As discussed in section IV.A.1, although electric hot water and electric steam boilers are in the scope of this rulemaking, these products were not analyzed for AFUE energy conservation standards and accordingly are not shown in this table.

Table V.2 Trial Standard Levels for Residential Boilers by AFUE

Product Class*	Trial Standard Levels				
	1	2	3	4	5
Gas-Fired Hot Water Boiler	83%	84%	85%	92%	96%
Gas-Fired Steam Boiler	82%	82%	82%	82%	83%
Oil-Fired Hot Water Boiler	85%	86%	86%	91%	91%
Oil-Fired Steam Boiler	84%	86%	86%	86%	86%

*As discussed in section IV.A.1, electric hot water and electric steam boilers were not analyzed for AFUE energy conservation standards and accordingly are not shown in this table.

2. TSLs for Standby Mode and Off Mode

Table V.3 presents the TSLs and the corresponding product class efficiency levels (by efficiency level) that DOE considered for boiler standby mode and off mode power consumption. Table V.4 presents the TSLs and the corresponding product class efficiency levels (expressed in watts) that DOE considered for boiler standby mode and off mode power consumption. For boiler product classes, DOE considered three efficiency levels.

Table V.3 Standby Mode and Off Mode Trial Standard Levels for Residential Boilers by Efficiency Level

Product Class	Trial Standard Levels		
	1	2	3
Gas-Fired Hot Water Boiler	1	2	3
Gas-Fired Steam Boiler	1	2	3
Oil-Fired Hot Water Boiler	1	2	3
Oil-Fired Steam Boiler	1	2	3
Electric Hot Water Boiler	1	2	3
Electric Steam Boiler	1	2	3

Table V.4 Standby Mode and Off Mode Trial Standard Levels for Residential Boilers by Watts

Product Class	Trial Standard Levels		
	1	2	3
Gas-Fired Hot Water Boiler	10.0	9.7	9.0
Gas-Fired Steam Boiler	9.0	8.7	8.0
Oil-Fired Hot Water Boiler	12.0	11.7	11.0
Oil-Fired Steam Boiler	12.0	11.7	11.0

Electric Hot Water Boiler	9.0	8.7	8.0
Electric Steam Boiler	9.0	8.7	8.0

B. Economic Justification and Energy Savings

1. Economic Impacts on Individual Consumers

DOE analyzed the economic impacts on residential boilers consumers by looking at the effects potential amended 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 potential amended energy conservation standards on consumers of residential boilers, DOE conducted LCC and PBP analyses for each TSL. In general, higher-efficiency products would affect consumers in two ways: (1) annual operating expense would decrease, and (2) purchase price would increase. Inputs used for calculating the LCC and PBP include total installed costs (i.e., product price plus installation costs), operating costs (i.e., annual energy use, energy prices, energy price trends, repair costs, and maintenance costs), product lifetime, and discount rates.

The key outputs of the LCC analysis are a mean LCC savings (or cost) and a median PBP relative to the base-case efficiency distribution for each product class of residential boilers, as well as the percentage of consumers for whom the LCC under an amended standard would decrease (net benefit), increase (net cost), or exhibit no change (no impact). No impacts occur when the base-case efficiency of the boiler of a particular household equals or exceeds the efficiency at a given TSL.

DOE also performed a PBP analysis as part of the consumer impact analysis. The PBP is the number of years it would take for the consumer to recover the increased costs of higher-efficiency product as a result of energy savings based on the operating cost savings. The PBP is an economic benefit-cost measure that uses benefits and costs without discounting. Chapter 8 of the NOPR TSD provides detailed information on the LCC and PBP analyses.

DOE's LCC and PBP analyses provide five key outputs for each efficiency level above the baseline, as reported in Table V.5 through Table V.8 for the considered AFUE TSLs. (Results for all efficiency levels are reported in chapter 8 of the NOPR TSD.) These outputs include the proportion of residential boiler purchases in which the purchase of a boiler compliant with the amended energy conservation standard creates a net LCC increase, no impact, or a net LCC savings for the consumer. Another output is the average LCC savings from standard-compliant products, as well as the median PBP for the consumer investment in standards-compliant products. Savings are measured relative to the base-case efficiency distribution (see section IV.F.2), not the baseline efficiency level.

Table V.5. Summary AFUE Life-Cycle Cost and Payback Period Results for Gas-Fired Hot Water Residential Boilers

Trial Standard Level	AFUE	Life-Cycle Cost 2013$			Life-Cycle Cost Savings				Payback Period years
		Total Installed Cost	Discounted Operating Cost	LCC	Average Savings 2013$	% of Consumers that Experience*			Median
						Net Cost	No Impact	Net Benefit	
1	83%	$5,447	$21,837	$27,284	$35	4%	79%	18%	1.6
2	84%	$5,461	$21,616	$27,077	$100	3%	68%	29%	1.6
3	85%	$5,585	$21,431	$27,016	$123	13%	57%	30%	7.7
4	92%	$6,768	$20,022	$26,790	$201	38%	29%	33%	18.8
5	96%	$7,523	$19,338	$26,860	$134	57%	7%	36%	22.1

* Rounding may cause some items to not total 100 percent.

Table V.6. Summary AFUE Life-Cycle Cost and Payback Period Results for Gas-Fired Steam Residential Boilers

Trial Standard Level	AFUE	Life-Cycle Cost 2013$			Life-Cycle Cost Savings				Payback Period years
		Total Installed Cost	Discounted Operating Cost	LCC	Average Savings 2013$	% of Consumers that Experience*			Median
						Net Cost	No Impact	Net Benefit	
1	82%	$5,621	$21,472	$27,093	$61	1%	86%	14%	1.3
2	82%	$5,621	$21,472	$27,093	$61	1%	86%	14%	1.3
3	82%	$5,621	$21,472	$27,093	$61	1%	86%	14%	1.3
4	82%	$5,621	$21,472	$27,093	$61	1%	86%	14%	1.3
5	83%	$5,928	$21,287	$27,215	$250	28%	11%	61%	11.6

* Rounding may cause some items to not total 100 percent.

Table V.7. Summary AFUE Life-Cycle Cost and Payback Period Results for Oil-Fired Hot Water Residential Boilers

Trial Standard Level	AFUE	Life-Cycle Cost 2013$			Life-Cycle Cost Savings				Payback Period years
		Total Installed Cost	Discounted Operating Cost	LCC	Average Savings 2013$	% of Consumers that Experience*			Median
						Net Cost	No Impact	Net Benefit	
1	85%	$7,332	$49,200	$56,532	$72	4%	81%	15%	8.3
2	86%	$7,527	$48,648	$56,175	$257	9%	49%	42%	7.6
3	86%	$7,527	$48,648	$56,175	$257	9%	49%	42%	7.6
4	91%	$9,555	$46,600	$56,155	$273	54%	8%	38%	21.4
5	91%	$9,555	$46,600	$56,155	$273	54%	8%	38%	21.4

* Rounding may cause some items to not total 100 percent.

Table V.8. Summary AFUE Life-Cycle Cost and Payback Period Results for Oil-Fired Steam Residential Boilers

Trial Standard Level	AFUE	Life-Cycle Cost 2013$			Life-Cycle Cost Savings				Payback Period years
		Total Installed Cost	Discounted Operating Cost	LCC	Average Savings 2013$	% of Consumers that Experience*			Median
						Net Cost	No Impact	Net Benefit	
1	84%	$7,422	$48,429	$55,850	$259	3%	71%	27%	6.3
2	86%	$7,873	$47,345	$55,218	$723	23%	10%	67%	10.5
3	86%	$7,873	$47,345	$55,218	$723	23%	10%	67%	10.5
4	86%	$7,873	$47,345	$55,218	$723	23%	10%	67%	10.5
5	86%	$7,873	$47,345	$55,218	$723	23%	10%	67%	10.5

* Rounding may cause some items to not total 100 percent.

Table V.9 through Table V.14 show the key LCC and PBP results for each product class for standby mode and off mode.

Table V.9. Summary Standby Mode and Off Mode Life-Cycle Cost and Payback Period Results for Gas-Fired Hot Water Residential Boilers

Trial Standard Level	Efficiency Level	Life-Cycle Cost 2013$			Life-Cycle Cost Savings				Payback Period years
		Total Installed Cost	Discounted Operating Cost	LCC	Average Savings 2013$	% of Consumers that Experience*			Median
						Net Cost	No Impact	Net Benefit	
1	1	$2	$196	$198	$14	0%	51%	49%	1.1
2	2	$22	$190	$212	$7	11%	51%	38%	10.4
3	3	$23	$176	$199	$14	6%	51%	44%	7.8

* Rounding may cause some items to not total 100 percent.

Table V.10. Summary Standby Mode and Off Mode Life-Cycle Cost and Payback Period Results for Gas-Fired Steam Residential Boilers

Trial Standard Level	Efficiency Level	Life-Cycle Cost 2013$			Life-Cycle Cost Savings				Payback Period years
		Total Installed Cost	Discounted Operating Cost	LCC	Average Savings 2013$	% of Consumers that Experience*			Median
						Net Cost	No Impact	Net Benefit	
1	1	$2	$187	$189	$15	0%	51%	49%	1.1
2	2	$21	$181	$202	$9	9%	51%	41%	10.3
3	3	$23	$166	$188	$15	4%	51%	45%	7.4

* Rounding may cause some items to not total 100 percent.

Table V.11. Summary Standby Mode and Off Mode Life-Cycle Cost and Payback Period Results for Oil-Fired Hot Water Residential Boilers

Trial Standard Level	Efficiency Level	Life-Cycle Cost 2013$			Life-Cycle Cost Savings				Payback Period years
		Total Installed Cost	Discounted Operating Cost	LCC	Average Savings 2013$	% of Consumers that Experience*			Median
						Net Cost	No Impact	Net Benefit	
1	1	$2	$253	$255	$15	0%	51%	49%	1.0
2	2	$21	$247	$268	$9	9%	51%	41%	10.2
3	3	$22	$232	$254	$15	4%	51%	45%	7.4

* Rounding may cause some items to not total 100 percent.

Table V.12. Summary Standby Mode and Off Mode Life-Cycle Cost and Payback Period Results for Oil-Fired Steam Residential Boilers

Trial Standard Level	Efficiency Level	Life-Cycle Cost 2013$			Life-Cycle Cost Savings				Payback Period years
		Total Installed Cost	Discounted Operating Cost	LCC	Average Savings 2013$*	% of Consumers that Experience			Median
						Net Cost	No Impact	Net Benefit	
1	1	$2	$247	$249	$14	0%	51%	49%	1.3
2	2	$21	$241	$262	$8	9%	51%	41%	10.7
3	3	$22	$226	$249	$15	4%	51%	45%	8.4

* Rounding may cause some items to not total 100 percent.

Table V.13. Summary Standby Mode and Off Mode Life-Cycle Cost and Payback Period Results for Electric Hot Water Residential Boilers

Trial Standard Level	Efficiency Level	Life-Cycle Cost 2013$			Life-Cycle Cost Savings				Payback Period years
		Total Installed Cost	Discounted Operating Cost	LCC	Average Savings 2013$	% of Consumers that Experience*			Median
						Net Cost	No Impact	Net Benefit	
1	1	$2	$141	$143	$11	0%	51%	49%	2.0
2	2	$21	$136	$158	$3	19%	51%	30%	17.7
3	3	$23	$126	$148	$8	11%	51%	38%	11.0

* Rounding may cause some items to not total 100 percent.

Table V.14. Summary Standby Mode and Off Mode Life-Cycle Cost and Payback Period Results for Electric Steam Residential Boilers

Trial Standard Level	Efficiency Level	Life-Cycle Cost 2013$			Life-Cycle Cost Savings				Payback Period years
		Total Installed Cost	Discounted Operating Cost	LCC	Average Savings 2013$	% of Consumers that Experience*			Median
						Net Cost	No Impact	Net Benefit	
1	1	$2	$144	$146	$11	0%	51%	49%	2.0
2	2	$21	$139	$161	$4	19%	51%	31%	10.5
3	3	$23	$128	$151	$9	11%	51%	38%	10.9

* Rounding may cause some items to not total 100 percent.

b. Consumer Subgroup Analysis

In the consumer subgroup analysis, DOE estimated the impacts of the considered AFUE TSLs on low-income and senior-only households. The average LCC savings and median payback periods for low-income and senior-only households are shown in Table V.15. Chapter 11 of the NOPR TSD presents detailed results of the consumer subgroup analysis.

Table V.15. Comparison of Impacts for Consumer Subgroups with All Consumers, Gas-Fired Hot Water Boilers (AFUE TSLs)

TSL	AFUE	Average Life-Cycle Cost Savings 2013$			Median Payback Period Years		
		Senior-Only	Low-Income	All Consumers	Senior-Only	Low-Income	All Consumers
1	83%	$27	$24	$35	1.8	1.5	1.6
2	84%	$76	$79	$100	1.9	1.5	1.6
3	85%	$73	$82	$123	9.9	9.1	7.7
4	92%	($34)	($128)	$201	20.6	22.3	18.8
5	96%	($202)	($294)	$134	24.5	23.7	22.1

Note: Parentheses indicate negative values.

Table V.16. Comparison of Impacts for Consumer Subgroups with All Consumers, Gas-Fired Steam Boilers (AFUE TSLs)

TSL	AFUE	Average Life-Cycle Cost Savings 2013$			Median Payback Period Years		
		Senior-Only	Low-Income	All Consumers	Senior-Only	Low-Income	All Consumers
1	82%	$50	$53	$61	1.7	1.3	1.3
2	82%	$50	$53	$61	1.7	1.3	1.3
3	82%	$50	$53	$61	1.7	1.3	1.3
4	82%	$50	$53	$61	1.7	1.3	1.3
5	83%	$160	$180	$250	13.0	11.1	11.6

Table V.17. Comparison of Impacts for Consumer Subgroups with All Consumers, Oil-Fired Hot Water Boilers (AFUE TSLs)

TSL	AFUE	Average Life-Cycle Cost Savings 2013$			Median Payback Period Years		
		Senior-Only	Low-Income	All Consumers	Senior-Only	Low-Income	All Consumers
1	85%	$58	$25	$72	7.9	9.8	8.3
2	86%	$234	$103	$257	6.3	10.9	7.6
3	86%	$234	$103	$257	6.3	10.9	7.6
4	91%	$75	($1,019)	$273	19.8	47.5	21.4
5	91%	$75	($1,019)	$273	19.8	47.5	21.4

Note: Parentheses indicate negative values.

Table V.18. Comparison of Impacts for Consumer Subgroups with All Consumers, Oil-Fired Steam Boilers (AFUE TSLs)

TSL	AFUE	Average Life-Cycle Cost Savings 2013$			Median Payback Period Years		
		Senior-Only	Low-Income	All Consumers	Senior-Only	Low-Income	All Consumers
1	84%	$8	$120	$259	1.0	9.5	6.3
2	86%	$13	$247	$723	1.0	15.7	10.5
3	86%	$13	$247	$723	1.0	15.7	10.5
4	86%	$13	$247	$723	1.0	15.7	10.5
5	86%	$13	$247	$723	1.0	15.7	10.5

c. Rebuttable Presumption Payback Period

As discussed in section III.E.2, EPCA establishes a rebuttable presumption that an energy conservation standard is economically justified if the increased purchase cost for a product that meets the standard is less than three times the value of the first-year energy savings resulting from the standard. Accordingly, DOE calculated a rebuttable-presumption PBP for each TSL for residential boilers based on average usage profiles. As a result, DOE calculated a single rebuttable-presumption payback value, and not a distribution of PBPs, for each TSL. 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 under 42 U.S.C. 6295(o)(2)(B)(i). The results of that analysis serve as the basis for DOE to definitively evaluate the economic justification for a potential standard level, thereby supporting or rebutting the results of any preliminary determination of economic justification. Table V.19 shows the rebuttable-presumption PBPs for the considered AFUE TSLs for the residential boilers product classes. Table V.20 shows the rebuttable-presumption PBPs for the considered TSLs for standby mode and off mode for the residential boilers product classes.

Table V.19. Rebuttable-Presumption Payback Periods (years) for Residential Boilers for Analysis of AFUE Standards

	Rebuttable Presumption Payback (years)				
Product Class	**TSL 1**	**TSL 2**	**TSL 3**	**TSL 4**	**TSL 5**
Gas-fired hot water boilers	6.1	3.4	6.1	10.6	12.5
Gas-fired steam boilers	1.8	1.8	1.8	1.8	8.4
Oil-fired hot water boilers	7.3	5.9	5.9	9.4	9.4
Oil-fired steam boilers	3.4	4.8	4.8	4.8	4.8

Table V.20. Standby Mode and Off Mode Rebuttable-Presumption Payback Periods (years) for Residential Boilers

	Rebuttable Presumption Payback (years)		
Product Class	**TSL 1**	**TSL 2**	**TSL 3**
Gas-fired hot water boilers	1.7	15.0	11.4
Gas-fired steam boilers	1.5	12.9	9.9
Oil-fired hot water boilers	1.5	12.7	9.7
Oil-fired steam boilers	1.5	12.8	9.8
Electric hot water boilers	1.3	11.7	8.9
Electric steam boilers	1.3	11.7	8.9

2. Economic Impacts on Manufacturers

As noted previously, DOE performed an MIA to estimate the impact of amended energy conservation standards on manufacturers of residential boilers. The following section describes the expected impacts on manufacturers at each considered TSL. DOE first discusses the impacts of potential AFUE standards and then turns to the impacts of potential standby mode and off mode standards. Chapter 12 of the NOPR TSD explains the analysis in further detail.

a. Industry Cash-Flow Analysis Results

Cash-Flow Analysis Results for Residential Boilers AFUE Standards

Table V.21 and Table V.22 depict the estimated financial impacts (represented by changes in INPV) of amended energy conservation standards on manufacturers of residential 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 residential boiler 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 lower (less severe) end 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 higher (more severe) end of the range of potential impacts, DOE modeled the preservation of per-unit 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 base 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.2), in addition to markup scenarios, the MPC, shipments, and conversion cost assumptions also affect INPV results.

The results in Table V.21 and Table V.22 show potential INPV impacts for residential boiler manufacturers; Table V.21 reflects the lower bound of impacts, and Table V.22 represents the upper bound.

Each of the modeled scenarios in the AFUE standards 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 base case and each standards case that results from the sum of discounted cash flows from the base year 2014 through 2049, 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 base 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 base case.

Table V.21. Manufacturer Impact Analysis for Residential Boilers for AFUE Standards - Preservation of Gross Margin Percentage Markup Scenario*

	Units	Base Case	Trial Standard Level				
			1	2	3	4	5
INPV	2013$ millions	380.96	380.91	383.35	381.73	369.87	380.46
Change in INPV	2013$ millions	-	(0.04)	2.39	0.77	(11.08)	(0.50)
	%	-	(0.01)	0.63	0.20	(2.91)	(0.13)
Product Conversion Costs	2013$ millions	-	1.32	1.69	3.38	25.04	36.59
Capital Conversion Costs	2013$ millions	-	-	0.90	0.90	60.13	68.41
Total Conversion Costs	2013$ millions	-	1.32	2.59	4.28	85.16	105.00
Free Cash Flow (base case = 2019)	2013$ millions	25.83	25.44	24.92	24.41	(8.73)	(15.92)
Change in Free Cash Flow (change from base case)	2013$ millions	-	(0.40)	(0.90)	(1.40)	(34.60)	(41.80)
	%		(1.53)	(3.54)	(5.49)	(133.80)	(161.64)

* Parentheses indicate negative values.

Table V.22. Manufacturer Impact Analysis for Residential Boilers for AFUE Standards - Preservation of Per-Unit Operating Profit Markup Scenario*

	Units	Base Case	Trial Standard Level				
			1	2	3	4	5
INPV	2013$ millions	380.96	379.17	378.31	372.97	284.75	241.69
Change in INPV	2013$ millions	-	(1.79)	(2.65)	(7.99)	(96.21)	(139.26)
	%		(0.47)	(0.70)	(2.10)	(25.25)	(36.56)
Product Conversion Costs	2013$ millions		1.32	1.69	3.38	25.04	36.59
Capital Conversion Costs	2013$ millions		-	0.90	0.90	60.13	68.41
Total Conversion Costs	2013$ millions		1.32	2.59	4.28	85.16	105.00
Free Cash Flow (base case = 2019)	2013$ millions	25.83	25.44	24.92	24.41	(8.73)	(15.92)
Change in Free Cash Flow (change from the base case)	2013$ millions		(0.40)	(0.90)	(1.40)	(34.60)	(41.80)
	%		(1.53)	(3.54)	(5.49)	(133.80)	(161.64)

* Parentheses indicate negative values.

TSL 1 represents EL 1 for all product classes. At TSL 1, DOE estimates impacts on INPV for residential boiler manufacturers to range from -0.47 percent to -0.01 percent, or a change in INPV of -$1.79 million to -$0.04 million. At this potential standard level, industry free cash flow would be estimated to decrease by approximately 1.53 percent to $25.44 million, compared to the base-case value of $25.83 million in 2019, the year before the compliance date.

At TSL 1, DOE does not anticipate manufacturers would lose a significant portion of their INPV. This is largely due to the fact that the vast majority of shipments would already meet or exceed the efficiency levels prescribed at TSL 1. DOE projects that in 2020, the expected year of compliance, approximately 80 percent of residential boiler shipments would meet or exceed the efficiency levels at TSL 1. As a result, only a small percentage of residential boiler shipments would need to be converted at TSL 1, so DOE expects low conversion costs at this TSL. DOE expects residential boiler manufacturers to incur $1.32 million in product conversion costs for boiler redesign and testing. DOE does not expect the modest efficiency gains at this TSL to require any major product upgrades or capital investments.

At TSL 1, under the preservation of gross margin percentage scenario, the shipment-weighted average MPC increases by approximately 1 percent relative to the base-case MPC. Manufacturers are able to fully pass on this cost increase to consumers by design in this markup scenario. This slight price increase would not mitigate the

$1.32 million in conversion costs estimated at TSL 1, resulting in slightly negative INPV impacts at TSL 1 under the this scenario.

Under the preservation of per-unit operating profit markup scenario, manufacturers earn the same operating profit as would be earned in the base case, but do not earn additional profit from their investments. The 1-percent MPC increase is outweighed by a slightly lower average markup and $1.32 million in conversion costs, resulting in small negative impacts at TSL 1.

TSL 2 sets the efficiency level at EL 1 for one product class (gas-fired steam boilers), EL 2 for two product classes (gas-fired hot water boilers and oil-fired hot water boilers) and EL 3 for one product class (oil-fired steam boilers). At TSL 2, DOE estimates impacts on INPV for residential boilers manufacturers to range from -0.70 percent to 0.63 percent, or a change in INPV of -$2.65 million to $2.39 million. At this potential standard level, industry free cash flow would be estimated to decrease by approximately 3.54 percent to $24.92 million, compared to the base-case value of $25.83 million in 2019, the year before the compliance date.

DOE does not anticipate manufacturers would lose a substantial portion of their INPV, because a large percentage of shipments would still meet or exceed the efficiency levels prescribed at this TSL. At TSL 2, DOE estimates that in 2020, 63 percent of residential boiler shipments would meet or exceed the efficiency levels analyzed. The drop in the percentage of compliant products is largely due to the fact that the oil-fired hot water product class would move to EL 2 and the oil-fired steam product class would move to EL 3. At these efficiency levels, DOE projects only 41 percent and 10 percent of shipments of hot water and steam oil-fired boilers, respectively, would meet or exceed the levels at TSL 2 in 2020, the year of compliance. These figures do not have a large impact on INPV, however, because oil-fired boilers would only comprise approximately 30 percent of residential boiler shipments in 2020 according to DOE projections, while gas-fired boilers would comprise over 70 percent of shipments.

DOE expects conversion costs would increase, but would still remain small compared to total industry value, as most manufacturers have gas-fired boilers at the prescribed efficiency levels on the market and would only have to make minor changes to their production processes. While the percentage of oil-fired boilers at these efficiency levels on the market is lower, manufacturers did not cite any major investments that would have to be made to reach the efficiency levels at EL 2 for hot water products and EL 3 for steam products. Manufacturers also pointed out that gas-fired boiler shipments vastly out-pace oil-fired boiler shipments and that the market is continuing to trend towards gas-fired products. Overall, DOE estimates manufacturers would incur $1.69 million in product conversion costs for product redesign and testing and $0.90 million in capital conversion costs to make minor changes to their production lines.

At TSL 2, under the preservation of gross margin percentage scenario, the shipment-weighted average MPC increases by 2 percent relative to the base-case MPC. In this scenario, INPV impacts are slightly positive because of manufacturers' ability to pass the higher production costs to consumers outweighs the $2.59 million in conversion costs. Under the preservation of per-unit operating profit markup scenario, the 2-percent MPC increase is outweighed by a slightly lower average markup and $2.59 million in total conversion costs, resulting in minimally negative impacts at TSL 2.

TSL 3 represents EL 1 for one product class (gas-fired steam boilers), EL 2 for one product class (oil-fired hot water boilers), and EL 3 for two product classes (gas-fired hot water boilers and oil-fired steam boilers). At TSL 3, DOE estimates impacts on INPV for residential boiler manufacturers to range from -2.10 percent to 0.20 percent, or a change in INPV of -$7.99 million to $0.77 million. At this potential standard level, industry free cash flow would be estimated to decrease by approximately 5.49 percent in 2019, the year before compliance, to $24.41 million compared to the base-case value of $25.83 million.

While more significant than the impacts at TSL 2, the impacts on INPV at TSL 3 would still be relatively minor compared to the total industry value. Percentage impacts on INPV would be slightly positive to slightly negative at TSL 3. DOE does not anticipate that manufacturers would lose a significant portion of their INPV at this TSL. While less than the previous TSLs, DOE projects that in 2020, over half of total shipments would already meet or exceed the efficiency levels prescribed at TSL 3. DOE expects conversion costs to remain small at TSL 3 compared to the total industry value. DOE estimates that product conversion costs would increase as manufacturers would have to redesign a larger percentage of their offerings and may have to design new products to replace lower-efficiency commodity products. At this TSL, DOE estimates that residential boiler manufacturers would incur $3.38 million in product conversion costs. Manufacturers, however, did not cite any major changes that would need to be made to production equipment to achieve the efficiency levels at this TSL. DOE, therefore, estimates that capital conversion costs would remain at $0.90 million for the industry.

At TSL 3, under the preservation of gross margin percentage markup scenario, the shipment-weighted average MPC increases by 4 percent relative to the base-case MPC. In this scenario, INPV impacts are slightly positive because manufacturers' ability to pass the higher production costs to consumers outweighs the $4.28 million in total conversion costs. Under the preservation of per-unit operating profit markup scenario, the 4 percent MPC increase is slightly outweighed by a slightly lower average markup and $4.28 million in total conversion costs, resulting in minimally negative impacts at TSL 3.

TSL 4 represents EL 1 for one product class (gas-fired steam boilers), EL 3 for two product classes (oil-fired hot water boilers and oil-fired steam boilers), and EL 5 for one product class (gas-fired hot water boilers). At TSL 4, DOE estimates impacts on INPV for residential boiler manufacturers to range from -25.25 percent to -2.91 percent, or a change in INPV of -$96.21 million to -$11.08 million. At this potential standard level, industry free cash flow would be estimated to decrease by approximately 133.8 percent in the year before compliance (2019) to -$8.73 million relative to the base-case value of $25.83 million.

Percentage impacts on INPV are moderately to significantly negative at TSL 4. DOE projects that in 2020, only 28 percent of residential boiler shipments would meet or exceed the efficacy levels at TSL 4. DOE expects that conversion costs would increase significantly at this TSL due to the fact that manufacturers would meet these efficiency levels by using condensing heat exchangers in their gas-fired and oil-fired hot water boiler products.[91] Currently, the majority of gas-fired hot water boilers on the market is made from cast iron, carbon steel, or copper and contains noncondensing heat exchangers, because if these boilers were designed to condense, the acidic condensate from the flue gas would corrode these metals and cause the boiler to fail prematurely. If standards were set where manufacturers of gas-fired hot water boiler products could only meet the efficiency levels with condensing technology, companies that produce their own cast iron sections or their own carbon steel or copper heat exchangers would have to eliminate many of their commodity products, close foundries and casting facilities, and restructure their businesses. Domestic manufacturers who currently offer condensing products import their condensing heat exchangers (constructed from either stainless steel or aluminum) from Europe. DOE believes that if standards were set where manufacturers of gas-fired hot water boiler products could only meet the efficiency levels with condensing technology, some manufacturers may choose to develop their own condensing heat exchanger production capacity in order to gain a cost advantage and remain vertically integrated. This would require large capital investments in higher-tech,

[91] At these efficiency levels, manufacturers would also use a condensing heat exchanger for oil-fired hot water boiler products; however, these models are much less common, and DOE believes that the majority of the conversion costs at this TSL would be driven by gas-fired hot water boiler products.

more-automated 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 and may choose to exit the market. As noted above, these companies also may choose to source condensing heat exchangers and assemble a product designed around the sourced part, rather than invest in their own heat exchanger production capacity. This strategy would remove a significant piece of the value chain for these companies.

While condensing products and condensing technology are not entirely unfamiliar to the companies that already make condensing products domestically, most manufacturers in the residential boiler industry have relatively little experience in manufacturing the heat exchanger itself. If manufacturers choose to develop their own heat exchanger production capacity, a great deal of testing, prototyping, design, and manufacturing engineering resources will be required to design the heat exchanger and the more advanced control systems found in more-efficient products.

These capital and production conversion expenses lead to the large reduction in cash flow in the years preceding the standard. DOE believes that only a few domestic manufacturers have the resources for this undertaking and believes that some large manufacturers and many smaller manufacturers would continue to source their heat exchangers. Ultimately, DOE estimates that manufacturers would incur $25.04 million in product conversion costs, as some manufacturers would be expected to attempt to add production capacity for condensing heat exchangers and others would have to design baseline products around a sourced condensing heat exchanger. In addition, DOE estimates that manufacturers would incur $60.13 million in capital conversion costs, which would be driven by capital investments in heat exchanger production lines.

At TSL 4, under the preservation of gross margin percentage markup scenario, the shipment-weighted average MPC increases by 37 percent relative to the base-case MPC. In this scenario, INPV impacts are slightly negative because manufacturers' ability to pass the higher production costs to consumers is slightly outweighed the $85.16 million in total conversion costs. Under the preservation of per-unit operating profit markup scenario, the 37-percent MPC increase is outweighed by a lower average markup of 1.37 (compared to 1.41 in the preservation of gross margin percentage markup scenario) and $85.16 million in total conversion costs, resulting in significantly negative impacts at TSL 4.

TSL 5 represents EL 2 for one product class (gas-fired steam boilers), EL 3 for two product classes (oil-fired hot water boilers and oil-fired steam boilers), and EL 6 for one product class (gas-fired hot water boilers). TSL 5 represents max-tech for all product classes. At TSL 5, DOE estimates impacts on INPV for residential boiler manufacturers to range from -36.59 percent to -0.13 percent, or a change in INPV of -$139.26 million to -$0.50 million. At this potential standard level, industry free cash flow would be estimated to decrease by approximately 161.64 percent in the year before compliance (2019) to -$15.92 million relative to the base-case value of $25.83 million.

At TSL 5, percentage impacts on INPV range from slightly negative to significantly negative. DOE estimates that in 2020, only 7 percent of residential boiler shipments would already meet or exceed the efficiency levels prescribed at TSL 5. DOE expects conversion costs to continue to increase at TSL 5, as almost all products on the market would have to be redesigned and new products would have to be developed. As with TSL 4, DOE believes that at these efficiency levels, some manufacturers would choose to develop their own condensing heat exchanger production, rather than continuing to source these components. DOE estimates that product conversion costs would increase to $36.59 million as manufacturers would have to redesign a larger percentage of their offerings, implement complex control systems, and meet max-tech for all product classes. DOE estimates that manufacturers would incur $68.41 million in capital conversion costs due to some manufacturers choosing to develop their own heat exchanger production and others having to increase the throughput of their existing condensing boiler production lines.

At TSL 5, under the preservation of gross margin percentage markup scenario, the shipment-weighted average MPC increases by 58 percent relative to the base-case MPC. In this scenario, INPV impacts are negative because manufacturers' ability to pass the higher production costs to consumers is outweighed by the $105.0 million in total conversion costs. Under the preservation of per-unit operating profit markup scenario, the 58-percent MPC increase is outweighed by a lower average markup of 1.36 and $105.0 million in total conversion costs, resulting in significantly negative impacts at TSL 5.

Cash-Flow Analysis Results for Residential Boilers in Standby Mode and Off Mode

Standby mode and off mode standards results are presented in Table V.23 and Table V.24. The impacts of standby mode and off mode features were analyzed for the same product classes as the amended AFUE standards, but at different efficiency levels, which correspond to a different set of technology options for reducing standby mode and off mode energy consumption. Therefore, the TSLs in the standby mode and off mode analysis do not correspond to the TSLs in the AFUE analysis. Also, the electric boiler product classes were not analyzed in the GRIM for AFUE standards. As a result, quantitative numbers are also not available for the GRIM analyzing standby mode and off mode standards. However, the standby mode and off mode technology options considered for electric boilers are identical to the technology options for all other residential boiler product classes. Consequently, DOE expects the standby mode and off mode impacts on electric boilers to be of the same order of magnitude as the impacts on all other boiler product classes.

The impacts of standby mode and off mode features were analyzed for the same two markup scenarios to represent the upper and lower bounds of industry impacts for residential boilers that were used in the AFUE analysis: (1) a preservation of gross margin percentage scenario; and (2) a preservation of per-unit operating profit scenario. As with the AFUE analysis, the preservation of gross margin percentage represents the lower bound of impacts, while the preservation of per-unit operating profit scenario represents the upper bound of impacts.

Each of the modeled scenarios in the standby mode and off mode analyses 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 base case and each standards case that results from the sum of discounted cash flows from the base year 2014 through 2049, 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 base 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 base case.

Table V.23. Manufacturer Impact Analysis for Residential Boilers for Standby Mode and Off Mode Standards - Preservation of Gross Margin Percentage Markup Scenario*

	Units	Base Case	Trial Standard Level		
			1	2	3

INPV	2013$ millions	380.96	380.88	381.16	381.17
Change in INPV	2013$ millions	-	(0.07)	0.20	0.22
	%	-	(0.02)	0.05	0.06
Product Conversion Costs	2013$ millions	-	0.21	0.21	0.21
Capital Conversion Costs	2013$ millions	-	-	-	-
Total Conversion Costs	2013$ millions	-	0.21	0.21	0.21
Free Cash Flow (base case = 2019)	2013$ millions	25.83	25.77	25.77	25.77
Change in Free Cash Flow (change from base case)	2013$ millions	-	(0.06)	(0.06)	(0.06)
	%	-	(0.24)	(0.24)	(0.24)

* Parentheses indicate negative values.

Table V.24. Manufacturer Impact Analysis for Residential Boilers for Standby Mode and Off Mode Standards - Preservation of Per-Unit Operating Profit Markup Scenario*

	Units	**Base Case**	**Trial Standard Level**		
			1	**2**	**3**
INPV	2013$ millions	380.96	380.77	379.94	379.88
Change in INPV	2013$ millions	-	(0.19)	(1.02)	(1.08)
	%	-	(0.05)	(0.27)	(0.28)
Product Conversion Costs	2013$ millions	-	0.21	0.21	0.21
Capital Conversion Costs	2013$ millions	-	-	-	-
Total Conversion Costs	2013$ millions	-	0.21	0.21	0.21
Free Cash Flow (base case = 2019)	2013$ millions	25.83	25.77	25.77	25.77
Decrease in Free Cash Flow (change from base case)	2013$ millions	-	(0.06)	(0.06)	(0.06)
	%	-	(0.24)	(0.24)	(0.24)

* Parentheses indicate negative values.

TSL 1 represents EL 1 for all product classes. At TSL 1, DOE estimates impacts on INPV for residential boiler manufacturers to decrease by less than one tenth of a percent in both markup scenarios, which corresponds to a change in INPV of -$0.19 million to -$0.07 million. At this potential standard level, industry free cash flow is estimated to decrease by approximately 0.24 percent to $25.77 million, compared to the base-case value of $25.83 million in 2019, the year before the compliance date.

At TSL 1, DOE does not anticipate that manufacturers would lose a significant portion of their INPV. This is largely due to the small incremental costs of standby mode and off mode components relative to the overall costs of residential boiler products. DOE expects residential boiler manufacturers to incur $0.21 million in product conversion costs at TSL 1, primarily for testing. DOE does not expect that manufacturers would incur any capital conversion costs, as the product upgrades will only involve integrating a purchase-part.

TSL 2 sets the efficiency level at EL 2 for all product classes. At TSL 2, DOE estimates impacts on INPV for residential boilers manufacturers to range from -0.27 percent to 0.05 percent, or a change in INPV of -$1.02 million to $0.20 million. At this potential standard level, industry free cash flow is estimated to decrease by approximately 0.24 percent to $25.77 million, compared to the base-case value of $25.83 million in 2019, the year before the compliance date.

At TSL 2, DOE does not anticipate that manufacturers would lose a significant portion of their INPV. This is largely due to the small incremental costs of standby mode and off mode components relative to the overall costs of residential boiler products.

DOE expects residential boiler manufacturers to incur $0.21 million in product conversion costs at TSL 2, primarily for testing. DOE does not expect that manufacturers would incur any capital conversion costs, as the product upgrades will only involve integrating a purchase-part.

TSL 3 represents EL 3 for all product classes. At TSL 3, DOE estimates impacts on INPV for residential boiler manufacturers to range from -0.28 percent to 0.06 percent, or a change in INPV of -$1.08 million to $0.22 million. At this potential standard level, industry free cash flow is estimated to decrease by approximately 0.24 percent in the year before compliance to $25.77 million compared to the base case value of $25.83 million.

At TSL 3, DOE does not anticipate that manufacturers would lose a significant portion of their INPV. As with TSLs 1 and 2, this is largely due to the small incremental costs of standby mode and off mode components relative to the overall costs of residential boiler products. DOE expects residential boiler manufacturers to incur $0.21 million in product conversion costs at TSL 3, primarily for testing. DOE does not expect that manufacturers would incur any capital conversion costs, as the product upgrades will only involve integrating a purchase-part.

Combining Cash-Flow Analysis Results for Residential Boilers (AFUE standard and in Standby Mode and Off Mode standard)

As noted in section III.B, DOE analyzed the AFUE standard and the standby and off mode standard independently. The AFUE metric accounts for the fuel use consumption whereas the standby and off mode metric accounts for the electrical energy use in standby and off mode. There are five trial standard levels under consideration for the AFUE standard and three trial stand levels under consideration for the standby and off mode standard.

Both the AFUE standard and the standby and off mode standard could necessitate changes in manufacturer production costs, as well as conversion cost investments. . The assumed design changes for the two standards in the engineering analysis are independent, therefore changes in manufacturing production costs and the conversion costs are additive. DOE expects that the costs to manufacturers would be mathematically the same regardless of whether or not the stand-by and off mode standards were combined or analyzed separately. However, DOE requests comment on whether an analysis that considers the cumulative costs of both standards when making technology choices would be more reflective of manufacturer decision making.

Using the current approach that considers AFUE and standby and off mode standards separately, the range of potential impacts of combined standards on INPV is determined by summing the range of potential changes in INPV from the AFUE standard and from the standby and off mode standard. Similarly, to estimate the combined conversion costs, DOE sums the estimated conversion costs from the two standards. DOE does not present the combined impacts of all possible combinations of AFUE and standby and off mode TSLs in this notice. However, DOE expects the combined impact of the TSLs proposed for AFUE and standby and off mode electrical consumption in this

NOPR to range from -2.38 to 0.26 percent, which is approximately equivalent to a reduction of $9.07 million to an increase of $0.99 million.

b. Impacts on Direct Employment

To quantitatively assess the impacts of energy conservation standards on direct employment in the residential boiler industry, DOE used the GRIM to estimate the domestic labor expenditures and number of employees in the base case and at each TSL in 2020. DOE used statistical data from the U.S. Census Bureau's 2011 Annual Survey of Manufacturers (ASM) [92], the results of the engineering analysis, and interviews with manufacturers to determine the inputs necessary to calculate industry-wide labor expenditures and domestic employment levels. Labor expenditures related to manufacturing of the product are a function of the labor intensity of the product, the sales volume, and an assumption that wages remain fixed in real terms over time. The total labor expenditures in each year are calculated by multiplying the MPCs by the labor percentage of MPCs.

The total labor expenditures in the GRIM are converted to domestic production employment levels by dividing production labor expenditures by the annual payment per production worker (production worker hours times the labor rate found in the U.S. Census Bureau's 2011 ASM). The estimates of production workers in this section cover

[92] U.S. Census Bureau, Annual Survey of Manufacturers: General Statistics: Statistics for Industry Groups and Industries (2011) (Available at: http://factfinder2.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t).

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 residential boilers, as compared to the base case. In general, more-efficient 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.

On the other hand, some manufacturers may choose not to make the necessary investments to meet the amended standards for all product classes. Alternatively, they may choose to relocate production facilities where conversion costs and production costs are lower. To establish a lower bound to negative employment impacts, DOE estimated the maximum potential job loss due to manufacturers either leaving the industry or moving production to foreign locations as a result of amended standards. In the case of residential boilers, most manufacturers agreed that higher standards would probably not push their production overseas due to shipping considerations. Rather, high enough standards could force manufacturers to rethink their business models. Instead of vertically integrated manufacturers, they would become assemblers and would source most of their components from overseas. This would mean any workers involved in casting metals that would be corroded in a condensing product would likely lose their jobs. These lower bound estimates were based on GRIM results, conversion cost estimates, and content from manufacturers interviews. The lower bound of employment is presented in Table V.25 below.

DOE estimates that in the absence of amended energy conservation standards, there would be 785 domestic production workers in the residential boiler industry in 2020, the year of compliance. DOE estimates that 90 percent of residential boilers sold in the United States are manufactured domestically. Table V.25 shows the range of the impacts of potential amended energy conservation standards on U.S. production workers of residential boilers.

Table V.25. Potential Changes in the Total Number of Residential Boilers Production Workers in 2020

	Trial Standard Level*					
	Base Case	1	2	3	4	5
Total Number of Domestic Production Workers in 2020 (without changes in production locations)	785	785 to 793	777 to 801	769 to 821	393 to 1,024	196 to 1,035
Potential Changes in Domestic Production Workers in 2020*	-	0 to 8	(8) to 16	(16) to 36	(392) to 239	(589) to 250

* 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 boilers tends to require more labor, and DOE estimates that if residential boiler manufacturers chose to keep their current production in the U.S., domestic employment could increase at each TSL. In interviews, several 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. Others stated that a condensing standard would require additional engineers to redesign production processes, as well as metallurgy experts and other workers with experience working with higher-efficiency products. DOE, however, acknowledges that particularly at higher standard levels, manufacturers may not keep their production in the U.S. and also may choose to restructure their businesses or exit the market entirely.

DOE does not expect any significant changes in domestic employment at TSL 1 or TSL 2. Most manufactures agreed that these efficiency levels would require minimal changes to their production processes and most employees would be retained. DOE estimates that there could be a small loss of domestic employment at TSL 3 due to the fact that some manufacturers would have to drop their 82 to 83-percent-efficient products, which several commented were their commodity products and drove a high percentage of their sales. Several manufacturers expressed that they could lose a significant number of employees at TSL 4 and TSL 5, due to the fact that these TSLs contain condensing efficiency levels for the gas-fired hot water boiler product class. 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 its estimates of the impacts on direct employment are based on the analysis of amended AFUE energy efficiency standards only. Standby mode and off mode technology options considered in the engineering analysis would result in component swaps, which would not make the product significantly more complex and would not be difficult to implement. While some product development effort would be required, DOE does not expect the standby mode and off mode standard to meaningfully affect the amount of labor required in production. Consequently, DOE does not anticipate that the proposed standby mode and off mode standards will have a significant impact on direct employment.

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 residential boiler manufacturers stated that their current production is only running at 50-percent to 70-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 manufactures 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 3 (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 residential boiler 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 13 manufacturers in the residential boiler industry that qualify as small businesses. For a discussion of the impacts on the small manufacturer subgroup, see the regulatory flexibility analysis in section VI.B of this notice 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 appliance efficiency.

For the cumulative regulatory burden analysis, DOE looks at other regulations that could affect residential boiler manufacturers that will take effect approximately three years before or after the 2020 compliance date of amended energy conservation standards for these products. In interviews, manufacturers cited Federal regulations on equipment other than residential 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 the Table V.26. DOE has included certain Federal regulations in the Table V.26 that have compliance dates beyond the three-year range of DOE's analysis, because those regulations were cited multiple times by manufacturers in interviews and written comments; they are included here for reference.

Table V.26. Compliance Dates and Expected Conversion Expenses of Federal Energy Conservation Standards Affecting Residential Boilers Manufacturers

Federal Energy Conservation Standards	Approximate Compliance Date	Estimated Total Industry Conversion Expense
2007 Residential Furnaces & Boilers 72 FR 65136 (Nov. 19, 2007)	2015	$88M (2006$)*
2011 Residential Furnaces 76 FR 37408 (June 27, 2011); 76 FR 67037 (Oct. 31, 2011)	2015	$2.5M (2009$)**
Commercial Refrigeration Equipment	2017	$184.0M (2012$)
Dishwashers***	2018	TBD
Commercial Packaged Air Conditioners and Heat Pumps***	2018	TBD
Commercial Warm-Air Furnaces***	2018	TBD
Furnace Fans	2019	$40.6M (2013$)
Miscellaneous Residential Refrigeration***	2019	TBD
Single Package Vertical Air Conditioners and Heat Pumps***	2019	TBD
Commercial Water Heaters***	2019	TBD
Packaged Terminal Air Conditioners and Heat Pumps***	2019	TBD
Kitchen Ranges and Ovens***	2020	TBD
Commercial Packaged Boilers***	2020	TBD
Non-weatherized Gas-fired Furnaces and Mobile Home Furnaces***	2021	TBD
Direct Heating Equipment/Pool Heaters***	2021	TBD
Residential Water Heaters***	2021	TBD
Clothes Dryers***	2022	TBD
Central Air Conditioners***	2022	TBD
Residential Refrigerators and Freezers***	2022	TBD
Room Air Conditioners***	2022	TBD
Commercial Packaged Air Conditioning and Heating	2023	TBD

Equipment (Evaporatively and Water Cooled) ***		
Residential Clothes Washers***	2023	TBD

* Conversion expenses for manufacturers of oil-fired furnaces and gas-fired and oil-fired boilers associated with the November 2007 final rule for residential furnaces and boilers are excluded from this figure. The 2011 direct final rule for residential furnaces sets a higher standard and earlier compliance date for oil furnaces than the 2007 final rule. As a result, manufacturers will be required design to the 2011 direct final rule standard. The conversion costs associated with the 2011 direct final rule are listed separately in this table. EISA 2007 legislated higher standards and earlier compliance dates for residential boilers than were in the November 2007 final rule. As a result, gas-fired and oil-fired boiler manufacturers were required to design to the EISA 2007 standard beginning in 2012. The conversion costs listed for residential gas-fired and oil-fired boilers in the November 2007 residential furnaces and boilers final rule analysis are not included in this figure.
**Estimated industry conversion expenses and approximate compliance date reflect a court-ordered April 24, 2014 remand of the residential non-weatherized and mobile home gas furnaces standards set in the 2011 Energy Conservation Standards for Residential Furnaces and Residential Central Air Conditioners and Heat Pumps. The costs associated with this rule reflect implementation of the amended standards for the remaining furnace product classes (*i.e.*, oil-fired furnaces).
***The NOPR and final rule for this energy conservation standard have not been published. The compliance date and analysis of conversion costs are estimates and have not been finalized at this time.

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

Revised DOE Test Procedure for Residential Boilers

DOE is currently considering revisions to its test procedure for residential furnaces and boilers, and it is expected that a revised test procedure would increase testing burden for manufacturers. On July 28, 2008, DOE published a technical amendment to the 2007 furnaces and boilers final rule, whose purpose was to add design requirements established in the Energy Independence and Security Act of 2007 (EISA 2007). 73 FR 43611. These requirements prohibit constant-burning pilot lights for gas-fired hot water boilers and gas-fired steam boilers, and require an automatic means for adjusting the water temperature for gas-fired hot water boilers, oil-fired hot water boilers, and electric hot water boilers. The test procedure is expected to be revised to include two test methods to verify the functionality of the automatic means of adjusting the water temperature, which would increase the testing burden for residential boiler manufacturers and thereby the cumulative regulatory burden.

3. National Impact Analysis

a. Significance of Energy Savings

For each TSL, DOE projected energy savings for residential boilers purchased in the 30-year period that begins in the year of anticipated compliance with amended standards (2020–2049). The savings are measured over the entire lifetime of product 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 base case. Table V.27 presents the estimated primary energy savings for each considered TSL for AFUE standards, and Table V.28 presents the estimated FFC energy savings for each TSL for AFUE standards. Table V.29 presents the estimated primary energy savings for each considered TSL for standby mode and off mode, and Table V.30 presents the estimated FFC energy savings for each TSL for standby mode and off mode. The approach for estimating national energy savings is further described in section IV.H.

Table V.27. Cumulative National Primary Energy Savings for Residential Boiler AFUE Trial Standard Levels for Units Sold in 2020–2049

Product Class	**Trial Standard Level**				
	1	2	3	4	5
	quads				
Gas-fired hot water boilers	0.030	0.076	0.134	0.735	1.231
Gas-fired steam boilers	0.006	0.006	0.006	0.006	0.023
Oil-fired hot water boilers	0.012	0.043	0.043	0.274	0.274

Oil-fired steam boilers	0.003	0.009	0.009	0.009	0.009
Total -- All Classes*	**0.05**	**0.13**	**0.19**	**1.02**	**1.54**

* Note: Components may not sum due to rounding.

Table V.28. Cumulative National Full-Fuel-Cycle Energy Savings for Residential Boiler AFUE Trial Standard Levels for Units Sold in 2020–2049

Product Class	**Trial Standard Level**				
	1	2	3	4	5
	quads				
Gas-fired hot water boilers	0.033	0.084	0.148	0.812	1.357
Gas-fired steam boilers	0.006	0.006	0.006	0.006	0.025
Oil-fired hot water boilers	0.014	0.050	0.050	0.321	0.321
Oil-fired steam boilers	0.003	0.011	0.011	0.011	0.011
Total -- All Classes*	**0.06**	**0.15**	**0.21**	**1.15**	**1.71**

* Note: Components may not sum due to rounding.

Table V.29. Cumulative National Primary Energy Savings for Residential Boiler Standby Mode and Off Mode Trial Standard Levels for Units Sold in 2020–2049

Product Class	**Trial Standard Level**		
	1	2	3
	quads		
Gas-Fired Hot Water Boilers	0.020	0.024	0.033
Gas-Fired Steam Boilers	0.0023	0.0027	0.0027
Oil-Fired Hot Water Boilers	0.0071	0.0071	0.0071
Oil-Fired Steam Boilers	0.0005	0.0005	0.0005
Electric Hot Water Boilers	0.0006	0.0006	0.0006
Electric Steam Boilers	0.0001	0.0001	0.0001
Total -- All Classes*	**0.020**	**0.024**	**0.033**

* Note: Components may not sum due to rounding.

Table V.30. Cumulative National Full-Fuel-Cycle Energy Savings for Residential Boiler Standby Mode and Off Mode Trial Standard Levels for Units Sold in 2020–2049

Product Class	Trial Standard Level		
	1	2	3
	quads		
Gas-Fired Hot Water Boilers	0.020	0.024	0.034
Gas-Fired Steam Boilers	0.0023	0.0028	0.0028
Oil-Fired Hot Water Boilers	0.0072	0.0072	0.0072
Oil-Fired Steam Boilers	0.0005	0.0005	0.0005
Electric Hot Water Boilers	0.0006	0.0006	0.0006
Electric Steam Boilers	0.0001	0.0001	0.0001
Total -- All Classes*	**0.031**	**0.035**	**0.045**

* Note: Components may not sum due to rounding.

OMB Circular A-4[93] requires agencies to present analytical results, including separate schedules of the monetized benefits and costs that show the type and timing of benefits and costs. Circular A-4 also directs agencies to consider the variability of key elements underlying the estimates of benefits and costs. For this rulemaking, DOE undertook a sensitivity analysis using nine, rather than 30, years of product shipments. The choice of a nine-year period is a proxy for the timeline in EPCA for the review of certain energy conservation standards and potential revision of and compliance with such revised standards.[94] The review timeframe established in EPCA is generally not

[93] 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/)

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

synchronized with the product lifetime, product manufacturing cycles, or other factors specific to residential boilers. Thus, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology. The NES results based on a nine-year analytical period are presented for the AFUE TSLs in Table V.31.[95] The impacts are counted over the lifetime of residential boilers purchased in 2020–2028.

Table V.31. Cumulative National FFC Energy Savings for Trial Standard Levels for Residential Boilers Sold in 2020–2028, AFUE Standards

Product Class	Trial Standard Level				
	1	2	3	4	5
	quads				
Gas-fired hot water boilers	0.012	0.030	0.054	0.301	0.381
Gas-fired steam boilers	0.002	0.002	0.002	0.002	0.008
Oil-fired hot water boilers	0.006	0.021	0.021	0.146	0.123
Oil-fired steam boilers	0.001	0.005	0.005	0.005	0.004
Total -- All Classes*	**0.02**	**0.06**	**0.08**	**0.45**	**0.52**

* Note: Components may not sum 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 residential boilers. In accordance with

occurs in the timing of standards reviews and the fact that for some consumer products, the compliance period is 5 years rather than 3 years.

[95] DOE presents results based on a nine-year analytical period only for the AFUE TSLs, because the corresponding impacts for the standby mode and off mode TSLs are very small.

OMB's guidelines on regulatory analysis,[96] DOE calculated the NPV using both a 7-percent and a 3-percent real discount rate.

Table V.32 shows the consumer NPV results for each AFUE TSL considered for residential boilers. In each case, the impacts cover the lifetime of products purchased in 2020–2049.

Table V.32. Cumulative Net Present Value of Consumer Benefits for Trial Standard Levels for Residential Boilers Sold in 2020–2049, AFUE Standards

Product Class	Discount Rate %	Trial Standard Level				
		1	2	3	4	5
		billion 2013$**				
Gas-fired hot water boiler	3%	0.17	0.48	0.65	1.86	2.33
Gas-fired steam boiler		0.03	0.03	0.03	0.03	0.01
Oil-fired hot water boiler		0.13	0.49	0.49	1.42	1.42
Oil-fired steam boiler		0.03	0.11	0.11	0.11	0.11
Total -- All Classes*		**0.37**	**1.12**	**1.28**	**3.42**	**3.87**
Gas-fired hot water boiler	7%	0.05	0.16	0.18	0.12	(0.24)
Gas-fired steam boiler		0.01	0.01	0.01	0.01	(0.02)
Oil-fired hot water boiler		0.04	0.14	0.14	0.02	0.02
Oil-fired steam boiler		0.01	0.03	0.03	0.03	0.03
Total -- All Classes*		**0.11**	**0.34**	**0.36**	**0.19**	**(0.20)**

* Note: Components may not sum due to rounding.
** Parentheses indicate negative values.

The NPV results based on the aforementioned nine-year analytical period are presented in Table V.33 for AFUE standards. The impacts are counted over the lifetime

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

of products purchased in 2020–2028. As mentioned previously, such results are presented for informational purposes only and is not indicative of any change in DOE's analytical methodology or decision criteria.

Table V.33. Cumulative Net Present Value of Consumer Benefits for Trial Standard Levels for Residential Boilers Sold in 2020–2028, AFUE Standards

Product Class	**Discount Rate %**	**Trial Standard Level**				
		1	2	3	4	5
		billion 2013$**				
Gas-fired hot water boiler	3%	0.07	0.19	0.26	0.84	1.11
Gas-fired steam boiler		0.01	0.01	0.01	0.01	0.01
Oil-fired hot water boiler		0.06	0.24	0.24	1.00	1.00
Oil-fired steam boiler		0.02	0.06	0.06	0.06	0.06
Total -- All Classes*		**0.16**	**0.50**	**0.57**	**1.90**	**2.18**
Gas-fired hot water boiler	7%	0.03	0.08	0.09	0.12	0.00
Gas-fired steam boiler		0.01	0.01	0.01	0.01	(0.01)
Oil-fired hot water boiler		0.02	0.09	0.09	0.18	0.18
Oil-fired steam boiler		0.01	0.02	0.02	0.02	0.02
Total -- All Classes*		**0.06**	**0.20**	**0.21**	**0.33**	**0.20**

* Note: Components may not sum due to rounding.
** Parentheses indicate negative values.

The above results reflect the use of a flat trend to estimate the change in price for residential boilers over the analysis period (see section IV.H). DOE also conducted a sensitivity analysis that considered one scenario with a lower rate of price decline than the reference case and one scenario with a higher rate of price decline than the reference case. The results of these alternative cases are presented in appendix 10C of the NOPR TSD.

Table V.34 shows the consumer NPV results for each standby mode and off mode TSL considered for residential boilers. In each case, the impacts cover the lifetime of products purchased in 2020–2049.

Table V.34. Cumulative Net Present Value of Consumer Benefits for Trial Standard Levels for Residential Boilers Sold in 2020–2049, Standby Mode and Off Mode Standards

Product Class	**Discount Rate %**	**Trial Standard Level**		
		1	2	3
		billion 2013$		
Gas-Fired Hot Water Boiler	3%	0.25	0.21	0.33
Gas-Fired Steam Boiler		0.031	0.027	0.027
Oil-Fired Hot Water Boiler		0.104	0.073	0.071
Oil-Fired Steam Boiler		0.008	0.006	0.006
Electric Hot Water Boiler		0.006	0.003	0.003
Electric Steam Boiler		0.0006	0.0005	0.0005
Total -- All Classes*		**0.401**	**0.325**	**0.437**
Gas-Fired Hot Water Boiler	7%	0.10	0.08	0.13
Gas-Fired Steam Boiler		0.013	0.010	0.010
Oil-Fired Hot Water Boiler		0.044	0.027	0.026
Oil-Fired Steam Boiler		0.003	0.002	0.002
Electric Hot Water Boiler		0.002	0.001	0.001
Electric Steam Boiler		0.0003	0.0002	0.0002
Total -- All Classes*		**0.167**	**0.121**	**0.167**

* Note: Components may not sum due to rounding.

c. Indirect Impacts on Employment

DOE expects that amended energy conservation standards for residential boilers would reduce energy costs for consumers, with the resulting net savings being redirected to other forms of economic activity. Those shifts in spending and economic activity could affect the demand for labor. As described in section IV.N, DOE used an input/output model of the U.S. economy to estimate indirect employment impacts of the TSLs that DOE considered in this rulemaking. DOE understands that there are uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Therefore, DOE generated results for near-term time frames (2020 to 2025), where these uncertainties are reduced.

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

4. Impact on Product Utility or Performance

DOE has tentatively concluded that the amended standards it is proposing in this NOPR would not lessen the utility or performance of residential boilers.

5. Impact of Any Lessening of Competition

DOE considered any lessening of competition that is likely to result from new or 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 in writing to the Secretary, together with an analysis of the nature and extent of such impact.

To assist the Attorney General in making such determination, DOE has provided DOJ with copies of this NOPR 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. Energy savings from amended standards for the residential boilers covered in this NOPR could also produce environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases associated with electricity production. Table V.35 provides DOE's estimate of cumulative emissions reductions projected to result from the AFUE TSLs considered. Table V.36 provides DOE's estimate of cumulative emissions reductions projected to result from the TSLs considered in this rulemaking for standby mode and off mode boiler efficiency. The tables include both power sector emissions and upstream emissions. The emissions were calculated using the multipliers discussed in section IV.K. DOE reports annual emissions reductions for each TSL in chapter 13 of the NOPR TSD.

Table V.35. Cumulative Emissions Reduction Estimated for Residential Boiler Trial Standard Levels for AFUE Standards

	Trial Standard Level				
	1	2	3	4	5
Site and Power Sector Emissions*					
CO_2 (million metric tons)	3.04	8.31	11.4	61.8	88.8
SO_2 (thousand tons)	0.088	0.600	0.165	(0.297)	0.193
NO_X (thousand tons)	2.73	7.35	10.3	57.2	80.5
Hg (tons)	0.000	0.000	(0.001)	(0.006)	(0.005)
CH_4 (thousand tons)	0.069	0.224	0.243	1.18	1.79
N_2O (thousand tons)	0.026	0.093	0.090	0.488	0.555
Upstream Emissions					
CO_2 (million metric tons)	0.404	1.12	1.52	8.34	11.6
SO_2 (thousand tons)	0.042	0.151	0.147	0.852	0.873
NO_X (thousand tons)	5.77	15.6	21.7	119	169
Hg (tons)	0.000	0.000	0.000	0.000	0.000
CH_4 (thousand tons)	28.5	66.3	110	584	938
N_2O (thousand tons)	0.002	0.007	0.007	0.041	0.047
Total FFC Emissions					
CO_2 (million metric tons)	3.45	9.43	12.9	70.2	100
SO_2 (thousand tons)	0.130	0.751	0.312	0.555	1.07
NO_X (thousand tons)	8.50	23.0	32.1	176	250
Hg (tons)	0.000	0.000	(0.001)	(0.005)	(0.004)
CH_4 (thousand tons)	28.6	66.5	110	585	940
CH_4 (thousand tons CO_2eq)**	800	1,863	3,084	16,381	26,325
N_2O (thousand tons)	0.028	0.100	0.097	0.529	0.602
N_2O (thousand tons CO_2eq)**	7.35	26.4	25.7	140	160

* Primarily site emissions. Values include the increase in power sector emissions from higher electricity use at TSLs 4 and 5.
** CO_2eq is the quantity of CO_2 that would have the same global warming potential (GWP).
Note: Parentheses indicate negative values.

Table V.36. Cumulative Emissions Reduction Estimated for Residential Boiler Trial Standard Levels for Standby Mode and Off Mode Standards

	Trial Standard Level		
	1	2	3
Power Sector Emissions			
CO_2 (million metric tons)	1.32	1.51	1.92
SO_2 (thousand tons)	1.49	1.71	2.16
NO_X (thousand tons)	0.016	0.018	0.021
Hg (tons)	0.002	0.003	0.003
CH_4 (thousand tons)	0.203	0.232	0.294
N_2O (thousand tons)	0.040	0.046	0.059
Upstream Emissions			
CO_2 (million metric tons)	0.09	0.11	0.14
SO_2 (thousand tons)	0.020	0.023	0.029
NO_X (thousand tons)	1.300	1.490	1.886
Hg (tons)	0.0001	0.0001	0.0001
CH_4 (thousand tons)	7.91	9.06	11.47
N_2O (thousand tons)	0.001	0.001	0.001
Total FFC Emissions			
CO_2 (million metric tons)	1.42	1.62	2.05
SO_2 (thousand tons)	1.51	1.73	2.19
NO_X (thousand tons)	1.32	1.51	1.91
Hg (tons)	0.002	0.003	0.004
CH_4 (thousand tons)	8.1	9.3	11.8
CH_4 (thousand tons CO_2eq)*	227.1	260.2	329.4
N_2O (thousand tons)	0.041	0.047	0.060
N_2O (thousand tons CO_2eq)*	11.0	12.6	15.9

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

As part of the analysis for this proposed rule, DOE estimated monetary benefits likely to result from the reduced emissions of CO_2 and NO_X that DOE estimated for each of the TSLs considered for residential boilers. As discussed in section IV.L, for $CO_{2,}$ DOE used the most recent values for the SCC developed by an interagency process. The four sets of SCC values for CO_2 emissions reductions in 2015 resulting from that process (expressed in 2013$) are represented by $12.0/metric ton (the average value from a distribution that uses a 5-percent discount rate), $40.5/metric ton (the average value from a distribution that uses a 3-percent discount rate), $62.4/metric ton (the average value from a distribution that uses a 2.5-percent discount rate), and $119/metric ton (the 95^{th}-percentile value from a distribution that uses a 3-percent discount rate). The values for later years are higher due to increasing damages (emissions-related costs) as the projected magnitude of climate change increases.

Table V.37 presents the global value of CO_2 emissions reductions at each TSL for AFUE standards. Table V.38 presents the global value of CO_2 emissions reductions at each TSL for standby and off mode. 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.37. Estimates of Global Present Value of CO_2 Emissions Reduction Under Residential Boiler AFUE Trial Standard Levels

TSL	SCC Case*			
	5% discount rate, average	3% discount rate, average	2.5% discount rate, average	3% discount rate, 95th percentile
	million 2013$			
Site and Power Sector Emissions**				
1	17.4	86.9	140	269
2	47.8	238	384	736
3	65.4	326	525	1,008
4	356	1,770	2,853	5,477
5	507	2,530	4,082	7,831
Upstream Emissions				
1	2.32	11.5	18.6	35.8
2	6.44	32.1	51.7	99.3
3	8.69	43.3	69.9	134
4	48.0	239	385	739
5	66.3	331	534	1,024
Total FFC Emissions				
1	19.7	98.4	159	305
2	54.3	270	435	836
3	74.1	369	595	1,142
4	404	2,009	3,238	6,216
5	573	2,861	4,616	8,855

* For each of the four cases, the corresponding SCC value for emissions in 2015 is $12.0, $40.5, $62.4, and $119 per metric ton (2013$). The values are for CO_2 only (*i.e.*, not CO_{2eq} of other greenhouse gases).

** Includes the increase in power sector emissions from higher electricity use at TSLs 4 and 5.

Table V.38. Estimates of Global Present Value of CO_2 Emissions Reduction Under Residential Boiler Standby Mode and Off Mode Trial Standard Levels

TSL	SCC Case*			
	5% discount rate, average	3% discount rate, average	2.5% discount rate, average	3% discount rate, 95th percentile
	million 2013$			
Power Sector Emissions				
1	7.5	37.6	60.7	116.3
2	8.6	43.0	69.5	133.2
3	10.9	54.4	87.7	168.1
Upstream Emissions				
1	0.52	2.6	4.3	8.1
2	0.59	3.0	4.9	9.3
3	0.75	3.8	6.2	11.8
Total FFC Emissions				
1	8.1	40.2	64.9	124.5
2	9.2	46.1	74.3	142.5
3	11.6	58.2	93.9	179.9

* For each of the four cases, the corresponding SCC value for emissions in 2015 is $12.0, $40.5, $62.4, and $119 per metric ton (2013$). The values are for CO_2 only (*i.e.*, not CO_{2eq} of other greenhouse gases).

DOE is well aware that scientific and economic knowledge about the contribution of CO_2 and other greenhouse gas (GHG) emissions to changes in the future global climate and the potential resulting damages to the world economy continues to evolve rapidly. Thus, any value placed on reducing CO_2 emissions in this rulemaking is subject to change. DOE, together with other Federal agencies, will continue to review various methodologies for estimating the monetary value of reductions in CO_2 and other GHG emissions. This ongoing review will consider the comments on this subject that are part of the public record for this and other rulemakings, as well as other methodological assumptions and issues. However, consistent with DOE's legal obligations, and taking into account the uncertainty involved with this particular issue, DOE has included in this proposed rule the most recent values and analyses resulting from the interagency review process.

DOE also estimated a range for the cumulative monetary value of the economic benefits associated with NO_X emissions reductions anticipated to result from amended standards for the residential boiler products that are the subject of this NOPR. The dollar-per-ton values that DOE used are discussed in section IV.L. Table V.39 presents the cumulative present values for NO_X emissions reductions for each AFUE TSL calculated using the average dollar-per-ton values and seven-percent and three-percent discount rates. Table V.40 presents the cumulative present values for NO_X emissions reductions for each standby mode and off mode TSL calculated using the average dollar-per-ton values and seven-percent and three-percent discount rates.

Table V.39. Estimates of Present Value of NO_X Emissions Reduction Under Residential Boiler AFUE Trial Standard Levels

TSL	3% Discount Rate	7% Discount Rate
	million 2013$	
Site and Power Sector Emissions*		
1	3.03	1.15
2	8.17	3.13
3	11.4	4.36
4	63.7	24.5
5	88.8	33.8
Upstream Emissions		
1	6.38	2.42
2	17.3	6.60
3	24.0	9.15
4	132	51.0
5	186	71.0

Total FFC Emissions**		
1	9.40	3.58
2	25.5	9.73
3	35.5	13.5
4	196	75.6
5	275	105

* Includes the increase in power sector emissions from higher electricity use at TSLs 4 and 5.
** Components may not sum to total due to rounding.

Table V.40. Estimates of Present Value of NO_X Emissions Reduction Under Residential Boiler Standby Mode and Off Mode Trial Standard Levels

TSL	3% Discount Rate	7% Discount Rate
	million 2013$	
Power Sector Emissions		
1	0.08	0.07
2	0.09	0.08
3	0.11	0.10
Upstream Emissions		
1	1.37	0.49
2	1.56	0.56
3	1.97	0.70
Total FFC Emissions**		
1	1.44	0.56
2	1.65	0.64
3	2.08	0.80

** Components may not sum to total due to rounding.

7. Other Factors

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

8. Summary of National Economic Impacts

The NPV of the monetized benefits associated with emissions reductions can be viewed as a complement to the NPV of the consumer savings calculated for each TSL considered in this rulemaking. Table V.41 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 AFUE TSL for residential boilers considered in this rulemaking, at both a seven-percent and three-percent discount rate. Table V.42 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 standby mode and off mode TSL for residential boilers considered in this rulemaking, at both a seven-percent and three-percent discount rate. The CO_2 values used in the columns of each table correspond to the four sets of SCC values discussed above.

Table V.41 Residential Boiler TSLs (AFUE): Net Present Value of Consumer Savings Combined with Present Value of Monetized Benefits from CO_2 and NO_X Emissions Reductions

TSL	Consumer NPV at 3% Discount Rate added with:			
	SCC Case $12.0/metric ton CO_2^* and Medium Value for NO_X	SCC Case $40.5/metric ton CO_2^* and Medium Value for NO_X	SCC Case $62.4/metric ton CO_2^* and Medium Value for NO_X	SCC Case $119/metric ton CO_2^* and Medium Value for NO_X
	Billion 2013$			
1	0.4	0.5	0.5	0.7
2	1.2	1.4	1.6	2.0
3	1.4	1.7	1.9	2.5
4	4.0	5.6	6.9	9.8
5	4.7	7.0	8.8	13.0
TSL	Consumer NPV at 7% Discount Rate added with:			
	SCC Case	SCC Case	SCC Case	SCC Case

	$12.0/metric ton CO_2*	$40.5/metric ton CO_2*	$62.4/metric ton CO_2*	$119/metric ton CO_2*
	Billion 2013$			
1	0.1	0.2	0.3	0.4
2	0.4	0.6	0.8	1.2
3	0.4	0.7	1.0	1.5
4	0.7	2.3	3.5	6.5
5	0.5	2.8	4.5	8.8

* These label values represent the global SCC in 2015, in 2013$. For NO_X emissions, each case uses the medium value, which corresponds to $2,684 per ton.

Table V.42 Residential Boiler TSLs (Standby Mode and Off Mode): Net Present Value of Consumer Savings Combined with Present Value of Monetized Benefits from CO_2 and NO_X Emissions Reductions

TSL	Consumer NPV at 3% Discount Rate added with:			
	SCC Case $12.0/metric ton CO_2* and Medium Value for NO_X	SCC Case $40.5/metric ton CO_2* and Medium Value for NO_X	SCC Case $62.4/metric ton CO_2* and Medium Value for NO_X	SCC Case $119/metric ton CO_2* and Medium Value for NO_X
	Billion 2013$			
1	0.41	0.44	0.47	0.53
2	0.34	0.37	0.40	0.47
3	0.45	0.50	0.53	0.62
TSL	Consumer NPV at 7% Discount Rate added with:			
	SCC Case $12.0/metric ton CO_2*	SCC Case $40.5/metric ton CO_2*	SCC Case $62.4/metric ton CO_2*	SCC Case $119/metric ton CO_2*
	Billion 2013$			
1	0.18	0.21	0.23	0.29
2	0.13	0.17	0.20	0.26
3	0.18	0.23	0.26	0.35

* These label values represent the global SCC in 2015, in 2013$. For NO_X emissions, each case uses the medium value, which corresponds to $2,684 per ton.

Although adding the value of consumer savings to the values of emission reductions provides a valuable perspective, two issues should be considered. First, the national operating cost savings are domestic U.S. 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 different time frames for analysis. The national operating cost savings is measured for the lifetime of products shipped in 2020–2049. The SCC values, on the other hand, reflect the present value of future climate-related impacts resulting from the emission of one metric ton of CO_2 in each year; these impacts continue well beyond 2100.

C. Proposed Standards

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

For this NOPR, DOE considered the impacts of amended standards for residential 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 summarize the quantitative analytical results for each TSL, based on the assumptions and methodology discussed herein. The efficiency levels contained in each TSL are described in section V.A. 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 consumer who may be disproportionately affected by a national standard (see section V.B.1.b), and impacts on employment. DOE discusses the impacts on direct employment in residential boiler manufacturing in section V.B.2.b, and discusses the indirect employment impacts in section V.B.3.c.

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

In DOE's current regulatory analysis, potential changes in the benefits and costs of a regulation due to changes in consumer purchase decisions are included in two ways. First, if consumers forego a purchase of a product in the standards case, this decreases sales for product manufacturers and the cost to manufacturers is included in the MIA. Second, DOE accounts for energy savings attributable only to products actually used by consumers in the standards case; if a standard decreases the number of products purchased by consumers, this decreases the potential energy savings from an energy conservation standard. DOE provides estimates of changes in the volume of product purchases in chapter 9 of the NOPR TSD. DOE's current analysis does not explicitly control for heterogeneity in consumer preferences, preferences across subcategories of products or specific features, or consumer price sensitivity variation according to household income.[97]

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

While DOE is not prepared at present to provide a fuller quantifiable framework for estimating the benefits and costs of changes in consumer purchase decisions due to an energy conservation standard, DOE is committed to developing a framework that can support empirical quantitative tools for improved assessment of the consumer welfare impacts of appliance standards. DOE has posted a paper that discusses the issue of consumer welfare impacts of appliance standards, and potential enhancements to the methodology by which these impacts are defined and estimated in the regulatory process.[98] DOE welcomes comments on how to more fully assess the potential impact of energy conservation standards on consumer choice and how to quantify this impact in its regulatory analysis.

1. Benefits and Burdens of Trial Standard Levels Considered for Residential Boilers for AFUE Standards

Table V.43 and Table V.44 summarize the quantitative impacts estimated for each AFUE TSL for residential boilers. The national impacts are measured over the lifetime of residential boilers purchased in the 30-year period that begins in the year of compliance with amended standards (2020-2049). The energy savings, emissions reductions, and value of emissions reductions refer to full-fuel-cycle results. The efficiency levels contained in each TSL are described in section IV.A.

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

Table V.43. Summary of Analytical Results for Residential Boilers AFUE TSLs: National Impacts

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
National FFC Energy Savings (quads)					
	0.06	0.15	0.21	1.15	1.71
NPV of Consumer Benefits (2013$ billion)					
3% discount rate	0.37	1.12	1.28	3.42	3.87
7% discount rate	0.11	0.34	0.36	0.19	(0.20)
Cumulative Emissions Reduction (Total FFC Emissions)*					
CO_2 (million metric tons)	3.45	9.43	12.9	70.2	100
SO_2 (thousand tons)	0.130	0.751	0.312	0.555	1.07
NO_X (thousand tons)	8.50	23.0	32.1	176	250
Hg (tons)	0.000	0.000	(0.001)	(0.005)	(0.004)
N_2O (thousand tons)	0.028	0.100	0.097	0.529	0.602
N_2O (thousand tons CO_2eq)	7.35	26.4	25.7	140	160
CH_4 (thousand tons)	28.6	66.5	110	585	940
CH_4 (thousand tons CO_2eq)**	800	1,863	3,084	16,381	26,325
Value of Emissions Reduction (Total FFC Emissions)					
CO_2 (2013$ billion)†	0.020 to 0.30	0.054 to 0.84	0.074 to 1.14	0.404 to 6.22	0.573 to 8.86
NO_X – 3% discount rate (2013$ million)	9.4	25.5	35.5	196	275
NO_X – 7% discount rate (2013$ million)	3.58	9.73	13.5	75.6	105

* Includes the increase in power sector emissions from higher electricity use at TSLs 4 and 5.
** CO_2eq is the quantity of CO_2 that would have the same global warming potential (GWP).
† Range of the economic value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions.
Note: Parentheses indicate negative values.

Table V.44. Summary of Analytical Results for Residential Boilers AFUE TSLs: Manufacturer and Consumer Impacts

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Manufacturer Impacts					
Industry NPV (2013$ million) Base Case = 380.96	379.17 to 380.91	378.31 to 383.35	372.97 to 381.73	284.75 to 369.87	241.69 to 380.46
Change in Industry NPV (2013$ million)	(1.79) to (0.04)	(2.65) to 2.39	(7.99) to 0.77	(96.21) to (11.08)	(139.26) to (0.50)
Change in Industry NPV (%)†	(0.47) to (0.01)	(0.70) to 0.63	(2.1) to 0.20	(25.25) to (2.91)	(36.56) to (0.13)
Consumer Mean LCC Savings (2013$)					
Gas-fired hot water boilers	35	100	123	201	134
Gas-fired steam boilers	61	61	61	61	250
Oil-fired hot water boilers	72	257	257	273	273
Oil-fired steam boilers	259	723	723	723	723
Shipment-Weighted Average**	52	155	169	221	195
Consumer Median PBP (years)					
Gas-fired hot water boilers	1.58	1.58	7.72	18.77	22.13
Gas-fired steam boilers	1.32	1.32	1.32	1.32	11.58
Oil-fired hot water boilers	8.34	7.59	7.59	21.36	21.36
Oil-fired steam boilers	6.31	10.51	10.51	10.51	10.51
Shipment-Weighted Average**	3.54	3.43	7.23	17.88	20.79
Distribution of Consumer LCC Impacts					
Gas-fired hot water boilers*					
Consumers with Net Cost (%)	4	3	13	38	57
Consumers with Net Benefit (%)	18	29	30	33	36
Consumers with No Impact (%)	79	68	57	29	7
Gas-fired steam boilers*					
Consumers with Net Cost (%)	1	1	1	1	28
Consumers with Net Benefit (%)	14	14	14	14	61
Consumers with No Impact (%)	86	86	86	86	11
Oil-fired hot water boilers*					
Consumers with Net Cost (%)	4	9	9	54	54
Consumers with Net Benefit (%)	15	42	42	38	38
Consumers with No Impact (%)	81	49	49	8	8
Oil-fired steam boilers*					
Consumers with Net Cost (%)	3	23	23	23	23
Consumers with Net Benefit (%)	27	67	67	67	67

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Consumers with No Impact (%)	71	10	10	10	10

* Rounding may cause some items to not total 100 percent.
‡ Note: Parentheses indicate negative values.
**Weighted by shares of each product class in total projected shipments in 2020.
† Note: Parentheses indicate negative values.

First, DOE considered TSL 5, the most efficient level (max-tech), which would save an estimated total of 1.71 quads of energy, an amount DOE considers significant. TSL 5 has an estimated NPV of consumer benefit of -$0.2 billion using a 7-percent discount rate, and $3.87 billion using a 3-percent discount rate.

The cumulative emissions reductions at TSL 5 are 100 million metric tons of CO_2, 250 thousand tons of NO_X, 1.07 thousand tons of SO_2, 0.602 thousand tons of N_2O, 940 thousand tons of CH_4, and -0.004 tons of Hg.[99] The estimated monetary value of the CO_2 emissions reductions at TSL 5 ranges from $0.57 billion to $8.86 billion.

At TSL 5, the average LCC savings are $134 for gas-fired hot water boilers, $250 for gas-fired steam boilers, $273 for oil-fired hot water boilers, and $723 for oil-fired steam boilers. The median PBP is 22.1 years for gas-fired hot water boilers, 11.6 years gas-fired steam boilers, 21.4 years for oil-fired hot water boilers, and 10.5 years for oil-fired steam boilers. The share of consumers experiencing a net LCC benefit is 36 percent for gas-fired hot water boilers, 61 percent for gas-fired steam boilers, 38 percent for oil-fired hot water boilers, and 67 percent for oil-fired steam boilers, while the share of

[99] TSL 5 is estimated to cause a very slight increase in mercury emissions due to associated increase in boiler electricity use.

consumers experiencing a net LCC cost is 57 percent for gas-fired hot water boilers, 28 percent for gas-fired steam boilers, 54 percent for oil-fired hot water boilers, and 23 percent for oil-fired steam boilers.

At TSL 5, the projected change in INPV ranges from a decrease of $139.26 million to a decrease of $0.5 million. If the decrease of $139.26 million were to occur, TSL 5 could result in a net loss of 36.56 percent in INPV to manufacturers of covered residential boilers.

The Secretary tentatively concludes that, at TSL 5 for residential boilers, the benefits of energy savings, positive NPV of total consumer benefits at a 3-percent discount rate, average consumer LCC savings, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the large reduction in industry value at TSL 5, the negative NPV of total consumer benefits at a 7-percent discount rate, and the high number of consumers experiencing a net LCC cost for gas-fired hot water boilers and oil-fired hot water boilers. Consequently, DOE has concluded that TSL 5 is not economically justified.

Next, DOE considered TSL 4, which would save an estimated total of 1.15 quads of energy, an amount DOE considers significant. TSL 4 has an estimated NPV of consumer benefit of $0.19 billion using a 7-percent discount rate, and $3.42 billion using a 3-percent discount rate.

The cumulative emissions reductions at TSL 4 are 70.2 million metric tons of CO_2, 176.12 thousand tons of NO_X, 0.55 thousand tons of SO_2, 0.529 thousand tons of N_2O, 585 thousand tons of CH_4, and -0.005 tons of Hg.[100] The estimated monetary value of the CO_2 emissions reductions at TSL 4 ranges from $0.40 billion to $6.22 billion.

At TSL 4, the average LCC savings are $201 for gas-fired hot water boilers, $61 for gas-fired steam boilers, $273 for oil-fired hot water boilers, and $723 for oil-fired steam boilers. The median PBP is 18.8 years for gas-fired hot water boilers, 1.3 years gas-fired steam boilers, 21.4 years for oil-fired hot water boilers, and 10.5 years for oil-fired steam boilers. The share of consumers experiencing a net LCC benefit is 33 percent for gas-fired hot water boilers, 14 percent for gas-fired steam boilers, 38 percent for oil-fired hot water boilers, and 67 percent for oil-fired steam boilers, while the share of consumers experiencing a net LCC cost is 38 percent for gas-fired hot water boilers, 1 percent for gas-fired steam boilers, 54 percent for oil-fired hot water boilers, and 23 percent for oil-fired steam boilers.

At TSL 4, the projected change in INPV ranges from a decrease of $96.21 million to a decrease of $11.08 million. If the decrease of $96.21 million were to occur, TSL 4 could result in a net loss of 25.25 percent in INPV to manufacturers of covered residential boilers.

[100] TSL 4 is estimated to cause a very slight increase in mercury emissions due to associated increase in boiler electricity use.

DOE strongly considered TSL 4, but based on the information available, the Secretary tentatively concludes that, at TSL 4 for residential boilers, the benefits of energy savings, positive NPV of total consumer benefits, average consumer LCC savings, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the large reduction in industry value at TSL 4 and the high number of consumers experiencing a net LCC cost for gas-fired hot water boilers and oil-fired hot water boilers. Consequently, DOE has tentatively concluded that TSL 4 is not economically justified. However, DOE requests comments and data from interested parties that would assist DOE in making a final decision on the weighting of benefits and burdens for TSL 4, and DOE intends to reconsider adoption of TSL 4 in the final rule in light of any comments received.

Next, DOE considered TSL 3, which would save an estimated total of 0.21 quads of energy, an amount DOE considers significant. TSL 3 has an estimated NPV of consumer benefit of $0.36 billion using a 7-percent discount rate, and $1.28 billion using a 3-percent discount rate.

The cumulative emissions reductions at TSL 3 are 12.9 million metric tons of CO_2, 32.1 thousand tons of NO_X, 0.31 thousand tons of SO_2, 0.097 thousand tons of N_2O, 110 thousand tons of CH_4, and -0.001 tons of Hg.[101] The estimated monetary value of the CO_2 emissions reductions at TSL 3 ranges from $0.07 billion to $1.14 billion.

[101] TSL 3 is estimated to cause a very slight increase in mercury emissions due to the associated increase in boiler electricity use.

At TSL 3, the average LCC savings are $123 for gas-fired hot water boilers, $61 for gas-fired steam boilers, $257 for oil-fired hot water boilers, and $723 for oil-fired steam boilers. The median PBP is 7.7 years for gas-fired hot water boilers, 1.3 years gas-fired steam boilers, 7.6 years for oil-fired hot water boilers, and 10.5 years for oil-fired steam boilers. The share of consumers experiencing a net LCC benefit is 30 percent for gas-fired hot water boilers, 14 percent for gas-fired steam boilers, 42 percent for oil-fired hot water boilers, and 67 percent for oil-fired steam boilers, while the share of consumers experiencing a net LCC cost is 13 percent for gas-fired hot water boilers, 1 percent for gas-fired steam boilers, 9 percent for oil-fired hot water boilers, and 23 percent for oil-fired steam boilers.

At TSL 3, the projected change in INPV ranges from a decrease of $7.99 million to an increase of $0.77 million. If the decrease of $7.99 million were to occur, TSL 3 could result in a net loss of 2.1 percent in INPV to manufacturers of covered residential boilers.

After considering the analysis and weighing the benefits and the burdens, DOE has tentatively concluded that at TSL 3 for residential boilers, the benefits of energy savings, positive NPV of consumer benefit, positive impacts on consumers (as indicated by positive average LCC savings, favorable PBPs, and a higher percentage of consumers who would experience LCC benefits as opposed to costs), emission reductions, and the estimated monetary value of the emissions reductions would outweigh the potential reductions in INPV for manufacturers. Accordingly, the Secretary of Energy has tentatively concluded that TSL 3 would save a significant amount of energy and is technologically feasible and economically justified. However, as noted above, based on comments received, DOE plans to reconsider TSL 4 in the final rule. Because DOE has not yet reached a final conclusion regarding the weighting of benefits and burdens at TSL 4, it seeks a more complete understanding of the benefits and burdens of moving forward at both TSL 3 and 4, as well as any implementation problems that might be reasonably foreseen.

Based on the above considerations, DOE today proposes to adopt the AFUE energy conservation standards for residential boilers at TSL 3. Table V.45 presents the proposed energy conservation standards for residential boilers.

Table V.45. Proposed Amended AFUE Energy Conservation Standards for Residential Boilers

Product Class	Proposed Standard: AFUE %	Design Requirement
Gas-fired hot water boiler	85	Constant-burning pilot not permitted. Automatic means for adjusting water temperature required (except for boilers equipped with tankless domestic water heating coils).
Gas-fired steam boiler	82	Constant-burning pilot not permitted.
Oil-fired hot water boiler	86	Automatic means for adjusting temperature required (except for boilers equipped with tankless domestic water heating coils).
Oil-fired steam boiler	86	None
Electric hot water boiler	None	Automatic means for adjusting temperature required (except for

		boilers equipped with tankless domestic water heating coils).
Electric steam boiler	None	None

2. Benefits and Burdens of Trial Standard Levels Considered for Residential Boilers for Standby Mode and Off Mode

Table V.46 through Table V.47 summarize the quantitative impacts estimated for each TSL considered for residential boiler standby mode and off mode power. The national impacts are measured over the lifetime of residential boilers purchased in the 30-year period that begins in the year of compliance with amended standards (2020-2049). The energy savings, emissions reductions, and value of emissions reductions refer to full-fuel-cycle results. The efficiency levels contained in each TSL are described in section V.A.

Table V.46 Summary of Analytical Results for Residential Boiler Standby Mode and Off Mode TSLs: National Impacts

Category	TSL 1	TSL 2	TSL 3
National FFC Energy Savings (quads)			
	0.031	0.035	0.045
NPV of Consumer Benefits (2013$ billion)			
3% discount rate	0.401	0.325	0.437
7% discount rate	0.167	0.121	0.167
Cumulative Emissions Reduction (Total FFC Emissions)*			
CO_2 (million metric tons)	1.42	1.62	2.05
SO_2 (thousand tons)	1.51	1.73	2.19
NO_X (thousand tons)	1.32	1.51	1.91
Hg (tons)	0.002	0.003	0.004
CH_4 (thousand tons)	8.1	9.3	11.8
CH_4 (thousand tons CO_2eq)	227.1	260.2	329.4
N_2O (thousand tons)	0.041	0.047	0.060
N_2O (thousand tons CO_2eq)	11.0	12.6	15.9
Value of Emissions Reduction (Total FFC Emissions)			
CO_2 (2013$ billion)*	0.008 to 0.124	0.009 to 0.142	0.012 to 0.180
NO_X – 3% discount rate (2013$ million)	1.44	1.65	2.08
NO_X – 7% discount rate (2013$ million)	0.56	0.64	0.80

* Range of the value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions.

Table V.47 Summary of Analytical Results for Residential Boiler Standby Mode and Off Mode TSLs: Manufacturer and Consumer Impacts

Category	TSL 1	TSL 2	TSL 3
Manufacturer Impacts			
Industry NPV (2013$ million) Base Case = 380.96	380.77 to 380.88	379.94 to 381.16	379.88 to 381.17
Change in Industry NPV (2013$ million)[†]	(0.19) to (0.07)	(1.02) to 0.20	(1.08) to 0.22
Changes in Industry NPV (%)[†]	(0.05) to (0.02)	(0.27) to 0.05	(0.28) to 0.06
Consumer Mean LCC Savings (2013$)			
Gas-Fired Hot Water Boilers	14	7	14
Gas-Fired Steam Boilers	15	9	15
Oil-Fired Hot Water Boilers	15	9	15
Oil-Fired Steam Boilers	14	8	15
Electric Hot Water Boilers	11	3	8
Electric Steam Boilers	11	4	9
Shipment-Weighted Average**	14	8	14
Consumer Median PBP (Years)			
Gas-Fired Hot Water Boilers	1.06	10.43	7.83
Gas-Fired Steam Boilers	1.06	10.30	7.39
Oil-Fired Hot Water Boilers	1.04	10.24	7.39
Oil-Fired Steam Boilers	1.31	10.71	8.35
Electric Hot Water Boilers	1.97	17.65	10.98
Electric Steam Boilers	1.96	10.54	10.88
Shipment-Weighted Average**	1.08	10.52	7.74
Distribution of Consumer LCC Impacts			
Gas-fired hot water boilers*			
Consumers with Net Cost (%)	0	11	6
Consumers with Net Benefit (%)	49	38	44
Consumers with No Impact (%)	51	51	51
Gas-fired steam boilers*			
Consumers with Net Cost (%)	0	9	4
Consumers with Net Benefit (%)	49	41	45
Consumers with No Impact (%)	51	51	51
Oil-fired hot water boilers*			
Consumers with Net Cost (%)	0	9	4
Consumers with Net Benefit (%)	49	41	45
Consumers with No Impact (%)	51	51	51
Oil-fired steam boilers*			
Consumers with Net Cost (%)	0	9	4
Consumers with Net Benefit (%)	49	41	45
Consumers with No Impact (%)	51	51	51
Electric hot water boilers*			
Consumers with Net Cost (%)	0	19	11
Consumers with Net Benefit (%)	49	30	38
Consumers with No Impact (%)	51	51	51
Electric steam boilers*			
Consumers with Net Cost (%)	0	19	11
Consumers with Net Benefit (%)	49	31	38

Consumers with No Impact (%)	51	51	51

* Rounding may cause some items not to total 100 percent.
** Weighted by shares of each product class in total projected shipments in 2020.
† Parentheses indicate negative (-) values.

First, DOE considered TSL 3, the most efficient level (max-tech), which would save an estimated total of 0.045 quads of energy, an amount DOE considers significant. TSL 3 has an estimated NPV of consumer benefit of $0.167 billion using a 7-percent discount rate, and $0.437 billion using a 3-percent discount rate.

The cumulative emissions reductions at TSL 3 are 2.05 million metric tons of CO_2, 1.91 thousand tons of NO_X, 2.19 thousand tons of SO_2, and 0.004 tons of Hg, 0.060 thousand tons of N_2O, and 11.8 thousand tons of CH_4. The estimated monetary value of the CO_2 emissions reductions at TSL 3 ranges from $0.012 billion to $0.180 billion.

At TSL 3, the average LCC savings are $14 for gas-fired hot water boilers, $15 for gas-fired steam boilers, $15 for oil-fired hot water boilers, $15 for oil-fired steam boilers, $8 for electric hot water boilers, and $9 for electric steam boilers. The median PBP is 7.83 years for gas-fired hot water boilers, 7.39 years gas-fired steam boilers, 7.39 years for oil-fired hot water boilers, 8.35 years for oil-fired steam boilers, 10.98 years for electric hot water boilers, and 10.88 years for electric steam boilers. The share of consumers experiencing a net LCC benefit is 44 percent for gas-fired hot water boilers, 45 percent for gas-fired steam boilers, 38 percent for oil-fired hot water boilers, 45 percent for oil-fired steam boilers, 45 percent for electric hot water boilers, and 38 percent for electric steam boilers, while the share of consumers experiencing a net LCC cost is 6 percent for gas-fired hot water boilers, 4 percent for gas-fired steam boilers, 4 percent for oil-fired hot water boilers, 4 percent for oil-fired steam boilers, 11 percent for electric hot water boilers, and 11 percent for electric steam boilers.

At TSL 3, the projected change in INPV ranges from a decrease of $1.08 million to an increase of $0.22 million, depending on the manufacturer markup scenario. If the larger decrease is realized, TSL 3 could result in a net loss of 0.28 percent in INPV to manufacturers of covered residential boilers.

Accordingly, the Secretary tentatively concludes that at TSL 3 for residential boiler standby mode and off mode power, the benefits of energy savings, positive NPV of consumer benefits at both 7-percent and 3-percent discount rates, positive impacts on consumers (as indicated by positive average LCC savings, favorable PBPs, and a higher percentage of consumers who would experience LCC benefits as opposed to costs), emission reductions, and the estimated monetary value of the CO_2 emissions reductions would outweigh the economic burden on a small fraction of consumers due to the increases in product cost. After considering the analysis and the benefits and burdens of TSL 3, the Secretary has tentatively concluded that this trial standard level offers the maximum improvement in energy efficiency that is technologically feasible and economically justified, and will result in the significant conservation of energy. Therefore, DOE proposes to adopt TSL 3 for residential boiler standby mode and off mode. The proposed energy conservation standards for standby mode and off mode, expressed as maximum power in watts, are shown in Table V.48.

Table V.48 Proposed Energy Conservation Standards for Residential Boiler Standby Mode and Off Mode

Product Class	$P_{W,SB}$ **(watts)**	$P_{W,OFF}$ **(watts)**
Gas-fired hot water	9	9
Gas-fired steam	8	8
Oil-fired hot water	11	11
Oil-fired steam	11	11
Electric hot water	8	8
Electric steam	8	8

3. Summary of Benefits and Costs (Annualized) of the Proposed Standards

The benefits and costs of today's proposed standards can also be expressed in terms of annualized values. The annualized monetary values are the sum of: (1) the annualized national economic value (expressed in 2013$) of the benefits from operating products that meet the proposed standards (consisting primarily of operating cost savings from using less energy, minus increases in product purchase costs, which is another way of representing consumer NPV), and (2) the annualized monetary value of the benefits of emission reductions, including CO_2 emission reductions.[102] The value of CO_2 reductions, otherwise known as the Social Cost of Carbon (SCC), is calculated using a range of values per metric ton of CO_2 developed by a recent interagency process.

[102] DOE used a two-step calculation process to convert the time-series of costs and benefits into annualized values. First, DOE calculated a present value in 2013, the year used for discounting the NPV of total consumer costs and savings, for the time-series of costs and benefits using discount rates of three and seven percent for all costs and benefits except for the value of CO_2 reductions. For the latter, DOE used a range of discount rates. From the present value, DOE then calculated the fixed annual payment over a 30-year period (2018 through 2047) that yields the same present value. The fixed annual payment is the annualized value. Although DOE calculated annualized values, this does not imply that the time-series of costs and benefits from which the annualized values were determined is a steady stream of payments.

Although combining the values of operating savings and CO_2 emission reductions provides a useful perspective, two issues should be considered. First, the national operating savings are domestic U.S. 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 CO_2 savings are performed with different methods that use different time frames for analysis. The national operating cost savings is measured for the lifetime of residential boiler products shipped in 2020 –2049. The SCC values, on the other hand, reflect the present value of some future climate-related impacts resulting from the emission of one metric ton of carbon dioxide in each year; these impacts continue well beyond 2100.

Estimates of annualized benefits and costs of the proposed standards for residential boilers 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 estimated cost of the residential boiler standards proposed in today's rule is \$32 million per year in increased equipment costs, while the estimated benefits are \$73 million per year in reduced equipment operating costs, \$22 million per year in CO_2 reductions, and \$1.53 million per year in reduced NO_X emissions. In this case, the net benefit would amount to \$64 million per year.

Using a 3-percent discount rate for all benefits and costs and the average SCC series, the estimated cost of the residential boiler standards proposed in today's rule is

$32 million per year in increased equipment costs, while the estimated benefits are $108 million per year in reduced equipment operating costs, $22 million per year in CO_2 reductions, and $2.10 million per year in reduced NO_X emissions. In this case, the net benefit would amount to $100 million per year.

Table V.49. Annualized Benefits and Costs of Proposed AFUE Standards (TSL 3) for Residential Boilers*

	Discount Rate	Primary Estimate	Low Net Benefits Estimate	High Net Benefits Estimate
		million 2013$/year		
Benefits				
Consumer Operating Cost Savings	7%	73	71	75
	3%	108	105	112
CO_2 Reduction Monetized Value ($12.0/t case)**	5%	6.1	6.1	6.2
CO_2 Reduction Monetized Value ($40.5/t case)**	3%	21.8	21.6	22.0
CO_2 Reduction Monetized Value ($62.4/t case)**	2.5%	32.2	31.9	32.5
CO_2 Reduction Monetized Value ($119/t case)**	3%	67.6	66.9	68.2
NO_X Reduction Monetized Value (at $2,684/ton)**	7%	1.53	1.52	1.53
	3%	2.10	2.08	2.12
Total Benefits†	7% plus CO_2 range	80 to 142	79 to 140	83 to 145
	7%	96	94	99
	3% plus CO_2 range	116 to 177	113 to 174	121 to 183
	3%	132	128	136
Costs				
Consumer Incremental Equipment Costs	7%	32.3	38.7	26.8
	3%	31.7	38.9	25.6
Net Benefits/Costs				
Total†	7% plus CO_2 range	48 to 110	40 to 101	56 to 118
	7%	64	56	72
	3% plus CO_2 range	84 to 146	74 to 135	95 to 157
	3%	100	89	111

* This table presents the annualized costs and benefits associated with residential boilers shipped in 2020‒2049. These results include benefits to consumers which accrue after 2049 from the products purchased in 2020‒2049. The results account for the incremental variable and fixed costs incurred by manufacturers due to the standard, some of which may be incurred in preparation for the rule. The Primary, Low Benefits, and High Benefits Estimates utilize projections of energy prices from the AEO 2013 Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental product costs reflect a medium decline rate for projected product price trends in the Primary Estimate, a low decline rate for projected product price trends in the Low Benefits Estimate, and a high decline rate for projected product price trends in the High Benefits Estimate. The methods used to derive projected price trends are explained in section IV.F.1.
** The interagency group selected four sets of SCC values for use in regulatory analyses. Three sets of values are based on the average SCC from the three integrated assessment models, at discount rates of 2.5, 3, and 5 percent. The fourth set, which represents the 95th percentile SCC estimate across all three models at a 3-percent discount rate, is included to represent higher-than-expected impacts from temperature change further out in the tails of the SCC distribution. The values in parentheses represent the SCC in 2015. The SCC time series incorporate an escalation factor. The value for NO_X is the average of the low and high values used in DOE's analysis.
† Total benefits for both the 3-percent and 7-percent cases are derived using the series corresponding to average SCC with a 3-percent discount rate ($40.5/t in 2015). 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.

Estimates of annualized benefits and costs of the proposed standards for residential boiler standby mode and off mode power are shown in Table V.50. 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 estimated cost of the residential boiler standards proposed in today's rule is $9.31 million per year in increased equipment costs, while the estimated benefits are $28 million per year in reduced equipment operating costs, $3 million per year in CO_2 reductions, and $0.09 million per year in reduced NO_X emissions. In this case, the net benefit would amount to $22 million per year.

Using a 3-percent discount rate for all benefits and costs and the average SCC series, the estimated cost of the residential boiler standards proposed in today's rule is

$9.35 million per year in increased equipment costs, while the estimated benefits are $35 million per year in reduced equipment operating costs, $3 million per year in CO_2 reductions, and $0.12 million per year in reduced NO_X emissions. In this case, the net benefit would amount to $29 million per year.

Table V.50. Annualized Benefits and Costs of Proposed Standby Mode and Off Mode Standards (TSL 3) for Residential Boilers*

	Discount Rate	Primary Estimate	Low Net Benefits Estimate	High Net Benefits Estimate
		million 2013$/year		
Benefits				
Consumer Operating Cost Savings	7%	28	27	29
	3%	35	34	36
CO_2 Reduction Monetized Value ($12.0/t case)**	5%	1	1	1
CO_2 Reduction Monetized Value ($40.5/t case)**	3%	3	3	4
CO_2 Reduction Monetized Value ($62.4/t case)**	2.5%	5	5	5
CO_2 Reduction Monetized Value ($119/t case)**	3%	11	10	11
NO_X Reduction Monetized Value (at $2,684/ton)**	7%	0.09	0.09	0.09
	3%	0.12	0.12	0.13
Total Benefits†	7% plus CO_2 range	29 to 39	28 to 38	30 to 40
	7%	32	30	33
	3% plus CO_2 range	36 to 46	35 to 44	38 to 47
	3%	39	37	40
Costs				
Consumer Incremental Equipment Costs	7%	9.31	9.48	9.13
	3%	9.35	9.55	9.15
Net Benefits/Costs				
Total†	7% plus CO_2 range	20 to 30	19 to 28	21 to 31
	7%	22	21	24
	3% plus CO_2 range	27 to 37	25 to 35	28 to 38
	3%	29	28	31

* This table presents the annualized costs and benefits associated with residential boilers shipped in 2020−2049. These results include benefits to consumers which accrue after 2049 from the products purchased in 2020−2049. The results account for the incremental variable and fixed costs incurred by manufacturers due to the standard, some of which may be incurred in preparation for the rule. The Primary, Low Benefits, and High Benefits Estimates utilize projections of energy prices from the AEO 2013 Reference case, Low Economic Growth case, and High Economic Growth case, respectively.
** The interagency group selected four sets of SCC values for use in regulatory analyses. Three sets of values are based on the average SCC from the three integrated assessment models, at discount rates of 2.5, 3, and 5 percent. The fourth set, which represents the 95th percentile SCC estimate across all three models at a 3-percent discount rate, is included to represent higher-than-expected impacts from temperature change further out in the tails of the SCC distribution. The values in parentheses represent the SCC in 2015. The SCC time series incorporate an escalation factor. The value for NO_X is the average of the low and high values used in DOE's analysis.
† Total benefits for both the 3-percent and 7-percent cases are derived using the series corresponding to average SCC with a 3-percent discount rate ($40.5/t in 2015). 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.

Estimates of the combined annualized benefits and costs of the proposed AFUE and standby mode and off mode standards are shown in Table V.51. The results under the primary estimate are as follows. Using a 7-percent discount rate for benefits and costs other than CO_2 reduction, for which DOE used a 3-percent discount rate along with the average SCC series that uses a 3-percent discount rate ($40.5/t in 2015), the estimated cost of the residential boilers AFUE and standby mode and off mode standards proposed in this rule is $41.7 million per year in increased equipment costs, while the estimated benefits are $101 million per year in reduced equipment operating costs, $25.3 million per year in CO_2 reductions, and $1.62 million per year in reduced NO_X emissions. In this case, the net benefit would amount to $86.3 million per year.

Using a 3-percent discount rate for all benefits and costs and the average SCC series that uses a 3-percent discount rate ($40.5/t in 2015), the estimated cost of the residential boilers AFUE and standby mode and off mode standards proposed in this rule is $41.0 million per year in increased equipment costs, while the estimated benefits are

$143 million per year in reduced equipment operating costs, $25.3 million per year in CO_2 reductions, and $2.22 million per year in reduced NO_X emissions. In this case, the net benefit would amount to $129 million per year.

Table V.51 Annualized Benefits and Costs of Proposed AFUE and Standby Mode and Off Mode Energy Conservation Standards for Residential Boilers (TSL 3)

	Discount Rate %	Primary Estimate*	Low Net Benefits Estimate*	High Net Benefits Estimate*
		million 2013$/year		
Benefits				
Consumer Operating Cost Savings	7	101	98	104
	3	143	138	149
CO_2 Reduction Monetized Value ($12.0/t case)*	5	7.11	7.04	7.18
CO_2 Reduction Monetized Value ($40.5/t case)*	3	25.3	25.0	25.6
CO_2 Reduction Monetized Value ($62.4/t case)*	2.5	37.3	36.8	37.7
CO_2 Reduction Monetized Value ($119/t case)*	3	78.2	77.3	79.1
NO_X Reduction Monetized Value (at $2,684/ton)**	7	1.62	1.61	1.63
	3	2.22	2.20	2.24
Total Benefits†	7 plus CO_2 range	110 to 181	107 to 177	113 to 185
	7	128	125	131
	3 plus CO_2 range	152 to 223	148 to 218	158 to 230
	3	170	165	177
Costs				
Consumer Incremental Installed Costs	7	41.7	48.2	35.9
	3	41.0	48.5	34.8
Net Benefits				
Total†	7 plus CO_2 range	68.1 to 139	58.8 to 129	77.0 to 149
	7	86.3	76.7	95.4
	3 plus CO_2 range	111 to 182	99 to 169	123 to 195
	3	129	117	142

* This table presents the annualized costs and benefits associated with residential boilers shipped in 2020−2049. These results include benefits to consumers which accrue after 2049 from the products purchased in 2020−2049. The results account for the incremental variable and fixed costs incurred by manufacturers due to the standard, some of which may be incurred in preparation for the rule. The Primary, Low Benefits, and High Benefits Estimates utilize projections of energy prices from the AEO 2013 Reference case, Low Estimate, and High Estimate, respectively.

** The CO_2 values represent global monetized values of the SCC, in 2013$, in 2015 under several scenarios of the updated SCC values. The first three cases use the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The fourth case represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The SCC time series used by DOE incorporate an escalation factor. The value for NO_X is the average of the low and high values used in DOE's analysis.
† Total Benefits for both the 3% and 7% cases are derived using the series corresponding to the average SCC with a 3-percent discount rate ($40.5/t in 2015). 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 these proposed standards address are as follows:

(1) There is a lack of consumer information and/or information processing capability about energy efficiency opportunities in the home appliance market.

(2) There is asymmetric information (one party to a transaction has more and better information than the other) and/or high transactions costs (costs of gathering information and effecting exchanges of goods and services).

(3) There are external benefits resulting from improved energy efficiency of residential boilers that are not captured by the users of such equipment. These benefits include externalities related to environmental protection and energy security that are not reflected in energy prices, such as reduced emissions of greenhouse gases.

In addition, this regulatory action is an "economically significant regulatory action" under section 3(f)(1) of Executive Order 12866. Accordingly, section 6(a)(3) of the Executive Order requires that DOE prepare a regulatory impact analysis (RIA) on this rule and that the Office of Information and Regulatory Affairs (OIRA) in the Office of Management and Budget (OMB) review this rule. DOE presented to OIRA for review the draft rule and other documents prepared for this rulemaking, including the RIA, and has included these documents in the rulemaking record. The assessments prepared pursuant to Executive Order 12866 can be found in the technical support document for this rulemaking.

DOE has also reviewed this regulation pursuant to Executive Order 13563, issued on January 18, 2011 (76 FR 3281 (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 Office of Information and Regulatory Affairs 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 website (http://energy.gov/gc/office-general-counsel). DOE has prepared the following IRFA for the products that are the subject of this rulemaking.

For manufacturers of residential boilers, the Small Business Administration (SBA) has set a size threshold, which defines those entities classified as "small businesses" for the purposes of the statute. DOE used the SBA's small business size standards to determine whether any small entities would be subject to the requirements of the rule. 65 FR 30836, 30848 (May 15, 2000), as amended at 65 FR 53533, 53544 (Sept. 5, 2000) and codified at 13 CFR part 121. The size standards are listed by North American Industry Classification System (NAICS) code and industry description and are available at http://www.sba.gov/category/navigation-structure/contracting/contracting-officials/small-business-size-standards. Manufacturing of residential boilers is classified under NAICS 333414, "Heating Equipment (except Warm Air Furnaces) Manufacturing." The SBA sets a threshold of 500 employees or less for an entity to be considered as a small business for this category.

1. Description and 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,[103] the California Energy Commission Appliance Efficiency Database[104]), individual company websites, 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 select companies on its list, as necessary, to determine whether they met the SBA's definition of a small business manufacturer of covered residential 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 36 potential manufacturers of residential boilers sold in the U.S. DOE then determined that 23 are large manufacturers, manufacturers that are foreign owned and operated, or manufacturers that do not produce products covered by this rulemaking. DOE was able to determine that 13 manufacturers meet the SBA's definition of a "small business." Of these 13 small businesses, nine manufacture boilers covered by this rulemaking, while the other four rebrand imported products or products manufactured by other small companies.

Before issuing this NOPR, DOE attempted to contact all the small business manufacturers of residential boilers it had identified. Two of the small businesses agreed

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[103] See www.ahridirectory.org/ahriDirectory/pages/home.aspx.
[104] See http://www.energy.ca.gov/appliances/.

to take part in an MIA interview. DOE also obtained information about small business impacts while interviewing large manufacturers.

DOE estimates that small manufacturers control approximately 17 percent of the residential boiler market. Based on DOE's research, three small businesses manufacture all four product classes of boilers domestically; four small businesses primarily produce condensing boiler products (most of which source heat exchangers from Europe or Asia); and two manufacturers primarily produce oil-fired hot water boiler products. The remaining four small businesses wholesale or rebrand products that are imported from Europe or Asia, or design products and source manufacturing to a domestic firm.

2. Description and Estimate of Compliance Requirements

The proposed standards for residential boilers could cause small manufacturers to be at a disadvantage relative to large manufacturers. For example, small manufacturers may be disproportionately affected by product conversion costs. Product redesign, testing, and certification costs tend to be fixed and do not scale with sales volume. When confronted with new or amended energy conservation standards, small businesses must make investments in research and development to redesign their products, but because they have lower sales volumes, they must spread these costs across fewer units. Moreover, smaller manufacturers may experience higher testing costs relative to larger manufacturers, as they may not possess their own test facilities and, therefore, must outsource all testing at a higher per-unit cost. In general, the three small manufacturers that offer all four product classes have product lines that are similar to those of larger competitors with similar market share. However, because these small manufacturers have fewer engineers and product development resources, they may have greater difficulty bringing their portfolio of products into compliance with amended energy conservation standards within the allotted timeframe. They also may have to divert engineering resources from customer and new product initiatives for a longer period of time. These considerations would also apply to the four manufacturers that only produce one or two product classes and small businesses that rebrand boilers that do their own design work.

Smaller manufacturers also may lack the purchasing power of larger manufacturers. For example, suppliers of bulk purchase parts and components (such as gas valves) give boiler manufacturers discounts based on the quantities purchased. Therefore, larger manufacturers may have a pricing advantage because they have higher volume purchases. This purchasing power differential between high-volume and low-volume orders applies to other residential boiler components as well, such as ignition systems and inducer fan assemblies.

In order to meet the proposed standard, manufacturers may have to seek outside capital to cover expenses related to testing and product design equipment. Smaller firms typically have a higher cost of borrowing due to higher perceived risk on the part of investors, largely attributed to lower cash flows and lower per-unit profitability. In these cases, small manufacturers may observe higher costs of debt than larger manufacturers.

While DOE does not expect high capital conversion costs at TSL 3, DOE does expect smaller businesses would have to make significant product conversion investments relative to larger manufacturers. As previously noted, some of these smaller manufacturers are heavily weighted toward baseline products and other products below the efficiency levels proposed in today's notice. As Table VI.1 illustrates, smaller manufacturers would have to increase their R&D spending to bring products into compliance and to develop new products at TSL 3, the proposed level.

Table VI.1 Impacts of Conversion Costs on a Small Manufacturer

	Capital Conversion Cost as a Percentage of Annual Capital Expenditures	Product Conversion Cost as a Percentage of Annual R&D Expense	Total Conversion Cost as a Percentage of Annual Revenue	Total Conversion Cost as a Percentage of Annual EBIT*
Average Large Manufacturer	5%	21%	0%	6%
Average Small Manufacturer	23%	145%	3%	38%

*EBIT means earnings before interest and taxes.

At TSL 3, the level proposed in this notice, DOE estimates capital conversion costs of $0.02 million and product conversion costs of $0.09 million for an average small manufacturer. DOE estimates that an average large manufacturer will incur capital conversion costs of $0.03 million and product conversion costs of $0.09 million. Based on the results in Table VI.1, DOE recognizes that small manufacturers will generally face a relatively higher conversion cost burden than larger competitors.

Manufacturers that have the majority of their products and sales at efficiency levels above today's standard may have lower conversion costs than those listed in Table

VI.1. In particular, the four small manufacturers that primarily sell condensing products are unlikely to be affected by the efficiency levels at TSL 3, as all of their products are already above the efficiency levels proposed.

Furthermore, DOE recognizes that small manufacturers that primarily sell low-efficiency products today will face a greater burden relative to the small manufacturers that primarily sell high-efficiency products. At TSL 3, the level proposed in this notice, DOE believes that the three manufacturers that manufacture across all four product classes would have higher conversion costs because the majority of their products do not meet the standard proposed in today's notice and would require redesign. DOE estimates that 63 percent of these companies' product offerings do not meet the standard levels at TSL 3. Consequently, these manufacturers would have to expend funds to redesign their commodity products, or develop a new, higher-efficiency baseline product.

The two companies that primarily produce oil-fired hot water boilers could also be impacted, as they are generally much smaller than the small businesses that produce all product classes, have fewer shipments and smaller revenues, and are likely to have limited R&D resources. Both of these companies, however, do have oil-fired hot water boiler product listings that meet the proposed efficiency standards in this notice.

DOE estimates that one of the four companies that rebrands imported or sourced products does its own design work, while the other three import high-efficiency products from Europe or Asia. It is possible that the company that designs its own products could be affected by product conversion costs at TSL 3, while it is unlikely that the other three would be greatly impacted.

Based on this analysis, DOE notes that on average, small businesses will experience total conversion costs on the order of $0.11 million. However, some companies will fall below the average. In particular, DOE has identified 6 small manufacturers that could experience greater conversion costs burdens than indicated by the average.

DOE seeks further information and data regarding the sales volume and annual revenues for small businesses so the agency can be better informed concerning the potential impacts to small business manufacturers of the proposed energy conservation standards, and would consider any such additional information when formulating and selecting standard levels for the final rule.

3. Duplication, Overlap, and Conflict with Other Rules and Regulations

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

4. Significant Alternatives to the Rule

The discussion above analyzes impacts on small businesses that would result from DOE's proposed rule. In addition to the other TSLs being considered, the proposed rulemaking TSD includes a regulatory impact analysis (RIA) in chapter 17. For residential boilers, the RIA discusses the following policy alternatives: (1) no change in standard; (2) consumer rebates; (3) consumer tax credits; (4) manufacturer tax credits; (5) voluntary energy efficiency targets; and (6) bulk government purchases. While these alternatives may mitigate to some varying extent the economic impacts on small entities compared to the proposed standards, DOE does not intend to consider these alternatives further because in several cases, they would not be feasible to implement without authority and funding from Congress, and in all cases, DOE has determined that the primary energy savings of these alternatives are significantly smaller than those that would be expected to result from adoption of the proposed standard levels (ranging from approximately 0.5 percent to 30.5 percent of the primary energy savings from the proposed standards). 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 $8,000,000 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 of 1995

Manufacturers of residential boilers must certify to DOE that their products comply with any applicable energy conservation standards. In certifying compliance, manufacturers must test their products according to the DOE test procedures for residential boilers, including any amendments adopted for those test procedures. DOE has established regulations for the certification and recordkeeping requirements for all covered consumer products and commercial equipment, including residential 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. Public reporting burden for the certification is estimated to average 20 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

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

D. Review Under the National Environmental Policy Act of 1969

Pursuant to the National Environmental Policy Act (NEPA) of 1969, DOE has determined that 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 products or industrial equipment, and for which none of the exceptions identified in CX B5.1(b) apply. Therefore, DOE has made a CX determination for this rulemaking, and DOE does not need to prepare an Environmental Assessment or Environmental Impact Statement for this proposed rule. DOE's CX determination for this 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 products 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) Therefore, no further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of Executive Order 12988, "Civil Justice Reform," imposes on Federal agencies the general duty to adhere to the following requirements: (1) eliminate drafting errors and ambiguity; (2) write regulations to minimize litigation; (3) provide a clear legal standard for affected conduct rather than a general standard; and (4) promote simplification and burden reduction. 61 FR 4729 (Feb. 7, 1996). Regarding the review required by section 3(a), section 3(b) of Executive Order 12988 specifically requires that Executive agencies make every reasonable effort to ensure that the regulation: (1) clearly specifies the preemptive effect, if any; (2) clearly specifies any effect on existing Federal law or regulation; (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction; (4) specifies the retroactive effect, if any; (5) adequately defines key terms; and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of Executive Order 12988 requires Executive agencies to review regulations in light of applicable standards in section 3(a) and section 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, this 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 them. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820. DOE's policy statement is also available at http://energy.gov/gc/office-general-counsel.

This proposed rule, which proposes amended energy conservation standards for residential boilers, does not contain a Federal intergovernmental mandate, and it does not require expenditures of $100 million or more by the private sector. Specifically, the proposed rule would likely result in a final rule that could require expenditures estimated to range from $$26 to $39 million per year (See Table I.7). including: (1) investment in research and development and in capital expenditures by residential 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 residential 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. 6295(f) and (o), this proposed rule would establish amended energy conservation standards for residential 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 rule would not have any impact on the autonomy or integrity of the family as an institution. Accordingly, DOE has concluded that it is not necessary to prepare a Family Policymaking Assessment.

I. Review Under Executive Order 12630

Pursuant to Executive Order 12630, "Governmental Actions and Interference with Constitutionally Protected Property Rights," 53 FR 8859 (March 15, 1988), DOE has determined that this proposed rule would not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution.

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

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516 note) provides for Federal agencies to review most disseminations of information to the public under information quality guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (Feb. 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). 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 amended energy conservation standards for residential 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 this 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." Id. at 2667.

In response to OMB's Bulletin, DOE conducted formal in-progress peer reviews of the energy conservation standards development process and analyses and has prepared a Peer Review Report pertaining to the energy conservation standards rulemaking analyses. Generation of this report involved a rigorous, formal, and documented evaluation using objective criteria and qualified and independent reviewers to make a judgment as to the technical/scientific/business merit, the actual or anticipated results, and the productivity and management effectiveness of programs and/or projects. The "Energy Conservation Standards Rulemaking Peer Review Report," dated February 2007, has been disseminated and is available at the following Web site: www1.eere.energy.gov/buildings/appliance_standards/peer_review.html.

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 notice. If you plan to attend the public meeting, please notify Ms. Brenda Edwards at (202) 586-2945 or Brenda.Edwards@ee.doe.gov. As explained in the **ADDRESSES** section, foreign nationals visiting DOE Headquarters are subject to advance security screening procedures. Any foreign national wishing to participate in the meeting should advise DOE of this fact as soon as possible by contacting Ms. Brenda Edwards to initiate the necessary procedures.

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 website at: http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx?ruleid=112 Participants are responsible for ensuring their systems are compatible with the webinar software.

B. Procedure for Submitting Requests to Speak and Prepared General Statements For Distribution

Any person who has an interest in the topics addressed in this notice, or who is representative of a group or class of persons that has an interest in these issues, may request an opportunity to make an oral presentation at the public meeting. Such persons may hand-deliver requests to speak to the address shown in the **ADDRESSES** section at the beginning of this NOPR between 9:00 a.m. and 4:00 p.m., Monday through Friday, except Federal holidays. Requests may also be sent by mail or email to: Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Office, Mailstop EE-5B, 1000 Independence Avenue, SW, Washington, DC 20585-0121, or Brenda.Edwards@ee.doe.gov. Persons who wish to speak should include with their request a computer diskette or CD-ROM in WordPerfect, Microsoft Word, PDF, or text (ASCII) file format that briefly describes the nature of their interest in this rulemaking and the topics they wish to discuss. Such persons should also provide a daytime telephone number where they can be reached.

DOE requests persons scheduled to make an oral presentation to submit an advance copy of their statements at least one week before the public meeting. DOE may permit persons who cannot supply an advance copy of their statement to participate, if those persons have made advance alternative arrangements with the Building Technologies Program. As necessary, requests to give an oral presentation should ask for such alternative arrangements.

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. There shall not be discussion of proprietary information, costs or prices, market share, or other commercial matters regulated by U.S. anti-trust laws. 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 notice and will be accessible on the DOE website. 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 proposed rule.

Submitting comments via www.regulations.gov. The www.regulations.gov webpage 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 website 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 www.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 facsimiles (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. Pursuant 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 further comment from interested parties regarding whether there are any technologies which have passed the screening analysis that should be screened out based on the four screening criteria. (i.e., technological feasibility; practicability to manufacture, install, and service;

impacts on product utility or product availability; and adverse impacts on health or safety). (See section IV.B.2 and chapter 3 of the NOPR TSD.)

2. DOE seeks comment from interested parties regarding the typical technological change associated with each efficiency level. (See section IV.C.1.b and chapter 5 in the NOPR TSD.)
3. DOE does not expect manufacturers will need to use condensing technology in order to meet the proposed standard. However, DOE requests further comment from interested parties regarding AFUE levels above 82 percent whether non-condensing boilers can exceed that level and to what extent and for which applications. DOE requests information on any additional costs (e.g. repair, maintenance, installation) ad information on other potential impacts to product performance or features (e.g. lifetime) associated with any non-condensing boiliers achieving AFUE levels above 82 percent. DOE requests comment on the the appropriateness of considering AFUE levels above 82 percent for non-condensing boilers for amended energy conservation standards for residential boilers and any potential trade-offs that should be considered when compared to employing condensing boilers at these efficiency levels(. (See section IV.C.1.b.)

4. DOE requests comment on the efficiency levels analyzed for standby mode and off mode, and on the assumption that standby mode and off

mode energy consumption (as defined by DOE) would be equal. (See section IV.C.1.b.)

5. DOE requests comments regarding how the mix of residential boilers with and without inducers would change under amended energy conservation standards, and how to best estimate and account for such changes in this analysis. (See section IV.C.1.b.)
6. DOE's approach seeks to account for the energy performance of residential boilers installed in the field by considering automatic means, jacket losses, and return water temperatures. DOE requests comments on the reasonableness of its assumptions regarding these factors. (See section IV.E.1.)
7. DOE makes the assumption that most consumers are unlikely to set their boilers to the off mode during the non-heating season. Specifically, DOE requests comments on its estimate that 25 percent of consumers shut the boiler off during the non-heating season, as well as any information that might support a different estimate. (See section IV.E.2 and chapter 7 in the NOPR TSD.)
8. DOE requests comment on residential boiler lifetimes, particularly the lifetime of condensing boilers, whether the lifetimes assumed in the analysis are reflective of residential boiler equipment covered by this rule. In addition, the agency is seeking comment on whether the energy efficiency standards would be expected to affect the lifetime of the products covered by the proposed standards and any information

supporting this affect. (See section IV.F.2.d and appendix 8-F of the NOPR TSD.)

9. DOE requests comment on the fraction of residential boilers:

    a. that are used for domestic water heating (see section IV.E);

    b. that are used in commercial applications (see section IV.E);

    c. that are used in low-temperature vs. high-temperature applications (see section IV.E);

    d. at each standby efficiency level (see section IV.E);

    e. that use polypropylene, PVC, or chlorinated polyvinyl chloride (CPVC) venting (see section IV.F.1);

    f. that require stainless steel venting (by efficiency level) (see section IV.F.1); and

    g. that require a draft inducer (by efficiency level) (see section IV.F.1).

10. DOE requests comment on installation costs for condensing boilers. (See section IV.F.1 and chapter 8 of the NOPR TSD.)

11. DOE requests comment on the fraction of oil-fired hot water boiler shipments that would be expected to switch to gas-fired hot water boiler shipments due to the proposed standards. (See section IV.G and chapter 9 of the NOPR TSD.)

12. DOE requests comment on its projections of the market share of high-efficiency (condensing) boilers in 2020 in the absence of amended energy

conservation standards, as well as the long-term market penetration of higher-efficiency residential boilers. (See section IV.H and appendix 8-H of the NOPR TSD.)

13. DOE requests comment on the reasonableness of its assumption to not apply a trend to the manufacturer selling price (in real dollars) of residential boilers, as well as any information that would support the use of alternative assumptions. (See section IV.H and appendix 10-C of the NOPR TSD.)

14. DOE requests data that would allow for use of different price trend projections for condensing and non-condensing boilers. (See section IV.F.1.)

15. DOE requests comment on DOE's methodology and data sources used for projecting the future shipments of residential boilers in the absence of amended energy conservation standards. (See section IV.G.)

16. To estimate the impact on shipments of the price increase for the considered efficiency levels, DOE used a relative price elasticity approach. DOE welcomes stakeholder input on the effect of amended standards on future residential boiler shipments. (See section IV.G.)

17. DOE requests comment on the potential impacts on product shipments related to fuel and equipment switching. (See section IV.G.)

18. DOE requests comment on the reasonableness of the revised values that DOE used to characterize the rebound effect with higher-efficiency

residential boilers. Specifically, the agency lowered the assumed rebound affect in this proposed rule to 15 percent compared to the NODA in which the agency assumed a 20 percent rebound effect. (See section IV.F.2.a.)

19. DOE requests comment on the approach for conducting the emissions analysis for residential boilers. (See section IV.K.)

20. DOE requests comment on DOE's approach for estimating monetary benefits associated with emissions reductions. (See section IV.L.)

21. DOE requests comment on the technical feasibility of the proposed standards and whether any proprietary technology that would be a unique pathway to achieving any of these efficiency levels would be required. (See section IV.B.)

22. DOE seeks comment regarding any potential impacts on small business manufacturers from the proposed standards. In particular, DOE seeks further information and data regarding the sales volume and annual revenues for small businesses so the agency can be better informed concerning the potential impacts to small business manufacturers of the proposed energy conservation standards, and would consider any such additional information when formulating and selecting AFUE and standby/off-mode electrical energy conservation standards for the final rule and whether any feasible compliance flexibilities that the agency may consider. (See section IV.J.)

23. DOE seeks further information in order to balance the benefits and burdens of adopting TSL4 rather than TSL3 in the final rule. (See section V.C.1.)

24. DOE requests comment on whether manufacturers make their engineering design decisions for the two standards (i.e. standby and active mode) independently, therefore changes in manufacturing production costs and the conversion costs are additive. DOE requests comment on whether their engineering design decisions are integrated for the two standards and if an incremental analysis that simultaneously considers the manufacturing production costs and conversion costs would be more reflective of manufacturer decision making.

VIII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of today's notice of proposed rulemaking.

List of Subjects in 10 CFR Part 430

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

Issued in Washington, DC, on March 13, 2015.

David T. Danielson
Assistant Secretary
Energy Efficiency and Renewable Energy

For the reasons set forth in the preamble, DOE proposes to amend part 430 of chapter II, subchapter D, of title 10 of the Code of Federal Regulations, as set forth below:

PART 430 - ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

1. The authority citation for part 430 continues to read as follows:

Authority: 42 U.S.C. 6291-6309; 28 U.S.C. 2461 note.

2. Appendix N to subpart B of part 430 is amended by revising the note after the heading to read as follows:

Appendix N to Subpart B of Part 430— Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers

Note: The procedures and calculations that refer to standby mode and off mode energy consumption (*i.e.*, sections 8.6 and 10.11 of this appendix N) need not be performed to determine compliance with energy conservation standards for furnaces and boilers until required as specified below. However, any representation related to standby mode and off mode energy consumption of these products made after July 1, 2013 must be based upon results generated under this test procedure, consistent with the requirements of 42 U.S.C. 6293(c)(2). For furnaces, the statute requires that after July 1, 2010, any adopted energy conservation standard shall address standby mode and off mode energy consumption for these products, and upon the compliance date for such standards, compliance with the applicable provisions of this test procedure will be required. For boilers manufactured on and after (*compliance date of final rule***)**, compliance with the applicable provisions of this test procedure is required in order to determine compliance with energy conservation standards.

*   *   *   *   *

3. Section 430.32 is amended by:

a. Adding in paragraph (e)(2)(ii), the words "and before (*compliance date of final rule*)," after "2012,";

b. Redesignating paragraphs (e)(2)(iii) and (e)(2)(iv) as paragraphs (e)(2)(iv) and (e)(2)(v), respectively;

c. Adding a new paragraph (e)(2)(iii) to read as follows:

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

*   *   *   *   *

(e)   *   *   *

(2)   *   *   *

(iii)(A) Except as provided in paragraph (e)(2)(v) of this section, the AFUE of residential boilers, manufactured on and after (*compliance date of final rule***)**, shall not be less than the following and must comply with the design requirements as follows:

Product Class	**AFUE[1] (percent)**	**Design Requirements**
(1) Gas-fired hot water boiler	85	Constant-burning pilot not permitted. Automatic means for adjusting water temperature required (except for boilers equipped with tankless domestic water heating coils).
(2) Gas-fired steam boiler	82	Constant-burning pilot not permitted.
(3) Oil-fired hot water boiler	86	Automatic means for adjusting temperature required (except for boilers equipped with tankless domestic water heating coils).
(4) Oil-fired steam boiler	86	None
(5) Electric hot water boiler	None	Automatic means for adjusting temperature required (except for boilers equipped with tankless domestic water heating coils).
(6) Electric steam boiler	None	None

[1]Annual Fuel Utilization Efficiency, as determined in §430.23(n)(2) of this part.

(B) Except as provided in paragraph (e)(2)(v) of this section, the standby mode power consumption ($P_{W,SB}$) and off mode power consumption ($P_{W,OFF}$) of residential boilers, manufactured on and after (*compliance date of final rule*), shall not be more than the following:

Product Class	$P_{W,SB}$ **(watts)**	$P_{W,OFF}$ **(watts)**
(1) Gas-fired hot water boiler	9	9
(2) Gas-fired steam boiler	8	8
(3) Oil-fired hot water boiler	11	11
(4) Oil-fired steam boiler	11	11
(5) Electric hot water boiler	8	8
(6) Electric steam boiler	8	8

* * * * *