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10 CFR Part 430

Energy Conservation Program: Energy Conservation Standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters; Proposed Rule

DEPARTMENT OF ENERGY

10 CFR Part 430

[Docket Number EE–2006–BT–STD–0129]

RIN 1904–AA90

Energy Conservation Program: Energy Conservation Standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters

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

ACTION: Notice of proposed rulemaking and public meeting.

SUMMARY: The Energy Policy and Conservation Act (EPCA) prescribes energy conservation standards for various consumer products and commercial and industrial equipment, including residential water heaters, direct heating equipment (DHE), and pool heaters. EPCA also requires the U.S. Department of Energy (DOE) to determine whether more stringent, amended standards for these products would be technologically feasible and economically justified, and would save a significant amount of energy. In this notice, DOE is proposing amended energy conservation standards for residential water heaters (other than tabletop and electric instantaneous models), gas-fired DHE, and gas-fired pool heaters. DOE also is announcing a public meeting to receive comment on these proposed standards and associated analyses and results.

DATES: DOE will hold a public meeting on Thursday, January 7, 2010, from 9 a.m. to 4 p.m., in Washington, DC. DOE must receive requests to speak at the public meeting before 4 p.m., Wednesday, December 23, 2009. DOE must receive a signed original and an electronic copy of statements to be given at the public meeting before 4 p.m., Wednesday, December 30, 2009.

DOE will accept comments, data, and information regarding this notice of proposed rulemaking (NOPR) before and after the public meeting, but no later than February 9, 2010. See section VII, ''Public Participation,'' of this NOPR for details.

ADDRESSES: The public meeting will be held at the U.S. Department of Energy, Forrestal Building, Room 1E–245, 1000 Independence Avenue, SW., Washington, DC 20585–0121. To attend the public meeting, 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. Brenda Edwards to initiate the necessary procedures.

Any comments submitted must identify the NOPR for Energy Conservation Standards for Heating Products, and provide the docket number EE–2006–BT–STD–0129 and/or regulatory information number (RIN) number 1904–AA90. Comments may be submitted using any of the following methods:

1. *Federal eRulemaking Portal: http://www.regulations.gov.* Follow the instructions for submitting comments.
2. *E-mail: ResWaterDirectPoolHtrs@ee.doe.gov.* Include docket number EE–2006–BT–STD–0129 and/or RIN 1904–AA90 in the subject line of the message.
3. *Mail:* Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, Mailstop EE–2J, 1000 Independence Avenue, SW., Washington, DC 20585–0121. Please submit one signed paper original.
4. *Hand Delivery/Courier:* Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, 950 L'Enfant Plaza, SW., Suite 600, Washington, DC 20024. Telephone: (202) 586–2945. Please submit one signed paper original.

For detailed instructions on submitting comments and additional information on the rulemaking process, see section VII of this document (Public Participation).

Docket: For access to the docket to read background documents or comments received, visit the U.S. Department of Energy, Resource Room of the Building Technologies Program, 950 L'Enfant Plaza, SW., Suite 600, Washington, DC, (202) 586–2945, between 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays. Please call Ms. Brenda Edwards at the above telephone number for additional information regarding visiting the Resource Room.

FOR FURTHER INFORMATION CONTACT: Mr. Mohammed Khan, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, EE–2J, 1000 Independence Avenue, SW., Washington, DC 20585–0121. Telephone: (202) 586–7892. E-mail: *Mohammed.Khan@ee.doe.gov.*

Mr. Eric Stas or Mr. Michael Kido, U.S. Department of Energy, Office of the General Counsel, GC–72, 1000 Independence Avenue, SW., Washington, DC 20585–0121. Telephone: (202) 586–9507. E-mail: *Eric.Stas@hq.doe.gov* or *Michael.Kido@hq.doe.gov.*

For information on how to submit or review public comments and on how to participate in the public meeting, contact Ms. Brenda Edwards, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, EE–2J, 1000 Independence Avenue, SW., Washington, DC 20585–0121. Telephone: (202) 586–2945. E-mail: *Brenda.Edwards@ee.doe.gov.*

SUPPLEMENTARY INFORMATION:

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I. Summary of the Proposed Rule

The Energy Policy and Conservation Act (42 U.S.C. 6291 *et seq.;* EPCA or the Act), as amended, provides that any new or amended energy conservation standard DOE prescribes for certain consumer products, including residential water heaters, direct heating equipment (DHE), and pool heaters (collectively referred to in this document as the ''three heating products''), shall be designed to ''achieve the maximum improvement in energy efficiency * * * which the Secretary determines is technologically feasible and economically justified.'' (42 U.S.C. 6295(o)(2)(A)) Furthermore, the new or amended standard must ''result in significant conservation of energy.'' (42 U.S.C. 6295(o)(3)(B)) In accordance with these and other statutory provisions discussed in this notice, DOE proposes amended energy conservation standards for the three types of heating products listed above. Compliance with the proposed standards would be required for all residential water heaters listed in Table I.1 that are manufactured in or imported into the United States on or after five years after the date of publication of the final rule. The proposed standards would apply to all DHE and pool heaters listed in Table I.1 that are manufactured in or imported into the United States on or after three years after the date of publication of the final rule. Table I.1 sets forth the proposed standards for the products that are the subject of this rulemaking.

TABLE I.1—PROPOSED AMENDED ENERGY CONSERVATION STANDARDS FOR RESIDENTIAL WATER HEATERS, DIRECT HEATING EQUIPMENT, AND POOL HEATERS

Product class	Proposed standard level	
Residential water heaters *		
Gas-fired Storage	For tanks with a Rated Storage Volume at or below 60 gallons: EF = 0.675 − (0.0012 × Rated Storage Volume in gallons).	For tanks with a Rated Storage Volume above 60 gallons: EF = 0.717 − (0.0019 × Rated Storage Volume in gallons).
Electric Storage	For tanks with a Rated Storage Volume at or below 80 gallons: EF = 0.96 − (0.0003 × Rated Storage Volume in gallons).	For tanks with a Rated Storage Volume above 80 gallons: EF = 1.088 − (0.0019 × Rated Storage Volume in gallons).
Oil-fired Storage	EF = 0.68 − (0.0019 × Rated Storage Volume in gallons).	
Gas-fired Instantaneous	EF = 0.82 − (0.0019 × Rated Storage Volume in gallons).	

Product class	Proposed standard level
Direct heating equipment **	
Gas wall fan type up to 42,000 Btu/h	AFUE = 76%
Gas wall fan type over 42,000 Btu/h	AFUE = 77%
Gas wall gravity type up to 27,000 Btu/h	AFUE = 70%
Gas wall gravity type over 27,000 Btu/h up to 46,000 Btu/h	AFUE = 71%
Gas wall gravity type over 46,000 Btu/h	AFUE = 72%
Gas floor up to 37,000 Btu/h	AFUE = 57%
Gas floor over 37,000 Btu/h	AFUE = 58%
Gas room up to 20,000 Btu/h	AFUE = 62%
Gas room over 20,000 Btu/h up to 27,000 Btu/h	AFUE = 67%
Gas room over 27,000 Btu/h up to 46,000 Btu/h	AFUE = 68%
Gas room over 46,000 Btu/h	AFUE = 69%
Gas hearth up to 20,000 Btu/h	AFUE = 61%
Gas hearth over 20,000 Btu/h and up to 27,000 Btu/h	AFUE = 66%
Gas hearth over 27,000 Btu/h and up to 46,000 Btu/h	AFUE = 67%
Gas hearth over 46,000 Btu/h	AFUE = 68%
Pool heaters	
Gas-fired	Thermal Efficiency = 84%

* EF is the "energy factor," and the "Rated Storage Volume" equals the water storage capacity of a water heater (in gallons), as specified by the manufacturer.

** Btu/h is "British thermal units per hour" and AFUE is "Annual Fuel Utilization Efficiency."

DOE's analyses indicate that the proposed standards would save a significant amount of energy—an estimated 2.85 quads of cumulative energy over a 30-year period. This amount is equivalent to 61 days of U.S. gasoline use. Breaking these figures down by product type, the national energy savings of the proposed standards is estimated to be 2.60 quads for residential water heaters, 0.22 quads for DHE, and 0.03 quads for pool heaters.

The cumulative national net present value (NPV) of total consumer costs and savings from the proposed standards (in 2008$) ranges from $5.73 billion (at 7-percent discount rate) to $18.1 billion (at 3-percent discount rate). This is the estimated total value of future operating-cost savings minus the estimated increased product and installation costs, discounted to 2010.

The NPV of the proposed standards for water heaters ranges from $4.79 billion (7-percent discount rate) to $15.6 billion (3-percent discount rate). DOE estimates the industry net present value (INPV) for water heaters to be approximately $1,455 million in 2008$. If DOE adopts the proposed standards, it estimates U.S. water heater manufacturers will lose between 0.2 percent and 5.6 percent of the INPV, which is approximately −$2.4 to −$81.0 million. However, the NPV for consumers (at the 7-percent discount rate) is 59 to 1996 times larger than the industry losses due to the proposed standards with the 7-percent discount rate, and 193 to 6500 times larger than the industry losses due to the proposed standards with the 3-percent discount rate.

For DHE, the NPV of the proposed standards ranges from $0.91 billion (7-percent discount rate) to $2.22 billion (3-percent discount rate). DOE estimates the INPV for DHE to be approximately $104 million in 2008$. If DOE adopts the proposed standards, it estimates U.S. DHE manufacturers will lose between 1.9 percent and 5.9 percent of the INPV, which is approximately −$2.0 to −$6.2 million. However, the NPV for consumers (at the 7-percent discount rate) is 147 to 455 times larger than the industry losses due to the proposed standards with the 7-percent discount rate, and 358 to 1,110 times larger than the industry losses due to the proposed standards with the 3-percent discount rate.

For pool heaters, the NPV of the proposed standard ranges from $0.03 billion (7-percent discount rate) to $0.25 billion (3-percent discount rate). DOE estimates the INPV for pool heaters to be approximately $61.4 million in 2008$. If DOE adopts the proposed standards, it expects the impacts on U.S. pool heater manufacturers will be between a gain of 0.9 percent and a loss of 12.1 percent of the INPV, which is approximately −$0.5 million to −$7.5 million. However, the NPV for consumers (at the seven-percent discount rate) is 4 to 60 times larger than the industry losses due to the proposed standards at the 7-percent discount rate, and 33 to 498 times larger than the industry losses due to the proposed standards at the 3-percent discount rate.

The economic impacts of the proposed standards on individual consumers (*i.e.,* the average life-cycle cost (LCC) savings) are predominately positive. For water heaters, DOE projects that the average LCC impact is a gain of $68 for gas-fired storage water heaters, $39 for electric storage water heaters, and $395 for oil-fired storage water heaters, and no change for gas-fired instantaneous water heaters. For DHE, DOE projects that the average LCC impact for consumers is a gain of $104 for gas wall fan DHE, $192 for gas wall gravity DHE, $13 for gas floor DHE, $143 for gas room DHE, and $96 for gas hearth DHE. For pool heaters, DOE projects that the average LCC impact for consumers is a loss of $13 (which represents only 0.2 percent of the average total LCC).

In addition, the proposed standards would be expected to provide significant environmental benefits. The proposed standards would potentially result in cumulative greenhouse gas emission reductions of 167 million tons (Mt) of carbon dioxide (CO_2) from 2013 to 2045. Specifically, the proposed standards for water heaters would reduce CO_2 emissions by 154 Mt; the proposed standards for DHE would reduce CO_2 emissions by 8.5 Mt; and the proposed standard for pool heaters would reduce CO_2 emissions by 4.2 Mt. For the three types of heating products together, DOE estimates that the range of the monetized value of CO_2 emission reductions based on global estimates of the value of avoided CO_2 is $0.399 billion to $4.386 billion at a 7-percent discount rate and $0.902 billion to $9.925 billion at a 3-percent discount rate.

The proposed standards would also be expected to result in reduction in cumulative nitrogen oxides (NO_X) emissions of 129 kilotons (kt). Specifically, the proposed water heater standards would result in cumulative NO_X emissions reductions of 118 kt; the proposed standards for DHE would result in 7.7 kt of NO_X emissions reductions; and the proposed standard for pool heaters would result in 3.7 kt of NO_X emissions reductions.

The proposed standards for heating products would also be expected to result in power plant mercury (Hg) emissions reductions. For water heaters, cumulative Hg emissions would be reduced by 0.20 tons (t). The proposed standards for DHE and pool heaters would be expected to have a negligible impact on mercury emissions.

The benefits and costs of today's proposed rule can also be expressed in terms of annualized values. The annualized values refer to consumer operating cost savings, consumer incremental product and installation costs, the quantity of emissions reductions for CO_2, NO_X, and Hg, and the monetary value of emissions reductions. DOE calculated annualized values using discount rates of three percent and seven percent. Although DOE calculated annualized values, this does not imply that the time-series of cost and benefits from which the annualized values were determined are a steady stream of payments.

Table I.2, Table I.3, and Table I.4 present the annualized values for the standards proposed for water heaters, DHE, and pool heaters, respectively. The tables also present the annualized net benefit that results from summing the two monetary benefits and subtracting the consumer incremental product and installation costs. Although summing the value of operating cost savings with the value of CO_2 reductions (and other emissions reductions) provides a valuable perspective, please note the following. The operating cost savings are domestic U.S. consumer monetary savings found in market transactions, but in contrast, the CO_2 value is based on an estimate of imputed marginal social cost of carbon (SCC), which is meant to reflect the global benefits of CO_2 reductions. In addition, the assessments of operating cost savings and CO_2 savings are performed with different computer models, leading to different time frames for analysis. The operating cost savings are measured for the lifetime of appliances shipped in 2015–2045 or 2013–2043. The value of CO_2, on the other hand is meant to reflect the present value of all future climate-related impacts, even those beyond 2065.

TABLE I.2—ANNUALIZED BENEFITS AND COSTS OF PROPOSED STANDARDS FOR WATER HEATERS (TSL 4)

Category	Unit	Primary estimate (*AEO* reference case)		Low estimate (*AEO* low-growth case)		High estimate (*AEO* high-growth case)	
		7%	3%	7%	3%	7%	3%
Benefits							
Monetized Operating Cost Savings	Million 2008$	1487.1	1842.4	1383.7	1708.4	1590.5	1976.2
Quantified Emissions Reductions	CO_2 (Mt)	4.58	4.92	5.34	5.28	0.61	1.04
	NO_X (kt)	3.54	3.79	4.17	4.11	0.58	0.92
	Hg (t)	0.009	0.008	(0.003)	(0.011)	0.010	0.013
Monetized Avoided Emissions Reductions* (Million 2008$).	CO_2 (at $20/t)	157.1	187.3	184.8	222.1	20.2	41.9
	NO_X	8.2	9.1	9.7	10.9	0.4	1.6
	Hg	0.1	0.1	(0.1)	(0.1)	0.1	0.2
Costs							
Monetized Incremental Product and Installation Costs.	Million 2008$	945.5	917.3	894.4	861.7	997.0	973.4
Net Benefits							
Monetized Value**	Million 2008$	698.8	1112.4	674.1	1068.9	613.7	1044.7

* For CO_2, benefits reflect value of $20/t, which is in the middle of the values considered by DOE for valuing the potential global benefits resulting from reduced CO_2 emissions. For NO_X and Hg, the benefits reflect values of $2,491/t and $17 million/t, respectively. These values are the midpoint of the range considered by DOE.

** Monetized Value does not include monetized avoided emissions reductions for NO_X and Hg.

TABLE I.3—ANNUALIZED BENEFITS AND COSTS OF PROPOSED STANDARDS FOR DIRECT HEATING EQUIPMENT (TSL 3)

Category	Unit	Primary estimate (*AEO* reference case)		Low estimate (*AEO* low-growth case)		High estimate (*AEO* high-growth case)	
		7%	3%	7%	3%	7%	3%
Benefits							
Monetized Operating Cost Savings	Million 2008$	132.2	164.4	126.4	156.9	136.2	169.6
Quantified Emissions Reductions	CO_2 (Mt)	0.24	0.27	0.43	0.46	0.13	0.14
	NO_X (kt)	0.22	0.24	0.36	0.38	0.14	0.15
	Hg (t)	0.000	(0.001)	0.000	(0.001)	0.000	0.000
Monetized Avoided CO_2 Value (at $20/t).*	Million 2008$	8.2	9.8	2.5	2.9	21.0	42.6
Costs							
Monetized Incremental Product and Installation Costs.	Million 2008$	41.8	40.6	41.8	40.6	41.8	40.6
Net Benefits							
Monetized Value	Million 2008$	98.5	133.5	87.1	119.2	115.4	171.6

* For CO_2, benefits reflect value of $20/t, which is in the middle of the values considered by DOE for valuing the potential global benefits resulting from reduced CO_2 emissions. For NO_X and Hg, the annual benefits are very small and are thus not reported in the table.

TABLE I.4—ANNUALIZED BENEFITS AND COSTS OF PROPOSED STANDARDS FOR POOL HEATERS (TSL 4)

Category	Unit	Primary estimate (*AEO* reference case)		Low estimate (*AEO* low-growth case)		High estimate (*AEO* high-growth case)	
		7%	3%	7%	3%	7%	3%
Benefits							
Monetized Operating Cost Savings	Million 2008$	59.88	68.79	57.29	65.66	61.62	70.86
Quantified Emissions Reductions	CO_2 (Mt)	0.13	0.13	0.16	0.17	0.09	0.10
	NO_X (kt)	0.112	0.119	0.134	0.143	0.085	0.091
	Hg (t)	0.000	0.000	(0.000)	(0.001)	(0.000)	0.000
Monetized Avoided CO_2 Value (at $20/t).*	Million 2008$	4.20	4.84	5.24	6.08	3.01	3.47
Costs							
Monetized Incremental Product and Installation Costs.	2008$	56.66	54.59	56.66	54.59	56.66	54.59
Net Benefits							
Monetized Value	Million 2008$	7.41	19.04	5.88	17.15	7.97	19.74

* For CO_2, benefits reflect value of $20/t, which is in the middle of the values considered by DOE for valuing the potential global benefits resulting from reduced CO_2 emissions. For NO_X and Hg, the annual benefits are very small and are thus not reported in the table.

DOE has tentatively concluded that the proposed standards represent the maximum improvement in energy efficiency that is technologically feasible and economically justified, and would result in significant conservation of energy. Products achieving these standard levels are already commercially available. Based on the analyses culminating in this proposal, DOE found the benefits to the Nation of the proposed standards (energy savings, consumer LCC savings, national NPV increase, and emission reductions) outweigh the burdens (loss of INPV and LCC increases for some consumers). DOE considered higher efficiency levels as trial standard levels, and is still considering them in this rulemaking; however, DOE has tentatively concluded that the burdens of the higher efficiency levels would outweigh the benefits. With that said, based on consideration of public comments DOE receives in response to this notice and related information, DOE may adopt efficiency levels in the final rule that are either higher or lower than the proposed standards, or some level(s) in between the proposed standards and other efficiency levels presented.

DOE is proposing TSL 4 for residential water heaters as the level which it has tentatively concluded meet the applicable statutory criteria (i.e., the highest level that is technologically feasible, economically justified, and would result in significant conservation of energy). Based upon public comments and any accompanying data submissions, DOE would strongly consider other TSLs (as presented in this NOPR or at some level in between), some of which might provide an even higher level of energy savings and promote a market for advanced water heating technologies, including heat pump and condensing water heaters. Accordingly, DOE is presenting a variety of issues throughout today's notice upon which it is seeking comment which will bear upon its consideration of TSL 5 or TSL 6 for residential water heaters in the final rule.

II. Introduction

A. Consumer Overview

EPCA currently prescribes energy conservation standards for the three heating products that are the subject of this rulemaking. DOE is proposing to raise the standards for the products shown in Table I.1. The proposed standards would apply to residential water heaters manufactured or imported on or after five years after the final rule publication date (*i.e.*, approximately March 31, 2015). The proposed standards would apply to DHE and pool heaters manufactured or imported on or after three years after the final rule publication date (*i.e.*, approximately March 31, 2013).

DOE's analyses suggest that consumers would realize benefits from the proposed standards. Although DOE expects that the purchase price of the more-efficient heating products would be higher than the average prices of these products today, for most consumers, the energy efficiency gains would result in lower energy costs that would more than offset the higher purchase price. For water heaters, the median payback period is 2.7 years for gas-fired storage water heaters, 5.8 years for electric storage water heaters, 0.5 years for oil-fired storage water heaters, and 23.5 years for gas-fired instantaneous water heaters. For DHE, the median payback period is 6.0 years for gas wall fan DHE, 8.3 years for gas wall gravity DHE, 14.7 years for gas floor DHE, 5.3 years for gas room DHE and 0.0 years for gas hearth DHE. (The reason that the median payback period for gas hearth DHE is zero is because for about two-thirds of the consumers, there is no incremental cost to get to the proposed standard level). For pool heaters, the median payback period is 13.0 years.

When the overall net savings are summed over the lifetime of these products, water heater consumers will save, on average, $68 for gas-fired storage water heaters, $30 for electric storage water heaters, $305 for oil-fired storage water heaters, and $0 for gas-fired instantaneous water heaters, compared to their life-cycle expenditures on base-case water heaters (*i.e.*, the equipment expected to be purchased in the absence of revised energy conservation standards). (For gas-fired instantaneous water heaters, the average LCC for the proposed standard level is the same as the average LCC in the base case, so the savings are zero.) The average LCC impact for DHE consumers is a gain of $104 for gas wall fan DHE, $192 for gas wall gravity DHE, $13 for gas floor DHE, $143 for gas room DHE, and $96 for gas hearth DHE, compared to their life-cycle expenditures on base-case products. Pool heater consumers will see, on average, a slight increase in their life-cycle costs, compared to their expenditures on base-case products.

B. Authority

Title III of EPCA sets forth a variety of provisions designed to improve energy efficiency. Part A [1] of Title III (42 U.S.C. 6291–6309) establishes the Energy Conservation Program for Consumer Products Other Than Automobiles. The program covers consumer products and certain commercial equipment (referred to hereafter as ''covered products''), including the three types of heating products that are subject to this rulemaking. (42 U.S.C. 6292(a)(4), (9) and (11)) EPCA prescribes energy conservation standards for the three heating products. (42 U.S.C. 6295(e)(1)–(3)) The statute further directs DOE to conduct two cycles of rulemakings to determine whether to amend these standards. (42 U.S.C. 6295(e)(4)) As explained in further detail in section II.C, ''Background,'' this rulemaking represents the second round of amendments to the water heater standards, and the first round of amendments to the DHE and pool heater standards.

Under the Act, DOE's energy conservation program for covered products consists essentially of three parts: (1) Testing; (2) labeling; and (3) Federal energy conservation standards. The Federal Trade Commission (FTC) is responsible for the labeling provisions for consumer products, and DOE implements the remainder of the program. Section 323 of the Act authorizes DOE, subject to certain criteria and conditions, to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating cost of each covered product. Manufacturers of covered products must use the DOE test procedure as the basis for certifying to DOE that their products comply with applicable energy conservation standards adopted under EPCA and for representing the efficiency of those products. Similarly, DOE must use these test procedures to determine whether the products comply with standards adopted under EPCA. (42 U.S.C. 6293) The test procedures for water heaters, unvented DHE, vented DHE, and pool heaters appear at Title 10 Code of Federal Regulations (CFR) part 430, subpart B, appendices E, G, O, and P, respectively.

EPCA provides criteria for prescribing amended standards for covered products. 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)) Furthermore, EPCA precludes DOE from adopting any standard that would not result in significant conservation of energy. (42 U.S.C. 6295(o)(3)(B)) Moreover, DOE may not prescribe a standard for certain products (including the three heating products) if no test procedure has been established. (42 U.S.C. 6295(o)(3)(A)) The Act also provides that, in deciding whether a standard is economically justified, DOE must determine whether the benefits of the standard exceed its burdens. (42 U.S.C. 6295(o)(2)(B)(i)) DOE must do so after receiving comments on the proposed standard and by considering, to the greatest extent practicable, the following seven factors:

1. The economic impact of the standard on manufacturers and consumers of the products subject to the standard;
2. The savings in operating costs throughout the estimated average life of the covered products in the type (or class) compared to any increase in the price, initial charges, or maintenance expenses for the covered products that are likely to result from the imposition of the standard;
3. The total projected amount of energy (or, as applicable, water) savings likely to result directly from the imposition of the standard;
4. Any lessening of the utility or the performance of the covered products likely to result from the imposition of 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 imposition of the standard;
6. The need for national energy and water conservation; and
7. Other factors the Secretary considers relevant.

(42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII))

Furthermore, EPCA contains what is commonly known as an ''anti-backsliding'' provision, which prohibits

[1] This part was originally titled Part B. It was redesignated Part A in the United States Code for editorial reasons.

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 a new or amended standard if interested persons have established by a preponderance of the evidence that the standard is likely to result in the unavailability in the United States of any covered product type (or class) with 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))

Under 42 U.S.C. 6295(o)(2)(B)(iii), 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 * * * savings during the first year that the consumer will receive as a result of the standard, as calculated under the applicable test procedure. * * *''

Under 42 U.S.C. 6295(q)(1), EPCA specifies requirements for promulgation of a standard for a type or class of covered product that has two or more subcategories. DOE must specify a different standard level than that which applies generally to such type or class of products ''for any group of covered products which have the same function or intended use, if * * * 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 which other products within such type (or class) do not have and such feature justifies a higher or lower standard'' than applies or will apply to the other products. (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 such a 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)) However, DOE can grant waivers of Federal preemption for particular State laws or regulations in accordance with the procedures and other provisions of section 327(d) of the Act. (42 U.S.C. 6297(d))

Finally, section 310(3) of the Energy Independence and Security Act of 2007 (EISA 2007; Pub. L. 110–140) amended EPCA to prospectively require that energy conservation standards address standby mode and off mode energy use. Specifically, when DOE adopts new or amended standards for a covered product after July 1, 2010, the final rule must, if justified by the criteria for adoption of standards in section 325(o) of EPCA, incorporate standby mode and off mode energy use into a single standard if feasible, or otherwise adopt a separate standard for such energy use for that product. (42 U.S.C. 6295(gg)(3)) Because the final rule in this rulemaking is scheduled for adoption by March 2010, this requirement does not apply in this rulemaking, and DOE has not attempted to address the standby mode or off mode energy use here. DOE is currently working on a test procedure rulemaking to address standby mode and off mode energy consumption for the three types of heating products that are the subject of this rulemaking.

C. Background

1. Current Standards

a. Water Heaters

On January 17, 2001, DOE prescribed the current energy conservation standards for residential water heaters manufactured on or after January 20, 2004. 66 FR 4474. This final rule completed the first amended standards rulemaking for water heaters required under 42 U.S.C. 6295(e)(4)(A). The standards consist of minimum energy factors (EF) that vary based on the storage volume of the water heater, the type of energy it uses (*i.e.*, gas, oil, or electricity), and whether it is a storage, instantaneous, or tabletop model. 10 CFR 430.32(d). The water heater energy conservation standards are set forth in Table II.1 below.

TABLE II.1—CURRENT FEDERAL ENERGY CONSERVATION STANDARDS FOR RESIDENTIAL WATER HEATERS

Product class	Energy factor as of January 20, 2004
1. Gas-Fired Storage Water Heater	EF = 0.67 − (0.0019 × Rated Storage Volume in gallons).
2. Oil-Fired Storage Water Heater	EF = 0.59 − (0.0019 × Rated Storage Volume in gallons).
3. Electric Storage Water Heater	EF = 0.97 − (0.00132 × Rated Storage Volume in gallons).
4. Tabletop Water Heater	EF = 0.93 − (0.00132 × Rated Storage Volume in gallons).
5. Gas-Fired Instantaneous Water Heater	EF = 0.62 − (0.0019 × Rated Storage Volume in gallons).
6. Instantaneous Electric Water Heater	EF = 0.93 − (0.00132 × Rated Storage Volume in gallons).

b. Direct Heating Equipment

EPCA prescribes the energy conservation standards for DHE, which apply to gas-fired products manufactured on or after January 1, 1990. (42 U.S.C. 6295(e)(3)) These standards consist of several minimum annual fuel utilization efficiency (AFUE) levels, each of which applies to units of a particular type (*i.e.*, wall fan, wall gravity, floor, room) and heating capacity range. *Id.* These statutory standards have been codified in DOE's regulations at 10 CFR 430.32(i). The DHE energy conservation standards are set forth in Table II.2 below. DOE notes that while electric DHE are available, standards for these products are outside the scope of today's rulemaking. See IV.A.1.b for a more detailed discussion of DHE coverage under EPCA.

TABLE II.2—CURRENT FEDERAL ENERGY CONSERVATION STANDARDS FOR DIRECT HEATING EQUIPMENT

Direct heating equipment design type	Product class Btu/h	Annual fuel utilization efficiency, as of Jan. 1, 1990 %
Gas Wall Fan	Up to 42,000	73
	Over 42,000	74
Gas Wall Gravity	Up to 10,000	59
	Over 10,000 and up to 12,000	60
	Over 12,000 and up to 15,000	61
	Over 15,000 and up to 19,000	62
	Over 19,000 and up to 27,000	63
	Over 27,000 and up to 46,000	64
	Over 46,000	65
Gas Floor	Up to 37,000	56
	Over 37,000	57
Gas Room	Up to 18,000	57
	Over 18,000 and up to 20,000	58
	Over 20,000 and up to 27,000	63
	Over 27,000 and up to 46,000	64
	Over 46,000	65

c. Pool Heaters

EPCA requires pool heaters manufactured on or after January 1, 1990 to have a thermal efficiency no less than 78 percent. The thermal efficiency for this product is measured by testing in accordance with the DOE test procedure for pool heaters codified in 10 CFR 430, subpart B, Appendix P. The statutory standard for pool heaters has been codified in DOE's regulations at 10 CFR 430.32(k).

2. History of Standards Rulemaking for Water Heaters, Direct Heating Equipment, and Pool Heaters

Before being amended by the National Appliance Energy Conservation Act of 1987 (NAECA; Pub. L. 100–12), Title III of EPCA included water heaters and home heating equipment as covered products. NAECA's amendments to EPCA included replacing the term ''home heating equipment'' with ''direct heating equipment,'' adding pool heaters as a covered product, establishing energy conservation standards for these two products as well as residential water heaters, and requiring that DOE determine whether these standards should be amended. (42 U.S.C. 6295(e)(1)–(4)) As indicated above, DOE amended the statutorily-prescribed standards for water heaters in 2001 (66 FR 4474 (Jan. 17, 2001)), but has not amended the statutory standards for DHE or pool heaters.

DOE initiated this rulemaking on September 27, 2006, by publishing on its Web site its ''Rulemaking Framework for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters.'' (A PDF of the framework document is available at *http://www.eere.energy.gov/buildings/appliance_standards/residential/pdfs/heating_equipment framework_092706.pdf.*) DOE also published a notice announcing the availability of the framework document and a public meeting and requesting comments on the matters raised in the document. 71 FR 67825 (Nov. 24, 2006). The framework document described the procedural and analytical approaches that DOE anticipated using to evaluate potential energy conservation standards for the three heating products and identified various issues to be resolved in conducting the rulemaking.

DOE held the public meeting on January 16, 2007, where it: Presented the contents of the framework document; described the analyses it planned to conduct during the rulemaking; sought comments from interested parties on these subjects; and in general, sought to inform interested parties about, and facilitate their involvement in, the rulemaking. Interested parties that participated in the public meeting discussed the following issues: the scope of coverage for the rulemaking; product classes; efficiency levels analyzed in the engineering analysis; installation, repair, and maintenance costs; and product and fuel switching. At the meeting and during the public comment period, DOE received many comments that helped DOE identify and resolve the issues involved in this rulemaking to consider amended energy conservation standards for the three types of heating products.

DOE then gathered additional information and performed preliminary analyses to help develop the potential energy conservation standards for the three heating products. This process culminated in DOE's announcement of another public meeting to discuss and receive comments on the following matters: The product classes DOE planned to analyze; the analytical framework, models, and tools that DOE has been using to evaluate standards; the results of the preliminary analyses DOE performed; and potential standard levels that DOE could consider. 74 FR 1643 (Jan. 13, 2009) (the January 2009 notice). DOE also invited written comments on these subjects and announced the availability of a preliminary technical support document (preliminary TSD) to inform interested parties and enable them to provide comments. *Id.* (The preliminary TSD is available at: *http://www1.eere.energy.gov/buildings/appliance_standards/residential/water_pool_heaters_prelim_tsd.html.*) DOE stated its interest in receiving comments on other relevant issues that participants believe DOE should address in this NOPR, which would affect energy conservation standards for the three heating products. *Id.* at 1646.

The preliminary TSD provided an overview of the activities DOE undertook in developing potential standard levels for the three heating products and discussed the comments DOE received in response to the framework document. It also described the analytical framework that DOE used (and continues to use in this rulemaking), including a description of the methodology, the analytical tools, and the relationships among the various analyses that are part of the rulemaking. The preliminary TSD described in detail each analysis DOE performed up to that point, including inputs, sources, methodologies, and results. DOE examined each of the three heating products in each of the following analyses:

- A *market and technology assessment* addressed the scope of this rulemaking (*i.e.*, which types of heating products this rulemaking covers), identified the potential classes for each product, characterized the markets for these products, and reviewed techniques and approaches for improving product efficiency.
- A *screening analysis* reviewed technology options to improve the efficiency of each of the three heating products and weighed these options against DOE's four prescribed screening criteria (*i.e.*, technological feasibility; practicability to manufacture, install, and service; adverse impacts on product utility or product availability; and adverse impacts on health or safety).
- An *engineering analysis* estimated the manufacturer selling prices (MSPs) associated with more efficient water heaters, DHE, and pool heaters.
- An *energy use analysis* estimated the annual energy use in the field of each of the three heating products.
- A *markups analysis* developed factors to convert estimated MSPs derived from the engineering analysis to consumer prices.
- A *life-cycle cost analysis* 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 a given standard.
- A *payback period (PBP) analysis* estimated the amount of time it takes consumers to recover the higher purchase expense of more energy efficient products through lower operating costs.
- A *shipments analysis* estimated shipments of each of the three heating products over the time period examined in the analysis (*i.e.,* 2015–2045 for water heaters and 2013–2043 for DHE and pool heaters) under both a base-case scenario (*i.e.,* assuming no new standards) and a standards-case scenario (*i.e.,* assuming new standards at the various levels under consideration). The shipments analysis provides key inputs to the national impact analysis (NIA).
- A *national impact analysis* assessed the aggregate impacts at the national level of potential energy conservation standards for each of the three heating products, as measured by the net present value of total consumer economic impacts and national energy savings.
- A *preliminary manufacturer impact analysis* took the initial steps in evaluating the effects on manufacturers of potential new efficiency standards.

In the January 2009 notice, DOE summarized in detail the nature and function of the following analyses: (1) Engineering, (2) energy use characterization, (3) markups to determine installed prices, (4) LCC and PBP analyses, and (5) national impact analysis. 74 FR 1643, 1645–46 (Jan. 13, 2009).

The public meeting announced in the January 2009 notice took place on February 9, 2009. At this meeting, DOE presented the methodologies and results of the analyses set forth in the preliminary TSD. The major topics discussed at the February 2009 public meeting included the product classes for the rulemaking, the treatment of ultra-low NO_X water heaters, heat pump water heaters screening considerations, installation costs and concerns for heat pump water heaters, the manufacturing costs for max-tech products, pool heater shipments, the energy-use adjustment for gas-fired instantaneous water heaters, and the compliance dates for amended standards. The comments received since publication of the January 2009 notice, including those received at the February 2009 public meeting, have contributed to DOE's proposed resolution of the issues in this rulemaking. This NOPR quotes and summarizes many of these comments, and responds to the issues they raised. (A parenthetical reference at the end of a quotation or paraphrase provides the location of the relevant source in the public record.)

III. General Discussion

A. Test Procedures

As noted above, DOE's current test procedures for water heaters, vented DHE, and pool heaters appear at Title 10 Code of Federal Regulations (CFR) part 430, subpart B, appendices E, O, and P, respectively. DOE uses these test procedures to determine whether the products comply with standards adopted under EPCA. (42 U.S.C. 6293)

1. Water Heaters

During the preliminary analysis, DOE received a number of comments on the test procedure for residential water heaters. Edison Electric Institute (EEI) stated that DOE should modify the values for hot water use and the number of daily draws in the water heater test procedure to more closely resemble field conditions (*i.e.,* include more shorter draws, rather than fewer longer draws), and SEISCO INTERNATIONAL (SEISCO) recommended the adoption of a testing protocol for water heaters that can best simulate real world usage patterns. (EEI, No. 40 at p.5; SEISCO, No. 41 at p. 3) [2] Southern Company (Southern), Bock Water Heaters (Bock), and EEI all stated that DOE needs to revise the test procedure to account for the actual performance of gas-fired instantaneous water heaters. (Southern, No. 50 at p. 2; Bock, No. 53 at p. 3; EEI, No. 40 at p. 5)

DOE acknowledges that the actual hot water use and the number of daily draws seen in the field can vary greatly depending upon occupancy and consumer usage patterns for each type of water heater. DOE's test procedure attempts to normalize the usage across fuel types by specifying a typical draw pattern and total hot water usage. DOE accounts for the variability of these parameters on the energy consumption of the water heater using: (1) A hot water draw model that accounts for field conditions in a representative sample of U.S. homes; and (2) data from field studies of gas-fired instantaneous water heaters that incorporate a distribution of correction factors to account for actual field operation. These adjustments are used to estimate the impacts on consumers of amended standards in the LCC and PBP analysis.

In the past, the issue of whether the efficiency levels examined by DOE in this NOPR are achievable using the current DOE test procedures for residential water heaters has received much attention from commenters. In particular, several manufacturers either through manufacturer interviews or docket submissions have expressed their concern that as efficiencies increase and approach the theoretical maximum efficiency for electric resistance water heating (*i.e.,* 1.0 EF), the ability to consistently and repeatedly achieve those efficiencies is significantly hindered by the variations and inaccuracies that are inherent in the current DOE test procedure. During engineering and manufacturer interviews, manufacturers have indicated that this becomes an increasingly important issue at 0.95 EF.

Rheem Manufacturing Company (Rheem) commented that the nature of the DOE test procedure, including test set-up variations, instrumentation, and measurement inaccuracies, limits the attainable energy factor values. Rheem

[2] ''EEI, No. 40 at p. 5'' refers to: (1) To a statement that was submitted by the Edison Electric Institute. It was recorded in the Resource Room of the Building Technologies Program in the docket under ''Energy Conservation Program: Energy Conservation Standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters,'' Docket Number EERE–2006–BT–STD–0129, as comment number 40; and (2) a passage that appears on page 5 of that statement.

stated that DOE should reevaluate the current test procedure to determine whether it can accurately measure the EF levels being proposed for standards, especially if a standard is set at or near the theoretically maximum-attainable EF. (Rheem, No. 49 at pp. 3–4)

DOE agrees with Rheem's assertion that as the theoretical limit is reached for a covered product utilizing a given technology (*e.g.,* electric resistance storage water heaters), the limitations imposed by the instrumentation, test set-up, and measurement accuracies become increasingly important. In response, DOE notes that there are currently several models in AHRI's Directory of certified residential water heaters that are listed with energy factors of 0.95 EF over a range of storage volumes. DOE believes this fact demonstrates that it is possible for manufacturers to make products that can repeatedly achieve an energy factor of 0.95 and can be certified at this efficiency level. In order to further verify the ability of manufacturers to achieve this efficiency level, DOE performed its own research, which consisted of independent third-party testing of several water heater models rated at 0.95 EF with rated storage volumes spanning 30 to 80 gallons. Of the five models tested that were rated at 0.95 EF, four fell within the acceptable range of values to be rated and certified at 0.95 EF, while only one model failed to achieve an efficiency that would be acceptable for a 0.95 EF rating. This further demonstrates the ability of manufacturers to consistently achieve 0.95 EF, as the large majority of the sample of models tested did reach an acceptable value for certification at 0.95 EF.

DOE has tentatively concluded that the TSLs being considering in the proposed rule provide ample room for manufacturers to innovatively design products which meet the standards using the existing test procedure. DOE's test results further provide evidence that electric storage water heaters exist at TSL 4 (0.95 EF at the representative rated storage capacity) across a range of storage volumes in the market today. In addition, DOE notes that once the product surpasses the theoretical maximum of a given technology by utilizing a different design these problems are mitigated. Consequently, DOE does not believe commenter's concerns regarding the repeatability and accuracy of the test procedure apply to TSL 6 and 7, where DOE is considering advance technology water heaters, including heat pump water heaters.

The Natural Resources Defense Council (NRDC) stated that the water heater test procedure fails to capture all of the cost-effective efficiency measures; the American Council for an Energy-Efficient Economy (ACEEE) and NRDC both stated that due to test procedure flaws (*e.g.,* giving no efficiency advantage for an insulated tank bottom), manufacturers are generally not willing to incorporate enhanced efficiency features because product costs are likely to rise without improving the rated energy efficiency. (NRDC, No. 48 at p. 3; ACEEE, No. 35 at p. 4) DOE acknowledges that the current test procedure may not reflect recent advances in technology. DOE believes, however, that the test procedure provides satisfactory methods for measuring performance of the efficiency levels considered in this rulemaking. Furthermore, the design paths that can be used to achieve the considered efficiency levels are given appropriate credit by the test procedure. DOE believes that the appropriate time to address the concerns raised is during the next revision of DOE's test procedure.

2. Direct Heating Equipment

The energy conservation standards set by EPCA for DHE are consistent with the energy efficiency metric described in the vented home heating equipment test procedure. On May 12, 1997, DOE published a final test procedure rule (the May 1997 final rule) in the **Federal Register** that amended the test procedures for DHE, particularly for vented home heating equipment. 62 FR 26140. In this rulemaking, DOE proposes that this test procedure be applied to establish the efficiency of vented gas hearth DHE.

3. Standby Mode and Off Mode Energy Consumption

EPCA, as amended by EISA 2007 requires DOE to amend the test procedures for the three types of heating products to include the standby mode and off mode energy consumption measurements. (42 U.S.C. 6295(gg)(2)(B)(v)) Consistent with EISA 2007's statutory deadline for these changes, DOE intends to amend its test procedures to incorporate these measurements by March 31, 2010. DOE is handling standby mode and off mode energy use for the three heating products in a separate rulemaking.

B. Technological Feasibility

1. General

In each energy conservation standards rulemaking, DOE conducts a screening analysis, which it bases on information it has gathered on all current technology options and prototype designs that could improve the efficiency of the products or equipment that are the subject of the rulemaking. As the first step in such analysis, DOE develops a list of design options for consideration in consultation with manufacturers, design engineers, and other interested parties. DOE then determines which of these means for improving efficiency are technologically feasible. DOE considers a design option to be technologically feasible if it is in use by the relevant industry or if research has progressed to the development of a working prototype. ''Technologies incorporated in commercial products or in working prototypes will be considered technologically feasible.'' 10 CFR 430, subpart C, appendix A, section 4(a)(4)(i).

Once DOE has determined that particular design options are technologically feasible, it evaluates each design option in light of the following additional screening criteria: (1) Practicability to manufacture, install, or service; (2) adverse impacts on product utility or availability; and (3) adverse impacts on health or safety. Section IV.B of this notice discusses the results of the screening analysis for the three types of heating products, particularly the designs DOE considered, those it screened out, and those that are the basis for the efficiency levels in this rulemaking. For further details on the screening analysis for this rulemaking, see chapter 4 of the NOPR TSD.

2. Maximum Technologically Feasible Levels

When DOE proposes to adopt (or not adopt) an amended or new energy conservation 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, DOE determined the maximum technologically feasible (''max-tech'') efficiency levels for the three heating products in the engineering analysis using the most efficient design parameters that lead to the creation of the highest product efficiencies possible. (See chapter 5 of the NOPR TSD.)

The max-tech efficiency levels are set forth in TSL 7 for residential water heaters, TSL 6 for DHE, and TSL 6 for pool heaters. For the representative rated storage volumes and input capacity ratings within a given product class, products with these efficiency levels were or are now being offered for sale, or there is a prototype that has been tested and developed. No products at higher efficiency levels are currently available. Table III.1 lists the max-tech efficiency levels that DOE determined for this rulemaking.

TABLE III.1—MAX-TECH EFFICIENCY LEVELS FOR THE RESIDENTIAL HEATING PRODUCTS RULEMAKING

Product class	Representative product	Max-tech efficiency level
Residential water heaters		
Gas-Fired Storage Water Heater	Rated Storage Volume = 40 Gallons	EF = 0.80
Electric Storage Water Heater	Rated Storage Volume = 50 Gallons	EF = 2.2
Oil-Fired Storage Water Heater	Rated Storage Volume = 32 Gallons	EF = 0.68
Gas-Fired Instantaneous Water Heater	Rated Storage Volume = 0 Gallons, Rated Input Capacity = 199,999 Btu/h.	EF = 0.95
Direct heating equipment		
Gas Wall Fan Type	Rated Input Capacity = Over 42,000 Btu/h	AFUE = 80%
Gas Wall Gravity Type	Rated Input Capacity = Over 27,000 Btu/h and up to 46,000 Btu/h.	AFUE = 72%
Gas Floor Type	Rated Input Capacity = Over 37,000 Btu/h	AFUE = 58%
Gas Room Type	Rated Input Capacity = Over 27,000 Btu/h and up to 46,000 Btu/h.	AFUE = 83%
Gas Hearth Type	Rated Input Capacity = Over 27,000 Btu/h and up to 46,000 Btu/h.	AFUE = 93%
Pool heaters		
Gas Fired	Rated Input Capacity = 250,000 Btu/h	Thermal Efficiency = 95%

See section IV.C.3 for additional details of the max-tech efficiency levels and discussion of related comments from interested parties on the preliminary analysis. In this NOPR, DOE again seeks public comment on the max-tech efficiency levels identified for its analyses. Specifically, DOE requests information about whether the efficiency levels identified by DOE would be achievable using the technologies screened-in during the screening analysis (see section IV.B), especially for gas-fired storage water heaters, and whether even higher efficiencies would be achievable using screened-in technologies. (See Issue 1 under ''Issues on Which DOE Seeks Comment'' in section VII.E of this NOPR.)

C. Energy Savings

1. Determination of Savings

DOE used its NIA spreadsheet to estimate energy savings expected to result from amended energy conservation standards for products that would be covered under today's proposed rule. (Section IV.F of this notice and chapter 10 of the NOPR TSD describe the NIA spreadsheet model.) For each TSL, DOE forecasted energy savings over the period of analysis (beginning in 2013 (DHE, pool heaters) or 2015 (water heaters), the year that compliance with the amended standards would be required, and ending 30 years later) relative to the base case. (The base case represents the forecast of energy consumption in the absence of amended energy conservation standards.) Stated another way, DOE quantified the energy savings attributable to potential amended energy conservation standards as the difference in energy consumption between the standards case and the base case.

The NIA spreadsheet model calculates the energy savings in site energy, which is the energy directly consumed on location by an individual product. DOE reports national energy savings on an annual basis in terms of the aggregated source (primary) energy savings, which are the energy savings used to generate and transmit the energy consumed at the site. To convert site energy to source energy, DOE derived conversion factors, which change with time, from the Energy Information Agency's (EIA) *Annual Energy Outlook 2009 (AEO2009)*.

For results of DOE's National Energy Savings (NES) analysis, see section V.B.3 of this notice or chapter 10 of the NOPR TSD.

2. Significance of Savings

As noted above, under 42 U.S.C. 6295(o)(3)(B), DOE is prohibited from adopting a standard for a covered product if such standard would not result in ''significant'' energy savings. While the term ''significant'' is not defined in the Act, the U.S. Court of Appeals for the District of Columbia Circuit, in *Natural Resources Defense Council* v. *Herrington,* 768 F.2d 1355, 1373 (D.C. Cir. 1985), indicated that Congress intended ''significant'' energy savings in this context to be savings that were not ''genuinely trivial.'' The energy savings for all of the TSLs considered in this rulemaking are nontrivial, and, therefore, DOE considers them ''significant'' within the meaning of section 325 of the EPCA.

D. Economic Justification

1. Specific Criteria

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

a. Economic Impact on Manufacturers and Consumers

EPCA requires DOE to consider the economic impact on manufacturers and consumers of products when determining the economic justification of a standard. (42 U.S.C. 6295(o)(2)(B)(i)(I)) In determining the impacts of an amended standard on manufacturers, DOE first determines the quantitative impacts using an annual cash-flow approach. This includes both a short-term assessment—based on the cost and capital requirements during the period between the announcement of a regulation and when the regulation comes into effect—and a long-term assessment over the 30-year analysis period. The impacts analyzed include INPV (which values the industry on the basis of expected future cash flows), annual cash flows, changes in revenue and income, and other measures of impact, as appropriate. DOE analyzes and reports the impacts on different types of manufacturers, paying particular attention to impacts on small manufacturers. DOE also considers the impact of standards on domestic manufacturer employment and manufacturing capacity, as well as the potential for plant closures and loss of capital investment. Finally, DOE accounts for cumulative impacts of different DOE regulations and other regulatory requirements on manufacturers.

For consumers, measures of economic impact include the changes in LCC and PBP for each TSL. The LCC, which is also separately specified as one of the seven factors to be considered in determining the economic justification for a new or amended standard (42 U.S.C. 6295(o)(2)(B)(i)(II)), is discussed in the following section.

For the results of DOE's analysis of the economic impacts of potential standards on manufacturers and consumers, see section V.B of this notice and chapters 8 and 12 of the NOPR TSD.

b. Life-Cycle Costs

The LCC is the sum of the purchase price of a product (including associated installation costs) and the operating expense (including energy, maintenance, and repair expenditures) discounted over the lifetime of the product. In this rulemaking, DOE calculated both LCC and LCC savings for various efficiency levels for each product. The LCC analysis estimated the LCC for representative heating products in housing units that represent the segment of the U.S. housing stock that uses these appliances. Through the use of a housing stock sample, DOE determined for each household in the sample the energy consumption of the heating product and the appropriate energy prices. By using a representative sample of households, the analysis captured the wide variability in energy consumption and energy prices associated with heating product use. For each household, DOE sampled the values of several inputs to the LCC calculation from probability distributions. For purposes of the analysis, DOE assumes that the consumer purchases the product in the year the standard becomes effective.

DOE presents the LCC savings as a distribution, with a mean value and a range across the sample for each product. This approach permits DOE to identify the percentage of consumers achieving LCC savings or attaining certain payback values due to an amended energy conservation standard, in addition to the average LCC savings or average payback for that standard.

For the results of DOE's LCC and PBP analyses, see section V.B.1.a of this notice and chapter 8 of the NOPR TSD.

c. Energy Savings

While significant conservation of energy is a separate statutory requirement for adopting an energy conservation standard, the Act 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)) DOE used the NES spreadsheet results in its consideration of total projected savings.

For the results of DOE's energy savings analyses, see section V.B.3.a of this notice and chapter 10 of the NOPR TSD.

d. Lessening of Utility or Performance of Products

In establishing product classes and evaluating their potential for improved energy efficiency, DOE sought to develop potential standards for the three types of heating products that would not lessen the utility or performance of these products. During the screening analysis, DOE tentatively concluded that the efficiency levels being considered would not necessitate changes in product design that would reduce utility or performance of the three types of heating products that are the subject of this rulemaking. Therefore, none of the TSLs presented in today's NOPR would reduce the utility or performance of the products under consideration. (42 U.S.C. 6295(o)(2)(B)(i)(IV))

For the results of DOE's analyses related to the impact of potential standards on product utility and performance, see section IV.B of this notice and chapter 4 of the NOPR TSD, the screening analysis.

e. Impact of Any Lessening of Competition

EPCA directs DOE to consider any lessening of competition likely to result from standards. It 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, not later than 60 days after the publication of a proposed rule, together with an analysis of the nature and extent of such impact. (42 U.S.C. 6295(o)(2)(B)(i)(V) and (B)(ii)) DOE has transmitted a copy of today's proposed rule to the Attorney General and has requested that the U.S. Department of Justice (DOJ) provide its determination on this issue. DOE will publish and address the Attorney General's determination in the final rule.

f. Need of the Nation To Conserve Energy

EPCA directs DOE to consider the need for national energy and water conservation as part of its standard-setting process. (42 U.S.C. 6295(o)(2)(B)(i)(VI)) DOE has preliminarily determined that the non-monetary benefits of the proposed standards would likely be reflected in improvements to the security and reliability of the Nation's energy system. Reductions in the demand for electricity may result in reduced costs for maintaining reliability of the Nation's electricity system. DOE conducts a utility impact analysis to estimate how standards may affect the Nation's power generation capacity requirements.

Energy savings from the proposed standards would also be likely to result in environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases associated with energy production, and through reduced use of fossil fuels at the homes where heating products are used. Although presented in summary form in section IV.K, DOE reports the environmental effects from the proposed standards and all of the considered TSLs in the environmental assessment contained in chapter 15 of the NOPR TSD. DOE also reports estimates of the economic value of emissions reductions resulting from the considered TSLs.

g. Other Factors

The Act 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)) Under this provision, DOE considered LCC impacts on identifiable groups of consumers, such as seniors and residents of multi-family housing, who may be disproportionately affected by any national energy conservation standard level. In addition, DOE considered the uncertainties associated with the heat pump water heater market related to the ability of manufacturers to ramp up production of heat pump water heaters to serve the U.S. market, the ability of heat pump component manufacturers to increase production to serve the water heater market, and the ability to retrain enough servicers and installers of water heaters to serve the market. See section V.C.1 for an additional discussion of the uncertainties in the heat pump water heater market.

For the results of DOE's LCC subgroup analysis, see section IV.G of this notice and chapter 11 of the NOPR TSD. For a full discussion of the uncertainties related to heat pump water heaters, see sections V.C.1 and IV.B.3 of this notice.

2. Rebuttable Presumption

As set forth in 42 U.S.C. 6295(o)(2)(B)(iii), EPCA provides for 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 level is less than three times the value of the first-year energy (and, as applicable, water) savings resulting from the standard, as calculated under the applicable DOE test procedure. The LCC and PBP analyses generate values that calculate the payback period for consumers of potential amended energy conservation standards. These analyses include, but are not limited to, the 3-year payback period contemplated under the rebuttable presumption test discussed above. 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). The rebuttable presumption payback calculation is discussed in section IV.D of this NOPR and chapter 8 of the NOPR TSD.

IV. Methodology and Discussion

In November 2006, DOE published a notice of public meeting and availability of the framework document. 71 FR 67825 (Nov. 24, 2006). DOE initially presented its proposed methodology for the analyses pertaining to the heating products rulemaking in the framework document. After receiving comments from interested parties on the approaches proposed in the framework document, DOE modified its methodology and assumptions, and performed a preliminary analysis for heating products. Subsequently, DOE published a notice of public meeting on January 13, 2009. 74 FR 1643. In the Executive Summary of that notice and preliminary TSD which accompanied it, DOE detailed its preliminary analysis conducted for the heating products rulemaking, including methodology, assumptions, and results. After receiving further comment from interested parties on the analytical approach and results of the preliminary analysis, DOE further refined its analyses for today's NOPR.

DOE used two spreadsheet tools to estimate the impact of today's proposed standards. The first spreadsheet calculates LCCs and PBPs of potential new energy conservation standards. The second provides shipments forecasts and then calculates national energy savings and net present value impacts of potential new energy conservation standards. DOE also assessed manufacturer impacts, largely through use of the Government Regulatory Impact Model (GRIM). These spreadsheets are available online at: *http://www1.eere.energy.gov/buildings/appliance_standards/residential/waterheaters.html.*

Additionally, DOE estimated the impacts on utilities and the environment of potential energy efficiency standards for the three heating products. DOE used a version of EIA's National Energy Modeling System (NEMS) for the utility and environmental analyses. The NEMS model simulates the energy sector of the U.S. economy. EIA uses NEMS to prepare its *AEO,* a widely-known energy forecast for the United States. The EIA approves the use of the name NEMS to describe only an *AEO* version of the model without any modification to code or data. For more information on NEMS, refer to *The National Energy Modeling System: An Overview 1998.* DOE/EIA–0581 (98) (Feb. 1998) (available at: *http://tonto.eia.doe.gov/FTPROOT/forecasting/058198.pdf*).

The version of NEMS used for appliance standards analysis is called NEMS–BT. Because the present analysis entails some minor code modifications and runs the model under various policy scenarios that deviate from *AEO* assumptions, the name ''NEMS–BT'' refers to the model as used here. (''BT'' stands for DOE's Building Technologies Program.) NEMS–BT offers a sophisticated picture of the effect of standards because it accounts for the interactions between the various energy supply and demand sectors and the economy as a whole.

A. Market and Technology Assessment

1. Consideration of Products for Inclusion in This Rulemaking

In this subsection, DOE is presenting its determination of scope and coverage for the rulemaking. Specifically, this subsection addresses whether EPCA covers certain products and provides DOE with the authority to adopt standards for those products. Second, it addresses certain types of heating products that are covered under EPCA, but for which DOE is not proposing amended standards at this time, due to other relevant statutory provisions, technological limitations, or other considerations.

a. Determination of Coverage Under the Act

i. Solar-Powered Water Heaters and Pool Heaters

As indicated above, EPCA directs DOE to determine whether to amend the energy conservation standards that the Act prescribes for residential water heaters and pool heaters. (42 U.S.C. 6295(e)(4)) Under EPCA, any standard for residential water heaters and pool heaters must establish either a maximum amount of energy use or a minimum level of efficiency that is based on energy use (42 U.S.C. 6291(5)–(6)). EPCA defines ''energy use,'' in part, as ''the quantity of energy'' that the product consumes. (42 U.S.C. 6291(4)) Further, EPCA covers these two products as consumer products. (42 U.S.C. 6291(2); 6292(a)(4), (9), and (11)) EPCA defines ''consumer product,'' in part, as an article that consumes or is designed to consume energy. (42 U.S.C. 6291(1)) EPCA defines ''energy'' as meaning ''electricity, or fossil fuels,'' or other fuels that DOE adds to the definition, by rule, upon determining ''that such inclusion is necessary or appropriate to carry out the purposes'' of EPCA. (42 U.S.C. 6291(3)) DOE does not have statutory authority to add solar energy (or any other type of fuel) to EPCA's definition of ''energy.'' Thus, DOE presently lacks authority to prescribe standards for these products when they use the sun's energy instead of fossil fuels or electricity because EPCA currently covers only water heaters and pool heaters that use electricity or fossil fuels, and because any ''energy conservation standard'' currently adopted under EPCA for these two products must address or be based on the quantity of these fuels, but not solar power, that the product consumes. As to water heaters, DOE lacks authority to adopt standards for solar-powered products for an additional reason. ''Water heater'' under EPCA currently means ''a product which utilizes oil, gas, or electricity to heat potable water,'' thereby excluding solar water heaters from coverage. (42 U.S.C. 6291(27); 10 CFR 430.2)

ii. Add-On Heat Pump Water Heaters

EPCA defines a residential ''water heater,'' in part, as a product that ''heat[s] potable water for use outside the heater upon demand, including * * * heat pump type units * * * which are products designed to transfer thermal energy from one temperature level to a higher temperature level for the purpose of heating water, including all ancillary equipment such as fans, storage tanks, pumps, or controls necessary for the device to perform its function.'' (42 U.S.C. 6291(27); 10 CFR 430.2) Integral heat pump water heaters are fully functioning water heaters when shipped by the manufacturer. They heat water for use outside the appliance upon demand and include in a single packaged product all of the components required for operation as a water heater. Therefore, integral units meet EPCA's definition of a ''water heater.''

Another product sold for residential use is commonly known as an add-on heat pump water heater. This product typically is marketed and used as an add-on component to a separately manufactured, fully functioning storage water heater (usually a conventional electric storage-type unit). The add-on unit consists of a small pump and a heat pump system. The pump circulates the refrigerant from the water heater storage tank through the heat pump system and back into the tank. The add-on heat pump extracts heat from the surrounding air and transfers it to the water in a process that is much more efficient than traditional electric resistance designs. The unit can be mounted on top of the storage tank, or can be separately placed on the floor or mounted on a wall. Add-on units cannot by themselves provide hot water on demand, but rather heat water only after being added to a storage-type water heater. Manufacturers do not ship the product as a fully-functioning water heating unit or paired with a storage tank. The add-on device, by itself, is not capable of heating water and lacks much of the equipment necessary to operate as a water heater. As such, it does not meet EPCA's definition of a ''water heater'' and currently is not a covered product. Consequently, DOE is not proposing in this rulemaking to adopt energy conservation standards for such add-on heat pump units.

iii. Gas-Fired Instantaneous Water Heaters With Inputs Above and Below the Levels Specified in Existing Definitions

Another element of EPCA's definition of a residential ''water heater'' is that it includes ''instantaneous type units which heat water but contain no more than one gallon of water per 4,000 Btu [British thermal units (Btu)] per hour of input, including gas instantaneous water heaters with an input of 200,000 Btu per hour or less * * *.'' (42 U.S.C. 6291(27)(B); 10 CFR 430.2) DOE's test procedure for residential water heaters implements and elaborates on this definition: ''*Gas Instantaneous Water Heater* means a water heater that * * * has an input greater than 50,000 Btu/hr (53 MJ/h) but less than 200,000 Btu/h (210 MJ/h) * * *.'' 10 CFR part 430, subpart B, appendix E, section 1.7.2. During the preliminary analysis and as today's NOPR was developed, DOE considered whether to evaluate for standards gas-fired instantaneous water heaters with inputs greater than 200,000 Btu/h and less than 50,000 Btu/h.

DOE's review of product literature from manufacturers of gas-fired instantaneous water heaters indicates that the majority of such products rated for residential, whole-house use has an input capacity of 199,000 Btu/h, and, thus, are covered by this rulemaking. Given the limitations set by Congress, residential gas-fired instantaneous water heaters with inputs greater than 200,000 Btu/h do not meet EPCA's definition of a ''water heater.'' Consequently, DOE is not proposing in this rulemaking to adopt energy conservation standards for such products.

Regarding the lower end of the range, DOE reviewed Air-Conditioning, Heating, and Refrigeration Institute's (AHRI)[3] *Consumers' Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment* and manufacturer literature to determine the input capacities of products currently being offered for sale on the U.S. market. DOE found that the Directory contains only one gas-fired instantaneous water heater with an input capacity less than 50,000 Btu/h. Moreover, DOE determined that this product has been discontinued and is being replaced by a comparable product that has an input capacity greater than 50,000 Btu/h. Therefore, DOE is not proposing standards for products with an input capacity below 50,000 Btu/h.

iv. Input Capacity for Residential Pool Heaters and Coverage of Spa Heaters

Under EPCA, ''pool heater'' is defined as ''an appliance designed for heating nonpotable water contained at atmospheric pressure, including heating water in swimming pools, spas, hot tubs and similar applications.'' (42 U.S.C. 6291(25); 10 CFR 430.2) During a preliminary phase of this rulemaking, DOE considered excluding from consideration pool heaters with an input capacity greater than 1 million Btu/h, based on its understanding that manufacturers market such pool heaters as light industrial or commercial products. Subsequently, two manufacturers advised DOE that the industry defines residential pool heaters as having an input capacity of less than or equal to 400,000 Btu/h. These comments suggested that DOE should use this capacity limit in its definition of residential pool heaters and for determining the scope of coverage of this product under EPCA.

As indicated by its definition of ''pool heater,'' quoted above, EPCA places no capacity limit on the pool heaters it covers. (42 U.S.C. 6291(25)) Furthermore, EPCA covers pool heaters as a ''consumer product,'' (42 U.S.C. 6291(2), 6292(a)(11)) and defines ''consumer product,'' in part, as an article that ''to any significant extent, is distributed in commerce for personal use or consumption by individuals.'' (42 U.S.C. 6291(1)) These provisions establish that EPCA, and standards adopted under it, apply to any pool heater distributed to any significant extent as a consumer product for residential use, regardless of input capacity; pool heaters marketed as commercial equipment, which contain additional design modifications related to safety requirements for installation in commercial buildings, are not covered by this standard. Therefore, DOE has tentatively concluded that an input capacity limit is neither necessary nor appropriate to determine the scope of coverage of this product under EPCA.

Regarding whether spa heaters, which heat the water in spas, are covered products, DOE notes that EPCA defines a ''pool heater'' to include appliances ''designed for * * * heating water in * * * spas.'' (42 U.S.C. 6291(25); 10 CFR 430.2) As the definition encompasses spa heaters, they are covered by EPCA as well as by the current standards for pool heaters, and DOE has included them in this rulemaking. Because spa heaters and pool heaters perform similar functions, include similar features, and lack performance or operating features that

[3] The Air-Conditioning, Heating, and Refrigeration Institute (AHRI) is the trade association that represents manufacturers of heating products. It was formed on January 1, 2008, by the merger of the Gas Appliance Manufacturers Association (GAMA), which formerly represented these manufacturers, and the Air-Conditioning and Refrigeration Institute. AHRI maintains a Consumers' Directory of Certified Product Performance for water heaters, direct heating equipment, and pool heaters which can be found on AHRI's Web site at *http://www.ahridirectory.org/ahridirectory/pages/home.aspx.*

would cause them to have inherently different energy efficiencies, DOE has not created a separate product class for such units.

v. Vented Hearth Products

As discussed in section II.C.2 above, before the enactment of NAECA, EPCA included ''home heating equipment'' in DOE's appliance standards program. EPCA did not define ''home heating equipment.'' NAECA's amendments to EPCA included replacing the term ''home heating equipment'' with ''direct heating equipment,'' and specified energy conservation standards for ''direct heating equipment.'' However, EPCA did not define this term, and subsequent legislation has not amended EPCA to provide a definition of ''direct heating equipment.''

DOE defined ''home heating equipment'' and related terms in its regulations. These definitions inform the meaning of ''direct heating equipment.'' 10 CFR 430.2. Specifically, DOE defines ''home heating equipment'' as meaning ''vented home heating equipment and unvented home heating equipment,'' and defines each of these two terms. *Id.* The definition of ''vented home heating equipment,'' relevant here, is as follows:

> * * * a class of home heating equipment, not including furnaces, designed to furnish warmed air to the living space of a residence, directly from the device, without duct connections (except that boots not to exceed 10 inches beyond the casing may be permitted) and includes: vented wall furnace, vented floor furnace, and vented room heater.'' *Id.*

DOE also defines the last three terms in this definition. *Id.* In order to provide additional clarity for interested parties, DOE is proposing to define the term ''direct heating equipment'' in today's rulemaking. Specifically, DOE is proposing to add the following definition in 10 CFR 430.2:

> Direct heating equipment means vented home heating equipment and unvented home heating equipment.

Given that background, the following addresses the issue of vented hearth products.

Vented hearth products include gas-fired products such as fireplaces, fireplace inserts, stoves, and log sets that typically include aesthetic features such as a yellow flame. Consumers typically purchase these products to add aesthetic qualities and ambiance to a room, and the products also provide space heating. They provide such heating by furnishing warmed air to the living space of a residence directly from the device without duct connections. There are two types of vented hearth product designs: (1) Recessed and (2) non-recessed. Recessed products are typically incorporated into or attached to a wall, whereas non-recessed products are typically free-standing and not attached to a wall. Both may include fireplace or hearth aesthetics, and the recessed product may include a surrounding mantle.

Vented hearth products meet DOE's definition of ''vented home heating equipment,'' because they are designed to furnish warmed air to the living space of a residence without duct connections. Furthermore, recessed and non-recessed vented hearth products are similar in design to some of the direct heating products for which EPCA prescribes standards, namely gas wall fan and gravity-type furnaces in the case of recessed products, and room heaters in the case of non-recessed products.

In sum, DOE has tentatively concluded that vented hearth products are covered products under EPCA, because they meet DOE's definition for ''vented home heating equipment'' and, therefore, are classified as DHE. Thus, DOE proposes to establish standards for these products in this rulemaking and subject these products to the existing testing and certification provisions for DHE. See section IV.2 and IV.3, below, for additional discussion on DOE's proposal for establishing coverage of hearth products and the product classes for the rulemaking analyses. If DOE finalizes this rulemaking as proposed for hearth type DHE, manufacturers of these products would be subject to the provisions in 10 CFR parts 430.23, 430.24, 430.27, 430.32, 430.33, 430.40 through 430.49, 430.50 through 430.57, 430.60 through 430.65, and 430.70 through 430.75, which currently apply to DHE. DOE seeks comment on the potential burdens to manufacturers of hearth-type DHE as a result of the testing, certification, reporting, and enforcement provisions in these sections. (See Issue 2 under ''Issues on Which DOE Seeks Comment'' in section VII.E of this NOPR.)

b. Covered Products Not Included in This Rulemaking

i. Unvented Direct Heating Equipment (Including Electric Equivalents to Gas-Fired Products)

When EPCA included ''home heating equipment'' as a covered product, DOE construed this term as including unvented as well as vented products, and prescribed a separate test procedure for each one. 43 FR 20128 (May 10, 1978); 43 FR 20147 (May 10, 1978). Each of these test procedures has since been amended, and they are codified in 10 CFR part 430, subpart B, appendices G and O, respectively. The new energy conservation standards for this equipment in NAECA's amendments to EPCA in 1987 were only for gas products, however, and used the AFUE descriptor, which applies to vented but not unvented equipment. (42 U.S.C. 6295(e)(3)) The AFUE descriptor is generally a measure of the amount of heat provided by the product compared to the amount of fuel supplied. Subsequent DOE actions concerning DHE—first in a NOPR proposing standards for eight separate products, 59 FR 10464 (March 4, 1994), and then in a final rule adopting test procedure amendments for DHE, 62 FR 26140 (May 12, 1997)—have focused solely on vented products. This approach reflects DOE's understanding that because unvented heating products dissipate any heat losses directly into the conditioned space rather than elsewhere through a vent, the amount of energy losses from these products is minimal.

The current test procedure for unvented equipment includes neither a method for measuring energy efficiency nor a descriptor for representing the efficiency of unvented home heating equipment. Instead, the current test procedure focuses on a method to measure and calculate the annual energy consumption of unvented equipment.10 CFR part 430, subpart B, appendix G. Nevertheless, it remains the case that the unvented products in question would dissipate any heat losses directly into the conditioned space, thereby resulting in minimal overall energy losses. Thus, DOE sees little benefit from setting a minimum efficiency level for these products and believes that it would be unnecessary to do so, given the extremely limited energy savings that could be achieved by such a standard. For these reasons, and consistent with previous rulemakings in which it has addressed DHE, DOE has not evaluated unvented products in this rulemaking and is not proposing standards for them at this time.

ii. Electric Pool Heaters

EPCA's definition of ''pool heater,'' quoted above, is not limited to appliances that use a particular type or types of fuel. (42 U.S.C. 6291(25); 10 CFR 430.2) Thus, EPCA covers both gas-fired pool heaters and electric pool heaters, including heat pump pool heaters. EPCA also specifies that the energy efficiency descriptor for residential pool heaters is thermal efficiency. (42 U.S.C. 6291(22)(E)). Lastly, EPCA defines the term ''thermal efficiency of pool heaters'' as ''a measure of the heat in the water delivered at the heater outlet divided by the heat input of the pool heater as measured under test conditions specified in section 2.8.1 of the American National Standard for Gas Fired Pool Heaters, Z21.56–1986, or as may be prescribed by the Secretary.'' (42 U.S.C. 6291(26))

Currently, DOE's test procedures specify only a method for testing gas-fired pool heaters (10 CFR part 430, subpart B, appendix P), and the current energy conservation standard for pool heaters is a minimum level of thermal efficiency that applies only to gas-fired products. In order for DOE to consider an energy conservation standard for electric pool heaters, DOE would first need to establish a test procedure for electric pool heaters using the thermal efficiency metric required by EPCA. DOE seeks comments from interested parties on how DOE could address EPCA's efficiency descriptor requirements in a future potential test procedure revision for electric pool heaters. For this reason, DOE is proposing amended standards for gas-fired pool heaters only and is not considering standards for electric pool heaters. This is identified as Issue 3 in Section VII.E, ''Issues on Which DOE Seeks Comment.''

iii. Tabletop and Electric Instantaneous Water Heaters

Standards are currently applicable to tabletop and electric instantaneous water heaters. (10 CFR 430.32(d)) These products meet EPCA's definition of ''water heater'' (42 U.S.C. 6291(27); 10 CFR 430.2) and are covered by the Act because they utilize electricity to heat potable water for use outside the heater upon demand. However, for the reasons explained below, DOE has not analyzed tabletop water heaters and electric instantaneous water heaters in this rulemaking, and is not proposing amended standards for them, because of the limited potential for energy savings from higher standards for these products.

Tabletop products are primarily electric and are relatively small units because they are designed to be located underneath tabletops in highly specialized applications. The only means of which DOE is aware for manufacturers to increase the energy efficiency of tabletop units is to increase the thickness of their insulation, which would make them larger. Manufacturers already maximize the size of these water heaters in order to meet the currently required minimum energy factors, and size restrictions do not allow the units to be any larger. Thus, DOE is unaware of any means to make tabletop water heaters more energy efficient. Put another way, if DOE were to adopt a higher efficiency standard for this product, it would force this class of covered product off the market, in violation of 42 U.S.C. 6295(o)(4). For these reasons, DOE has not evaluated tabletop products in this rulemaking and is not proposing standards for them.

Regarding electric instantaneous water heaters, DOE notes that the energy efficiency metric for electric instantaneous water heaters (and all other water heaters) is a combination of recovery efficiency and standby losses. All electric water heaters, including instantaneous products, have minor losses in recovery efficiency. Moreover, electric instantaneous water heaters have negligible standby losses because they store no more than two gallons of hot water. In addition, many of the electric instantaneous products currently on the market perform well above the existing applicable energy conservation standard and use available technologies to produce negligible standby losses. Therefore, DOE has not evaluated electric instantaneous water heaters in this rulemaking and is not proposing standards for them.

iv. Combination Water Heating/Space Heating Products

EPCA authorizes DOE to set more than one standard for any product that performs more than one major function by setting one energy conservation standard for each major function. (42 U.S.C. 6295(o)(5)) Some products on the market provide both water heating and space heating. To the extent such combination products meet EPCA's criteria for coverage, DOE could set standards for them, including a separate standard for each of those functions. *Id.* However, because DOE's current test procedure cannot handle combination appliances and DOE has not yet adopted a test procedure to determine the energy efficiency of these combination appliances, DOE has not evaluated them in this rulemaking and is not proposing standards for them.

2. Definition of Gas Hearth Direct Heating Equipment

In the preliminary analysis, DOE stated that vented hearth products can be used to provide residential space heating. When used to furnish heat to a living space, DOE reasoned that these products provide the same function and utility as vented heaters. DOE stated in the preliminary analysis that hearth heaters also provide the same utility and function as gas wall furnaces or gas room heaters, and do not use any unique technologies. See chapter 2 of the preliminary TSD. Additionally, AHRI's Consumers' Directory categorizes fireplace heaters as either room heaters or wall furnaces. DOE treated gas hearth DHE as either a room heater or a wall furnace for the purposes of the preliminary analysis and requested comment in the Executive Summary to the preliminary TSD on the need for a separate product definition and class for gas hearth DHE.

AHRI stated that gas-fired hearth heaters need a unique definition but that they can be included within the room heater DHE product class. AHRI further stated that DOE should use the safety standard in the American National Standards Institute (ANSI) Standard Z.21–88, *Vented Fireplace Heaters* as a reference for developing a fireplace heater definition. (AHRI, Public Meeting Transcript, No. 34.4 at p. 36)

DOE agrees with AHRI and has decided to establish a separate definition for ''hearth direct heating equipment'' to allow manufacturers to easily determine coverage under DOE's regulations. DOE has determined that hearth DHE should not be included with room heater DHE (the alternative suggested by AHRI) due to the unique constraints on hearth products that are not applicable to room heaters because of the former's aesthetic appeal to consumers (*e.g.,* glass viewing panes, yellow flames, and ceramic log sets). DOE reviewed the ''vented gas fireplace heater'' definition in ANSI Standard Z.21–88, as suggested by AHRI. The ''vented gas fireplace heater'' definition in ANSI Standard Z.21–88 reads as follows:

> *Vented gas fireplace heater* is a vented appliance which simulates a solid fuel fireplace and furnishes warm air, with our without duct connections, to the space in which it is installed. A vented gas fireplace heater is such that it may be controlled by an automatic thermostat. The circulation of heating room air may be by gravity or mechanical means. A vented gas fireplace heater may be freestanding, recessed, zero clearance, or a gas fireplace insert.

Part of the ''vented gas fireplace heater'' definition specified by ANSI Standard Z.21–88 would conflict with DOE's definition of ''home heating equipment.'' 10 CFR 430.2. Specifically, all types of home heating equipment under DOE's regulations must function without duct connections (although boots not to exceed 10 inches beyond the casing may be permitted). Therefore, DOE is modifying the definition of ''vented gas fireplace heater'' in ANSI Standard Z.21–88 to be consistent with the types of equipment covered under DOE's authority for home heating equipment. Consequently, in order to account for hearth DHE, DOE is proposing a definition of ''vented hearth heater'' in section 430.2 to read as follows:

Vented hearth heater means a vented, freestanding, recessed, zero clearance fireplace heater, a gas fireplace insert or a gas-stove, which simulates a solid fuel fireplace and is designed to furnish warm air, without ducts to the space in which it is installed.

DOE seeks comment on its definition for ''vented hearth heater.'' (See Issue 4 under ''Issues on Which DOE Seeks Comment'' in section VII.E of this NOPR.)

3. Product Classes

In evaluating and establishing energy conservation standards, DOE generally divides covered products into classes by the type of energy used or by capacity or other performance-related feature that justifies a different standard for products having such feature. (See 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 feature to users. *Id.* DOE normally establishes different energy conservation standards for different product classes based on these criteria.

Table IV.1 presents the product classes for the three types of heating products under consideration in this rulemaking. The subsections below provide additional details, discussion of comments relating to the product classes for the three heating products, as well as identified issues on which DOE is seeking comments.

TABLE IV.1—PROPOSED PRODUCT CLASSES FOR THE THREE HEATING PRODUCTS

Residential water heater type	Characteristics
Gas-Fired Storage Type	Nominal input of 75,000 Btu/h or less; rated storage volume from 20 to 100 gallons.
Oil-Fired Storage Type	Nominal input of 105,000 Btu/h or less; rated storage volume of 50 gallons or less.
Electric Storage Type	Nominal input of 12 kW (40,956 Btu/h) or less; rated storage volume from 20 to 120 gallons.
Gas-Fired Instantaneous	Nominal input of over 50,000 Btu/h up to 200,000 Btu/h; rated storage volume of 2 gallons or less.
Direct heating equipment type	**Heating capacity (Btu/h)**
Gas Wall Fan Type	Up to 42,000.
	Over 42,000.
Gas Wall Gravity Type	Up to 27,000.
	Over 27,000 and up to 46,000.
	Over 46,000.
Gas Floor	Up to 37,000
	Over 37,000.
Gas Room	Up to 20,000.
	Over 20,000 and up to 27,000.
	Over 27,000 and up to 46,000.
	Over 46,000.
Gas Hearth	Up to 20,000.
	Over 20,000 and up to 27,000.
	Over 27,000 and up to 46,000.
	Over 46,000.
Pool heater type	**Characteristics**
Residential Pool Heaters	Gas-fired.

a. Water Heaters

Residential water heaters can be divided into various product classes categorized by physical characteristics that affect product efficiency. Key characteristics affecting the energy efficiency of the residential water heater are the type of energy used and the volume of the storage tank.

The existing Federal energy conservation standards for residential water heaters correspond to the efficiency levels promulgated by the January 2001 final rule, as shown in 10 CFR 430.32(d). These product classes are differentiated by the type of energy used (*i.e.,* electric, gas, or oil) and the type of storage for the water heater (*i.e.,* storage, tabletop, or instantaneous). In this rulemaking, DOE has excluded tabletop water heaters and electric instantaneous water heaters from consideration for the reasons discussed above. Table IV.2 shows the four product classes presented in the preliminary analysis for consideration in today's rulemaking.

TABLE IV.2—PRODUCT CLASSES FOR RESIDENTIAL WATER HEATERS DESCRIBED IN THE PRELIMINARY ANALYSIS *

Residential water heater type	Characteristics
Gas-Fired Storage Type	Nominal input of 75,000 Btu/h or less; rated storage volume from 20 to 100 gallons.
Oil-Fired Storage Type	Nominal input of 105,000 Btu/h or less; rated storage volume of 50 gallons or less.

TABLE IV.2—PRODUCT CLASSES FOR RESIDENTIAL WATER HEATERS DESCRIBED IN THE PRELIMINARY ANALYSIS *—Continued

Residential water heater type	Characteristics
Electric Storage Type	Nominal input of 12 kW (40,956 Btu/h) or less; rated storage volume from 20 to 120 gallons.
Gas-Fired Instantaneous	Nominal input of over 50,000 Btu/h up to 200,000 Btu/h; rated storage volume of 2 gallons or less.

* Only the product classes covered by this rulemaking are shown. The table does not include tabletop and instantaneous electric water heaters.

In response to the preliminary analysis, DOE received several comments from interested parties about DOE's potential product classes and their organization. These comments are summarized and addressed immediately below.

i. Gas-Fired and Electric Instantaneous Water Heaters

EEI suggested that DOE should revisit the parameters for the input capacity range for gas-fired and electric instantaneous water heaters. Specifically, EEI stated that some gas-fired instantaneous water heaters on the market have an input capacity higher than 200,000 Btu/h, and some electric instantaneous water heaters have an input capacity much higher than 12 kW. (EEI, No. 40 at p. 2) Northwest Energy Efficiency Alliance (NEEA) and Northwest Power and Conservation Council (NPCC) recommended combining gas-fired storage and gas-fired instantaneous water heaters into one product class, because this would simplify the rulemaking, and the commenters do not believe manufacturers will reduce the efficiency of the products they offer now (most of which have EF ratings above 0.80) in response. (NEEA and NPCC, No. 42 at p. 4) SEISCO commented that DOE should establish a separate product class and definition for ''electric instantaneous water heaters''. SEISCO recommended creating a definition for ''whole house electric instantaneous water heaters'' and amending the current 12 kilowatt (kW) maximum to a more reasonable 18 to 36 kW maximum to more accurately reflect the marketplace. (SEISCO, No. 41 at p. 1)

In response, DOE notes that EPCA's definition of ''water heater,'' establishes the input capacity limits for residential instantaneous water heaters. Specifically, the term ''water heater'' means ''a product which utilizes oil, gas, or electricity to heat potable water for use outside the heater upon demand, including * * * (B) instantaneous type units which heat water but contain no more than one gallon of water per 4,000 Btu per hour of input, including gas instantaneous water heaters with an input of 200,000 Btu per hour or less, oil instantaneous water heaters with an input of 210,000 Btu per hour or less, and electric instantaneous water heaters with an input of 12 kilowatts or less * * *'' (42 U.S.C. 6291(27)) As noted above, this statutory definition demonstrates that residential, gas-fired instantaneous water heaters with inputs greater than 200,000 Btu/h and residential, electric instantaneous water heaters with inputs greater than 12 kW do not meet the definitions of a ''water heater'' under EPCA. Accordingly, instantaneous water heaters outside the specified capacity range are not covered products under EPCA and are outside DOE's authority for standard setting pursuant to 42 U.S.C. 6295(e)(4). The input capacity ranges for gas-fired instantaneous water heaters and electric instantaneous water heaters are discussed further in sections IV.A.1.a and IV.A.1.b, respectively, of today's NOPR.

Additionally, DOE disagrees with the suggestion from NEEA and NPCC that DOE should combine the gas-fired storage and gas-fired instantaneous water heater product classes for this rulemaking. As noted earlier in this section, storage capacity is a key characteristic affecting the energy efficiency of water heaters, and it is within DOE's authority to divide products into classes based on capacity. (42 U.S.C. 6295(q)) Thus, DOE is maintaining separate product classes for gas-fired storage and gas-fired instantaneous water heaters for today's NOPR.

ii. Low-Boy Water Heaters

AHRI recommended establishing a separate product class for low-boy heaters since they must fit under a 36-inch counter, be less than 34 inches high, and have a jacket diameter of less than 26 inches. AHRI stated that low-boy heaters provide a specific utility to space-constrained residences and that these products cannot be made any larger. Low-boy heaters account for approximately 18 percent of the residential market. (AHRI, No. 43 at p. 3)

DOE does not agree that a separate product class needs to be established for low-boy water heaters. In evaluating and establishing energy conservation standards, DOE generally divides covered products into classes by the type of energy used, or by capacity or another performance-related feature that justifies a different standard. (See 42 U.S.C. 6295(q)) DOE notes that low-boy water heaters use the same type of energy (*i.e.,* gas or electricity) and are offered in a range of storage volumes. Thus, the type of energy used and the functionality of low-boy units are similar to other types of water heaters, and the size constraints of these units do not appear to impact energy efficiency, since many ''low-boy'' models have efficiencies that are comparable to standard-size water heaters currently available on the market.

DOE seeks comment on its product classes for water heaters. In particular, DOE is seeking further comment about the need for a separate product class for low-boy water heaters. (See Issue 5 under ''Issues on Which DOE Seeks Comment'' in section VII.E of this NOPR.)

iii. Ultra-Low NO_X Water Heaters

In the preliminary analysis, DOE did not distinguish ultra-low NO_X gas-fired storage water heaters from traditional gas-fired storage water heaters with standard burners. AHRI recommended establishing a separate product class. AHRI argued that these water heaters employ unique burners, designed to meet the ultra-low NO_X requirements (imposed by local air quality management districts to limit NO_X emissions of certain products), but which limit the manufacturer's options to increase efficiency. (AHRI, No. 43 at p. 2)

Rheem commented that instantaneous gas-fired water heater ultra-low NO_X requirements from local air quality management districts will commence in 2012 and that this product design should be included in the analysis. (Rheem, No. 49 at p. 7)

DOE does not agree that a separate product class needs to be established for ultra-low NO_X gas-fired storage water heaters. As noted above, in evaluating and establishing energy conservation standards, DOE generally divides covered products into classes by the type of energy used, or by capacity or other performance-related feature that justifies a different standard for products having such feature. (See 42 U.S.C. 6295(q)) Ultra-low NO_X gas-fired storage water heaters use the same type of energy (*i.e.,* gas) and are offered in comparable storage volumes to traditional gas-fired storage water heaters using standard burners. In deciding whether the product incorporates a performance feature that justifies a different standard, DOE must consider factors such as the utility of the feature to users. *Id.* In terms of water heating, DOE believes ultra-low NO_X water heaters provide the same utility to the consumer. However, DOE also notes that ultra-low NO_X water heaters do incorporate a specific burner technology, allowing these units to meet the strict emissions requirements of local air quality management districts. Consequently, DOE developed an analysis on ultra-low NO_X gas-fired storage water heaters. See section IV.C.2 for additional details. DOE requests comment from interested parties regarding the approach to the analysis for ultra-low NO_X gas-fired storage water heaters. As indicated in section VII.E under Issue 6, DOE also seeks further comment about the need for a separate product class for ultra-low NO_X water heaters.

iv. Gas-Fired and Electric Storage Water Heaters Product Class Divisions

DOE received two comments about the product class divisions for gas-fired and electric storage water heaters. ACEEE stated that DOE should consider capacity-based product classes for gas-fired and electric storage water heaters. ACEEE stated that EPCA directs DOE to divide covered products into product classes by the type of energy used or by capacity or other performance-related features that affect efficiency. (42 U.S.C. 6295(q)) ACEEE also stated that DOE's energy efficiency equations demonstrate that capacity (*i.e.,* rated storage volume) is one determinant of efficiency. Accordingly, ACEEE recommended separating gas-fired and electric storage water heaters into two product classes, including ''very large'' and ''other.'' (ACEEE, No. 35 at p. 2) ACEEE expressed its belief that DOE will not adequately reflect the potential of the product classes without considering larger and smaller products as separate product classes. (ACEEE, Public Meeting Transcript, No. 34.4 at pp. 66–67)

ACEEE suggested that gas-fired storage water heaters with an input capacity greater than 65,000 Btu/h and electric storage water heaters with a rated storage volume greater than 75 gallons could be in the very large category. (ACEEE, No. 35 at p. 2) ACEEE commented that for heat pump water heaters, impacts such as air flow in small residences are much different for a 50-gallon model than a 30-gallon model. (ACEEE, Public Meeting Transcript, No. 34.4 at pp. 66–67)

In light of the above, ACEEE recommended that DOE should propose energy conservation standards for electric storage water heater products in the very large category requiring a minimum EF of 1.7, which would move the largest electric water heaters to utilize heat pump water heater technologies. ACEEE recommended that DOE should propose standards for the very large product class of gas-fired storage water heaters requiring a minimum EF of 0.77, which corresponds to the least-efficient condensing product. (ACEEE, No. 35 at p. 1)

Pacific Gas and Electric Company (PG&E), San Diego Gas and Electric (SDGE), and Southern California Gas Company (SoCal Gas) filed a joint comment and urged DOE to subdivide gas-fired storage water heaters and electric storage water heaters into subclasses based on rated storage volume. (PG&E, SDGE, and SoCal Gas, No. 38 at p. 3)

DOE believes considering separate efficiency levels for different rated storage volumes could offer a way for DOE to capture additional potential energy savings. Instead of dividing gas-fired and electric storage water heaters into separate product classes by rated storage volume or input capacity as ACEEE suggested, however, DOE is using energy efficiency equations that vary with rated storage volume to describe the relationship between rated storage volume and energy factor. Historically, DOE has used the energy efficiency equations to account for the variability in performance resulting from tank size; these equations consider the increases in standby losses as tank volume increases. DOE is using the energy efficiency equations along with TSL pairings to consider different amended standards in the proposed rule. DOE further discusses the energy efficiency equations and the proposed modifications in section IV.C.7. DOE is requesting comment from interested parties on the energy efficiency equations developed for gas-fired and electric storage water heaters (See section IV.C.7 and Issue 7 under ''Issues on Which DOE Seeks Comment'' in section VII.E of this NOPR for more information.) In addition, DOE further discusses the trial standard levels, which are comprised of various efficiency level pairings across the full range of rated storage volumes, in section V.A.

v. Heat Pump Water Heaters

In response to DOE's treatment of heat pump water heaters as a design option for electric storage water heaters in the preliminary analysis, DOE received several comments from interested parties. All of the commenters urged DOE to establish separate product classes for traditional electric resistance storage water heaters and heat pump water heaters. Their specific comments and DOE's response are presented below.

A.O. Smith stated DOE should separate the electric storage water heater product class into two products classes—one for electric resistance heaters and one for heat pump water heaters. A.O. Smith noted that DOE separated the two classes in the ENERGY STAR criteria. A.O. Smith further stated that since heat pump water heaters may not even fit in 30 percent of the installations that currently have resistance electric heaters, they cannot be considered to be a truly interchangeable technology. (A.O. Smith, No. 37 at p. 9)

AHRI agreed with some of the concerns DOE noted in the preliminary screening analysis for heat pump water heaters. Specifically, AHRI pointed to previous DOE studies, which found size-related installation issues with replacing an electric storage water heater with a heat pump water heater. To AHRI's knowledge, the heat pump water heater market has not changed significantly since DOE's 2001 water heater rulemaking, even with the recent initiation of the ENERGY STAR program and the enactment of legislation that provides a significant tax credit for the installation of these systems. With this in mind, AHRI recommended that DOE establish a separate product class for heat pump water heaters because its energy source is different than that of an electric water heater. While a heat pump water heater does use electricity to operate certain components, the actual energy source that heats the water is air. AHRI noted that an analogous situation exists for electric furnaces, which are not subject to the same standards as heat pump systems. (AHRI, No. 43 at p. 4)

Rheem also maintains that heat pump water heaters require a separate product class. (Rheem, No. 49 at p. 5) Rheem commented that heat pump water heater designs require unique installations, air flow, space, condensate drain, service, and operational provisions that are considerably different from conventional electric storage water heaters. Rheem also stated that installation and air flow conditions will affect energy efficiency, and that heat pump water heaters cannot replace all electric storage type water heaters, as space and air flow constraints are quite common. Furthermore, Rheem commented that heat pump water heater technology depends largely on the operating environment; this represents a special performance-related consideration that warrants defining a separate product class for heat pump water heaters. (Rheem, No. 49 at p. 6) Rheem commented that the utility heat pump water heaters provide is not equivalent to other electric storage water heaters across the entire range of rated storage volumes. Rheem stated that the reduced delivery performance was recognized by ENERGY STAR, which requires a minimum first-hour rating of 50 gallons, instead of 67 gallons for common conventional technologies. The difference in utility will result in differing sizing guidelines to meet equivalent capacities. Rheem commented that while the primary fuel source for heat pump water heaters is assumed to be electricity, the technology attains an economic benefit by moving energy from one location to another. According to Rheem, it is conceivable that a heat pump water heater may operate and be designed with gas as a primary back-up fuel. Rheem noted that with energy factors exceeding 2.0, it can be argued that electricity is no longer the dominant fuel source. Rheem commented that these differences support the argument that heat pump water heaters are not simply an extension of conventional resistance-type electric storage water heaters. (Rheem, No. 49 at pp. 5–6)

While DOE acknowledges some of the challenges associated with heat pump water heaters, DOE does not agree that they require a separate product class. Specifically, DOE does not believe heat pump water heaters provide a different utility from traditional electric resistance water heaters. Heat pump water heaters provide hot water to a residence just as a traditional electric storage water heater. In addition, both heat pump water heaters and traditional electric resistance storage water heaters use electricity as the primary fuel source. DOE believes heat pump water heaters can replace traditional electric resistance storage water heaters in most residences, although the installation requirements may be quite costly. DOE further addresses heat pump water heaters in the screening analysis at section IV.B.3 and the installation requirements in section IV.E.2.a.

DOE seeks further comment on the need for a separate product class for heat pump water heaters. In particular, DOE is interested in receiving comments and data on whether a heat pump water heater can be used as a direct replacement for an electric resistance water heater, and the types and frequency of installations where a heat pump water heater cannot be used as a direct replacement for an electric resistance water heater. (See Issue 8 under ''Issues on Which DOE Seeks Comment'' in section VII.E of this NOPR.)

b. Direct Heating Equipment

DHE can be divided into various product classes categorized by physical characteristics and rated input capacity, both of which affect product efficiency and function. Key characteristics affecting the energy efficiency of DHE are the physical construction (*i.e.,* fan wall units contain circulation blowers), intended installation (*i.e.,* floor furnaces are installed with the majority of the unit outside of the conditioned space), and input capacity.

In the preliminary analysis, DOE examined the possibility of consolidating product classes for DHE. (See chapter 3 of the preliminary TSD.) NAECA originally established the Federal energy conservation standards, which are differentiated by input capacity range. Thus, to determine whether consolidation of existing product classes is appropriate, DOE examined the relationship between AFUE and input rating for DHE. The results of this inquiry are presented below.

i. Gas Wall Fan-Type Direct Heating Equipment

For fan-type wall furnaces, DOE surveyed AHRI's Consumers' Directory and available product literature. DOE identified available products ranging from 8,000 to 65,000 Btu/h. The market data demonstrate two separate trends for fan-type wall furnaces based on the efficiency range of the products. For higher-efficiency products (*i.e.,* 78 percent AFUE and higher), DOE noticed that efficiency decreases as capacity increases. For lower-efficiency products (*i.e.,* 73 to 77 percent AFUE), DOE noticed that efficiency increases as capacity increases. Therefore, because of the differing trends between capacity and efficiency, DOE proposes that the two product classes for gas wall fan-type DHE should remain.

ii. Gas Wall Gravity-Type Direct Heating Equipment

DOE examined the relationship between AFUE and input rating for gravity-type wall furnaces by reviewing AHRI's Consumers' Directory and available product literature. DOE identified products with input capacities ranging from 5,000 to 50,000 Btu/h. The Federal energy conservation standards for gas wall gravity-type furnaces divide these products into seven product classes based on input capacity ranges. The seven product classes are differentiated by one AFUE percentage point increase for each increase in input capacity range (*i.e.,* the larger the input capacity, the higher the AFUE requirements). The market data for gas wall gravity-type furnaces indicate that manufacturers are not offering products over the entire input capacity range. Therefore, some product classes may be unnecessary. DOE proposes that five product classes (up to 10,000 Btu/h, over 10,000 and up to 12,000 Btu/h, over 12,000 and up to 15,000 Btu/h, over 15,000 and up to 19,000 Btu/h, and over 19,000 and up to 27,000 Btu/h) be consolidated into a single product class labeled up to 27,000 Btu/h, leaving three product classes for gas wall gravity-type furnaces.

iii. Gas Floor-Type Direct Heating Equipment

DOE surveyed the current market for gas floor furnaces by reviewing AHRI's Consumers' Directory and available product literature. The AHRI directory lists 23 products. The Federal energy conservation standard includes two product classes divided by input ratings, one above and one at or below 37,000 Btu/h. According to the AHRI directory, more than 75 percent of products are rated above 37,000 Btu/h. When comparing the models with the highest AFUE rating between the two product classes in the preliminary analysis, however, DOE found that the energy savings potential increases as the input capacity range increases. This fact suggests that input capacity affects the AFUE of gas floor-type furnaces. Therefore, DOE proposes that the two product classes for gas floor-type DHE should remain.

iv. Gas Room-Type Direct Heating Equipment

DOE examined currently available room heaters by reviewing AHRI's Consumers' Directory and product literature. DOE found that room heaters have inputs ranging from 20,000 to 70,000 Btu/h. DOE also determined that the relationship between AFUE and input rating established by the Federal energy conservation standards is generally similar to the trend found among products listed in the AHRI directory. The market data show a general trend of increasing AFUE with input capacity range. DOE is proposing to consolidate the two lower input capacity ranges into a single product class (*i.e.,* input ratings up to 20,000 Btu/h), because there are no products in the AHRI directory under 20,000 Btu/h and all products at this input rating have the same efficiency. As a result, DOE is proposing only four product classes for gas room heaters.

Overall, DOE only received one comment in response to its product class consolidation for the existing DHE product types in the preliminary analysis. AHRI agreed that the number of product classes (*i.e.,* divisions by input capacity) for DHE product classes can be reduced. (AHRI, Public Meeting Transcript, No. 34.4 at p. 43)

Therefore, for the NOPR, DOE is proposing to reduce the number of product classes as suggested in the preliminary analysis and described above. DOE is seeking comments on the proposed product classes. (See Issue 9 under ''Issues on Which DOE Seeks Comment'' in section VII.E of this NOPR.)

v. Gas Hearth Direct Heating Equipment

DOE is proposing to add new product classes for gas hearth DHE, which are distinguished by input heating capacity. DOE modeled the product class divisions for gas hearth DHE after the proposed product class divisions for room heaters. DOE is seeking comments on the proposed product class divisions for gas hearth DHE. (See Issue 10 under ''Issues on Which DOE Seeks Comment'' in section VII.E of this NOPR.)

Table IV.3 presents the proposed product classes for DHE being considered for this rulemaking.

TABLE IV.3—PROPOSED PRODUCT CLASSES FOR DIRECT HEATING EQUIPMENT

Direct heating equipment type	Input heating capacity *Btu/h*
Gas Wall Fan Type	Up to 42,000.
	Over 42,000.
Gas Wall Gravity Type	Up to 27,000.
	Over 27,000 and up to 46,000.
	Over 46,000.
Gas Floor	Up to 37,000.
	Over 37,000.
Gas Room	Up to 20,000.
	Over 20,000 and up to 27,000.
	Over 27,000 and up to 46,000.
	Over 46,000.
Gas Hearth	Up to 20,000.
	Over 20,000 and up to 27,000.
	Over 27,000 and up to 46,000.
	Over 46,000.

c. Pool Heaters

As discussed above, the existing Federal energy conservation standards for pool heaters correspond to the efficiency levels specified by EPCA, as amended (42 U.S.C. 6295(e)(2)), and codified in 10 CFR 430.32(k), classifying residential pool heaters with one product class. This product class is distinguished by fuel input type (*i.e.,* gas-fired). DOE notes there are currently electric heat pump pool heaters on the market, which are not being considering in today's rulemaking, as discussed in section IV.A.1.b.

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.* DOE will consider technologies incorporated in commercial products or in working prototypes to be technologically feasible.

2. *Practicability to manufacture, install, and service.* If mass production and reliable installation and servicing of a technology in commercial products could be achieved on the scale necessary to serve the relevant market at the time the standard comes into effect, then DOE will consider that technology practicable to manufacture, install, and service.

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

4. *Adverse impacts on health or safety.* If DOE determines that a technology will have significant adverse impacts on health or safety, it will not consider this technology further.

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

In the preliminary analysis, DOE initially identified the technology options that could improve the efficiency of the three types of heating products that are the subject of this rulemaking. These technologies are listed in Table IV.4. See chapter 3 of the NOPR TSD for a detailed description of each technology option.

TABLE IV.4—TECHNOLOGIES DOE CONSIDERED FOR HEATING PRODUCTS

Water heaters	Direct heating equipment	Pool heaters
Heat Traps Insulation Improvements Power Vent (Gas-Fired and Oil-Fired Only) Heat Exchanger Improvements Flue Damper (Electromechanical) Side-Arm Heater Electronic (or Interrupted) Ignition Heat Pump Water Heater (Electric Only) CO_2 Heat Pump Water Heater Flue Damper (Buoyancy Operated) Directly-Fired Condensing Condensing Pulse Combustion Thermophotovoltaic and Thermoelectric Generators Reduced Burner Size (Slow Recovery) Timer Control Two-Phase Thermosiphon (tpts) Modulating Controls Intelligent Controls Self-Cleaning	Heat Exchanger Improvements Electronic Ignition Thermal Vent Damper Electrical Vent Damper Power Burner Induced Draft Two Stage and Modulating Operation Improved Fan or Blower Motor Efficiency Increased Insulation (Floor Furnaces Only) Condensing Condensing Pulse Combustion Air Circulation Fan Sealed Combustion	Electronic Ignition Improved Heat Exchanger Design More Effective Insulation (Combustion Chamber) Power Venting Sealed Combustion Condensing Pulse Combustion Condensing

In response to DOE's request for comments at the preliminary analysis stage of the rulemaking, DOE did not receive any comments suggesting additional technologies beyond those technology options presented in the preliminary analysis. Therefore, DOE considered the same technology options for the NOPR screening analysis.

1. Comments on the Screening Analysis

In the preliminary analysis, DOE excluded several of the technologies listed in Table IV.4 from consideration in this rulemaking based on one or more of the screening criteria described above. The technology options that were screened out, along with the reasons for their exclusion, are shown below in Table IV.5. For greater detail regarding each technology option, please see Chapters 3 and 4 of the TSD accompanying today's notice.

TABLE IV.5—SUMMARY OF SCREENED-OUT TECHNOLOGY OPTIONS

Applicable product types	Excluded technology option	Reasons for exclusion			
		Technological feasibility	Practicability to manufacture, install, and service	Adverse impacts on product utility	Adverse impacts on health of safety
Water Heaters	Side-Arm Heater	X	X		
	Advanced Insulation	X	X		
	Thermophotovoltaic and Thermoelectric Generators.	X	X		
	U-Tube Flue Design		X		
	CO_2 Heat Pump Water Heaters		X		
	Two-Phase Thermosiphons		X		
	Reduced Burner Size (Slow Recovery).			X	
	Directly Fired Water Heater				X
	Flue Damper (Buoyancy Operated).				X
	Condensing Pulse Combustion	X	X		
Direct Heating Equipment	Increased Heat Transfer Coefficient.		X		
	Power Burner		X		
	Improved Fan Blower Motors		X		
	Condensing Pulse Combustion	X	X		
Pool Heaters	Condensing Pulse Combustion	X	X		

In response to the screening analysis performed for the preliminary analysis, DOE received feedback from several interested parties.

a. General Comments

NRDC commented generally that screening technologies because they have not penetrated the market for the covered product is a flawed approach. NDRC stated that determining if a product is practical to manufacture does not require someone to already be manufacturing it. Instead, NRDC stated that when determining whether a product is practical to manufacture, DOE should consider identified technology options even if they are not currently used in covered products. NRDC stated that DOE should gather data to determine whether technologies used in other products would be useful in the products in question. (NRDC, No. 48 at p. 3)

In response, as part of every rulemaking, DOE reviews the markets and technologies of the appliances under consideration using primary and secondary research. DOE considers prototype designs in the analysis that have not yet fully penetrated the market. In the case of a prototype design (or any design that has not penetrated the market at the time of the analysis) that is not being manufactured on a large scale, DOE examines the practicality of manufacturing, installing, and servicing the design, if it were required to be implemented on a larger scale by the anticipated compliance date of a standard, and accepts the product or screens it out of the analysis on that basis. DOE requires demonstration of a technology in at least a working prototype, because even though technologies may be proven for other applications, it may not translate to a different product type for a variety of reasons. NRDC did not point to specific examples of technologies DOE should consider, and hence, it is more difficult for DOE to specifically address the comment.

AHRI commented that DOE should recognize that many DHE products do not require electricity. AHRI stated that such designs allow consumers to use these products for emergency heat during power outages, which provides a real utility that needs to be factored into DOE's analysis. (AHRI, Public Meeting Transcript, No. 34.4 at p. 21)

DOE considers the impact of any lessening of utility from standards during the screening analysis. If DOE determines 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 consider this technology further. DOE considered several technology options for DHE that require electricity for the NOPR analyses, including electronic ignition systems and blowers or fans. Blowers and fans are generally not necessary for the products to operate and, because the equipment can be operated without them, do not impact the utility of being able to use the equipment for emergency heat during a power outage. For models with electronic ignition systems, electricity is required to light the burner, and, thus, required for product operation. In the case of a power failure, however, many products employ battery backup systems that can provide the electrical power needed to light the burner (or the pilot in the case of intermittent pilot ignitions) during the power outage. Because of this, an electronic ignition system with battery backup would not cause any lessening of utility as compared to a traditional standing pilot system for DHE. Therefore, DOE did not screen out these technologies.

b. Water Heaters

NEEA and NPCC stated that tank bottom insulation is an effective means of improving product efficiency. Accordingly, NEEA and NPCC urged DOE to consider this as a technology option for electric storage water heaters because field data from the Pacific Northwest suggest that tank bottom insulation decreases standby energy loss, especially when the tank is located on a concrete slab. (NEEA and NPCC, No. 42 at p. 4)

DOE considered various improvements in insulation for storage water heaters during the screening analysis, including tank bottom insulation. (See chapter 3 of the NOPR TSD for a full description of the insulation improvements DOE considered.) DOE notes that tank bottom insulation was not screened out during the screening analysis, which is in contrast to advanced forms of insulation which were screened out as unproven (*e.g.,* vacuum panels, aerogels). When listing the potential technology options at each efficiency level (see section IV.C.3), DOE shows only those technologies most commonly used in manufacturing, although specific implementation details vary by manufacturer. Manufacturers currently do not use increased tank bottom insulation as a primary means of increasing efficiency; therefore, it was not listed as one of the technologies used in achieving these efficiency levels for storage water heaters. Hence, DOE agrees with NEEA and NPCC that tank bottom insulation is an effective means of improving the energy factor of storage water heaters.

NEEA and NPCC also urged DOE to include as technology options heat pump water heaters that use CO_2 as the refrigerant. NEEA and NPCC commented that CO_2 heat pump water heaters have been sold and serviced by hundreds of thousands of manufacturers in Southeast Asia and elsewhere over the last 5 to 10 years. (NEEA and NPCC, No. 42 at pp. 4–5)

DOE is not considering CO_2-based heat pump water heaters because DOE research suggests U.S. manufacturers do not have the necessary infrastructure to support manufacturing, installation, and service of CO_2 heat pump water heaters on the scale necessary to serve the relevant market by the compliance date of an amended energy conservation standard. DOE also does not believe manufacturers would be able to develop the necessary infrastructure before the compliance date of an amended energy conservation standard because these products have not penetrated the U.S. market.

ACEEE commented that DOE should revisit the preliminary conclusions presented in the screening analysis, including the tentative decision to not further consider thermophotovoltaic and thermoelectric generators. (ACEEE, No. 35 at pp. 3–4) The commenter stated that the inclusion of thermophotovoltaic and thermoelectric generators would make other technologies such as side-arm themosiphons more feasible. ACEEE asserted that in the case of thermophotovoltaic and thermoelectric generators, DOE assumes that line voltage or 24-volt power cannot be required for gas-fired storage water heaters. DOE research suggests that the amount of power that can be generated by thermophotovoltaic and thermoelectric generators in a residential storage water application is quite limited. Commercially-available thermoelectric elements for water heaters typically produce less than 0.05 Watts of power, and so-called thermopiles can reach as high as 0.75 Watts. While it is theoretically possible to power devices other than the customary gas valves with thermoelectric power sources, DOE is unaware of an external device that has an impact on energy efficiency whose power demands are low enough to allow it to be powered by such generators. DOE is also unaware of any thermophotovoltaic power generators that have been developed to the point where they could be incorporated by the compliance date of the rulemaking, nor of any role that such generators would play in increasing the energy efficiency of gas-fired storage water heaters.

Rheem commented that DOE should recognize the special utility of self-powered water heaters. (Rheem, No. 49 at p. 4) DOE acknowledges that most gas-fired storage-water heaters on the market today do not require an electrical connection to operate (*i.e.,* they are self-powered). Typically, the gas valves on these units incorporate a thermoelectric element that is impinged on by a standing pilot flame. The minute power generated by the thermoelectric element opens the gas supply in the valve assembly via a low-power solenoid. Thus, thermoelectric elements typically act as a safety device. They do not provide sufficient power to run fan blower motors and other high-powered devices. Therefore, DOE has tentatively decided to continue to exclude thermophotovoltaic and thermoelectric generators from its analysis, because they are not an effective means of improving the efficiency of water heaters.

ACEEE also stated that DOE should revisit the preliminary conclusions presented in the screening analysis regarding flue dampers since electromechanical dampers were common on furnaces and boilers and appear to be available for residential boilers today. (ACEEE, No. 35 at pp. 3–4) DOE research suggests that there are no residential storage water heaters on the market today that incorporate such dampers.

Although electromechanical dampers may be found on some furnaces, boilers, and commercial water heaters, their benefit in a residential water heater application is unknown because no manufacturer incorporates them in their products. All products that incorporate electromechanical dampers of which DOE is aware require line power to operate them. Thus, such dampers may not be practicable for all consumers. Additionally, DOE researched damper systems that do not require electrical power to operate. Typically, such systems are based on a bi-metal damper installed on top of the flue pipe outlet that opens when heated and closes as it cools. DOE research suggests that such non-electrically-actuated dampers pose potential health and safety problems. For example, such dampers can fail in the closed position, which could cause the exhaust gases to be stuck in the flue. Furthermore, they rely on hot air impingement to open. However, when the water heater begins its combustion cycle, the flue and its baffles are relatively cold, and flue gas temperatures may require some time until they reach the point where they will open a bi-metal damper quickly and completely. This is especially true for flammable vapor ignition resistant (FVIR) water heaters (which all residential water heaters are) whose natural draft is already restricted by FVIR components. With the flue shut or mostly shut on start-up, water heater combustion can be impacted in a number of ways, including nuisance lockouts, increased carbon monoxide production, and flue gases spilling into living spaces. For these reasons, non-electromechanical dampers were screened out.

ACEEE commented that DOE should revisit the preliminary conclusions presented in the screening analysis regarding advanced forms of insulation, which resulted in DOE's tentative decision to screen out those technologies. (ACEEE, No. 35 at pp. 3–4) In response, DOE research suggests that emerging technologies such as vacuum-insulated-panels (VIPs) may allow manufacturers to reduce heat loss, but such technologies have yet to find application in storage water heaters. DOE notes that ACEEE did not provide any new rationale or data to support why DOE should reconsider its original conclusion presented in the preliminary screening analysis that advanced forms of insulation have not been demonstrated as practical to manufacture and install. Hence, DOE screened out advanced forms of insulation from the NOPR analyses.

ACEEE also stated that DOE should revisit its preliminary conclusions regarding sidearm heaters and two-phase thermosiphons (TPTS) which resulted in DOE's tentative decision to screen out those technologies. (ACEEE, No. 35 at pp. 3–4) Regarding two-phase thermosiphons, ACEEE did not provide any explanation in its comment as to why DOE should reconsider its initial conclusion that it is not practicable to manufacture, install, and service this technology on the scale necessary to serve the relevant market at the time compliance with the standard is required. TPTSs require a drastic redesign of the water heater and are typically not practical for indoor installation. Therefore, DOE has continued to screen out this technology.

Regarding side-arm heaters, ACEEE commented that sidearm heaters are more feasible with access to 24-volt power, which would allow them to be located above or below the unit. This assertion does not address DOE's concerns about sidearm heaters presented in the preliminary analysis. DOE research did not reveal any working prototypes for gas-fired or oil-fired storage water heaters, and manufacturers seem to no longer use this technology. Therefore, this technology is not feasible and not practical to manufacture, install, and service side-arm storage water heaters on the scale necessary to serve the relevant market at the time of the compliance date of the standard, and was not considered further in the analysis. See chapter 4 of the NOPR TSD, Screening Analysis, for more details about DOE's assessment of two-phase thermosiphons and sidearm heaters.

For the reasons listed above, DOE still believes that thermophotovoltaic and thermoelectric generators, side-arm heaters, and advanced forms of insulation are not technologically feasible and are impractical to manufacture, repair, and install; that two-phase thermosiphons are impractical to manufacture, repair, and install; and that buoyancy operated flue dampers have an adverse impact on the safety of these products.

Bradford White Corporation (BWC) stated that using multiple flues for gas-fired storage water heaters is difficult, costly, and impractical to produce on residential water heater tank production lines. (BWC, No. 46 at p. 2)

In response, DOE research suggests that multi-flue storage water heaters can be produced at a higher production scale than is commonly done now. The current low shipment-volume techniques are commonly used in commercial gas-fired and oil-fired water heater designs. Solutions for higher-volume production of such heaters would require significant investments but are not technically infeasible. Thus, DOE believes multiple flue designs could be implemented on residential storage water heaters and are a viable technology for improving the efficiency of oil-fired storage water heaters.

In summary, none of the comments DOE received on the screening analysis led DOE to reconsider its determination for any of the technologies that were excluded from the preliminary analysis. Therefore, DOE excluded the same technologies in the NOPR analysis. Chapter 4 of the NOPR TSD provides more details about the technologies that DOE screened out.

2. Technologies Considered

Based upon the totality of the available information, DOE has tentatively concluded that: (1) All of the efficiency levels discussed in today's notice are technologically feasible; (2) products at these efficiency levels could be manufactured, installed, and serviced on a scale needed to serve the relevant markets; (3) these efficiency levels would not force manufacturers to use technologies that would adversely affect product utility or availability; and (4) these efficiency levels would not adversely affect consumer health or safety. Thus, the efficiency levels that DOE analyzed and is discussing in this notice are all achievable through technology options ''screened in'' during the screening analysis. The technologies DOE considered are shown in Table IV.6 through Table IV.8.

TABLE IV.6—TECHNOLOGIES DOE CONSIDERED FOR THE WATER HEATER ENGINEERING ANALYSIS

Technology	Water heater type by Fuel Source			
	Storage			Instantaneous
	Gas-fired	Electric	Oil-fired	Gas-fired
Increased Jacket Insulation	X	X	X	
Foam Insulation			X	
Improve/Increased Heat Exchanger Surface Area	X	X	X	X
Enhanced Flue Baffle	X		X	
Direct-Vent (Concentric Venting)				X
Power Vent	X		X	X
Electronic (or Interrupted) Ignition	X		X	X
Heat Pump Water Heater		X		
Condensing	X		X	X

TABLE IV.7—TECHNOLOGIES DOE CONSIDERED FOR THE DIRECT HEATING EQUIPMENT ENGINEERING ANALYSIS

Technology
Increased Heat Exchanger Surface Area.
Direct-Vent (Concentric Venting).
Electronic Ignition.
Induced Draft.
Two Stage and Modulating Operation.
Condensing.

TABLE IV.8—TECHNOLOGIES DOE CONSIDERED FOR THE POOL HEATER ENGINEERING ANALYSIS

Technology
Increased Heat Exchanger Surface Area.
More Effective Insulation (Combustion Chamber).
Power Venting.
Sealed Combustion.
Condensing.

3. Heat Pump Water Heaters Discussion

For the preliminary analysis, DOE considered heat pump water heaters as a viable technology option for improving the efficiency of electric storage water heaters. DOE posted the preliminary TSD for residential heating products on its Web site on January 5, 2009 (for more information see *http://www1.eere.energy.gov/buildings/appliance_standards/residential/water_pool_heaters_prelim_tsd.html*). Pages 2–21 to 2–29 of chapter 2 of the preliminary TSD contain an extensive discussion of heat pump water heaters and the significant issues pertaining to the consideration of heat pump water heaters in this rulemaking. In the executive summary to the preliminary TSD, DOE sought comments on the viability of heat pump water heaters as a technology for electric storage water heaters and whether these water heaters would be practicable to manufacture, service, and install on a scale necessary to serve the relevant market by the compliance date of any amended standard, which would be five years after publication of the final rule.

In addition, DOE sought comment on several other issues regarding integral heat pump water heaters: (1) Whether manufacturers would be able to finance the investment costs necessary to convert their existing product lines to heat pump water heaters by the compliance date of an amended standard; (2) what percentage of manufacturers' product lines would be converted to heat pump water heaters by the compliance date of an amended standard (*e.g.,* if standards did not reach the levels provided by heat pump water heaters); (3) how the market for heat pump water heaters has changed since the January 2001 final rule, and the number of installations that would incur a significant increase in cost due to extensive modifications that will have to be made to a residence to accommodate a heat pump water heater; and (4) heat pump water heater programs that have been conducted since the January 2001 final rule.

In response to the preliminary analysis, DOE received a multitude of comments from interested parties, both at the public meeting and in written responses during the preliminary analysis comment period. A summary of the comments received and DOE's responses are presented below.

a. Consumer Utility

Southern stated that DOE needs to address issues regarding cold air produced by heat pump water heaters. According to Southern, simply increasing a residence's heat output is not an appropriate way to compensate for the cold air a heat pump water heater generates. Southern also asserted that constantly blowing cold air will create uneven temperatures within the dwelling space, leading to utility and comfort issues. (Southern, Public Meeting Transcript, No. 34.4 at p. 22) Southern noted that a heat pump water heater could provide supplemental cooling during a home's cooling hours; however, concentrated cooling at a particular location would result in uneven temperatures in a home, thereby being incompatible with the home's temperature needs. Southern stated that this would reduce the utility and performance of a home's HVAC system, and that there is no practical solution. (Southern, No. 50 at p. 2) The commenter stated that an HVAC supply vent near the unit would not help mitigating cold air issues. Southern commented that although a vent may cancel the effect of the cool air supplied in the winter (by supplying heat), during the cooling season, the supply vent (now supplying cool air) would exacerbate the temperature imbalance in the area of the heat pump water heater. (Southern, No. 50 at p. 2)

DOE agrees with Southern that cold air production of heat pump water heaters should be considered in the analysis. While DOE believes most consumers would choose to increase the use of their space heating system to deal with the increased heating load, DOE did account for the possibility that some consumers would choose to install ductwork to vent cold air away from the space surrounding the water heater to the outdoors to overcome uneven temperature problems. The increased installation costs of venting cold air away from a conditioned space, along with the increased cost of space heating for consumers who choose not to vent cold air away from the conditioned space, are accounted for in DOE's analysis for certain percentages of consumers (see section IV.E.2).

Southern also commented on noise issues. Southern stated that is difficult to comment on a hypothetical product where no specifications exist, but that existing electric storage water heaters are often located in utility closets close to bedrooms and living areas. The commenter asserted that even if the product generates decibel levels similar to a refrigerator, such noise is a matter of greater concern because a heat pump water heater would tend to be in closer proximity to a bedroom or other quiet living area, as compared to a refrigerator located in a kitchen. Noise dampening would not be practical because louvered doors would be required to allow adequate air flow for the heat pump water heater. Southern cited the EPCA criteria, stating that there would be a significant impact on the utility or performance of the appliance if excessive noise disturbs the consumer. (Southern, No. 50 at p. 2)

DOE does not agree that the additional noise from a compressor used for a heat pump water heater would affect consumer utility for two reasons. First, as Southern points out, noise from a heat pump water heater compressor may be comparable in decibel level to the noise created by a refrigerator compressor, which has not been found to adversely affect consumer utility. Second, while the actual impact of excess noise created by a compressor may vary greatly based on the location of the appliance installation, DOE does not have any reason to believe that water heaters are any more likely to be installed near a bedroom than a refrigerator. Water heaters are typically not installed in consumers' bedrooms or living spaces, but instead are usually installed in garages, closets, basements, attics, or other locations away from the living space. Thus, DOE believes that noise created by a compressor would not significantly impact consumer utility.

b. Production, Installation, and Servicing Issues

DOE received numerous comments in response to the preliminary analysis on the practicality of manufacturing, installing, and servicing heat pump water heaters.

Southern stated that it is difficult to determine whether heat pump water heaters would be practical to install and service and if they are reliable, because at the time Southern submitted this comment, there were no products on the market to compare against. (DOE notes several heat pump water heaters have recently become available on the market). Also, no product exists yet that could be mass produced and available in 2015 in response to a heat pump water heater energy efficiency standard. (Southern, Public Meeting Transcript, No. 34.4 at pp. 58–59) Further, Southern commented that installation of heat pump water heaters in new construction is still problematic for multifamily housing, although the issues are less severe than in replacement installations. In multifamily housing, interior locations are preferred for mechanical systems, and perimeter locations (*e.g.,* windows and balconies) are preferred for exterior exposures. Southern stated that a heat pump water heater could be installed in an interior, but the addition of supply and return vents to the outdoors would be expensive. Southern also stated that placing the heat pump water heater at a perimeter location is possible, but would reduce the architectural options available for builders. (Southern, No. 50 at pp. 2–3) Finally, Southern commented that it is very concerned about the possible selection of an amended conservation standard at an efficiency level that would require heat pump water heaters. Southern strongly encourages the use of heat pump water heaters, but it argued that given operational differences, they are not suitable for some consumers due to the need for very expensive building modifications. (Southern, No. 50 at p. 1)

BWC noted that the owner or installer can return a water heater to the manufacturer if a defect is claimed. BWC stated that in these cases, units are tested and typically there is no actual defect. According to BWC, if heat pump water heaters are introduced on a larger scale, it is likely that more water heaters will be returned to the manufacturer without servicing because many traditional plumbers (who would install the heat pump water heaters) have no HVAC training and no refrigerant licenses. (BWC, No. 46 at p. 2) BWC stated that training and education costs associated with heat pump water heaters were overlooked in the previous rulemaking and have been overlooked in the current rulemaking as well. (BWC, No. 46 at p. 2)

GE stated that it will be producing a heat pump water heater sometime in the near future, and asserted that it is practical to manufacturer, install, and service heat pump water heaters. Further, GE added that it has the facilities to both manufacture and service these products. It is GE's opinion that there will be a great deal of consumer interest in such products, and that this market will increase and be much larger than the current market. (GE, Public Meeting Transcript, No. 34.4 at p. 63)

In its written submission, GE also commented on the practicality of installation and service. GE stated that its heat pump water heater occupies the exact footprint of a standard water heater and requires the same electrical and plumbing connections. (GE, No. 51 at p. 2) According to GE, the vast majority of installations would be simple and straightforward, and consumers would achieve significant energy savings and often may obtain collateral installation benefits such as dehumidified basements or cooler attics. (GE, No. 51 at p. 2) GE argued that heat pump water heaters installed in humid locations could eliminate the need for a separate dehumidifier, which could save consumers both capital and energy. (GE, No. 51 at p. 2) GE acknowledged that a heat pump water heater produces a small amount of condensate. However, GE commented that this would not require any building modifications, as condensate is easily drained to a floor drain that should accompany each water heater for leakage or overflow. (GE, No. 51 at p. 2) Alternatively, GE commented that for heat pump water heaters that are not installed near a floor drain, a small condensate pump (similar to those used for HVAC installations) can be installed to pump condensate to a suitable drain. (GE, No. 51 at p. 2) GE did state that heat pump water heater installation in confined spaces with very small areas and no ventilation may present challenges. (GE, No. 51 at p. 2)

Regarding the reliability issues surrounding heat pump water heaters, ACEEE stated that the historical record of failures for heat pump water heaters arises from the fact that initial models were brought to market by laboratory-based applied research and development companies and commercial niche companies, rather than the major consumer appliance companies that are currently announcing heat pump water heater products. ACEE stated that an analysis which ignores the nature of the manufacturer is bound to misrepresent the potential of the heat pump water heater. (ACEEE, Public Meeting Transcript, No. 34.4 at pp. 65–66) NEEA and NPCC acknowledged the failure issues discussed in the preliminary analyses, but they argued that the failures have been attributable to the control boards, which other markets have experienced. NEEA and NPCC stated that the control board failures are not characteristic of the heat pump water heaters, but of the electronics industry itself, and replacement is a simple and inexpensive remedy. (NEEA and NPCC, No. 42 at p. 5)

In response to the comments provided by Southern, BWC, GE, ACEEE, NEEA, and NPCC, DOE believes that heat pump water heaters could potentially be installed and serviced on the scale necessary for the residential market before the potential compliance date of an amended energy conservation standard for water heaters. Although servicing heat pump water heaters will require significantly more training than servicing traditional electric storage water heater technologies, DOE notes that many domestic appliances are being installed and repaired today which feature compressors (*i.e.,* refrigerators, room air conditioners, and similar appliances). DOE believes that, given the 5-year delay between the issuance of the final rule and the compliance date and the fact that many manufacturers already have these products under development, it is unclear whether manufacturers would be able to retrain installers and service technicians to install and service heat pump water heater technology. DOE estimated the additional costs that would be incurred as a result of increased certification requirements to install and service heat pump water heaters in its analyses. See section IV.E.2 for details.

A.O. Smith asserted that heat pump water heaters are a viable technology to serve a portion of the water heater market, but that they are only practical for a small, niche part of the market and should never be considered when setting the ''efficiency floor'' of the electric water heater market. A.O. Smith argued that manufacturers could make the investment needed for the small volumes of heat pump water heaters that manufacturers believe are practical, but the cost of changing every line completely over to heat pump water heaters would be prohibitive. In addition, A.O. Smith stated that the percentage of heat pump water heaters to penetrate the market will be small and will be driven by market incentives such as tax credits and rebates. (A.O. Smith, No. 37 at p. 8) BWC stated that it could likely convert some of its product lines to heat pump water heaters by the compliance date of the standard. BWC also commented that without knowing the cost to retrofit current production lines and the cost of heat pump water heaters, it cannot comment on what percentage could be converted by the compliance date. (BWC, No. 46 at p. 1) Edison Electric Institute stated that heat pump water heaters are different from standard electric storage water heaters and cannot be considered for direct replacements due to technology, size, and other issues. EEI also stated its concern that industry would not be able to increase production from under 10,000 units per year to 4.5 million units per year by the compliance date of the standard. According to EEI, if DOE does not create a separate product class for heat pump water heaters, DOE should screen out this technology from this rulemaking. (EEI, No. 40 at p. 3)

DOE acknowledges there could be issues with converting entire production lines to manufacture heat pump water heaters before the compliance date of this standard. However, DOE also notes that significant portions of heat pump water heaters are expected to remain very similar in design to current standard electric storage water heaters. Manufacturers could choose to produce the heat pump portion of the water heater in-house or purchase it from a supplier. GE has already announced that a heat pump water heater will be available sometime this year, and other major manufacturers are also developing heat pump water heaters. Given the 5-year delay in compliance date from the issuance of the final rule, and the fact that many manufacturers are already developing heat pump water heaters, DOE believes manufacturers may be able to convert their entire product lines before the compliance date of an amended energy conservation standard. However, DOE also recognizes there would likely be significant impacts on manufacturers. DOE considers those impacts in the MIA section of this NOPR (section IV.H).

DOE is seeking comment on the manufacturability of heat pump water heaters and the capability of manufacturers to ramp up production. DOE is specifically seeking comment on how long it would take, and how much it would cost, for manufacturers to convert all product lines to heat pump water heaters if it were required by an amended energy conservation standard. Additionally, DOE is seeking comment about the capability of water heater installers and servicers to meet the unique demands created by heat pump water heaters. DOE is requesting comment about how long it would take to train installers and servicers to be able to serve the market created if heat pump water heaters were required by an amended energy conservation standard. DOE will consider all of these factors as it weighs the benefits and burdens of each TSL. (See Issue 11 under ''Issues on Which DOE Seeks Comment'' in section VII.E of this NOPR.)

c. General Comments

DOE received several general comments about the current condition of heat pump water heater technology and the market for this product. These comments are discussed immediately below.

Southern commented that, although not desirable, it would be less objectionable to require heat pump water heaters if the electric storage water heater class could be split at 40 gallons, with products larger than 40 gallons having a heat pump water heater efficiency level requirement, and products smaller than 40 gallons having a higher electric resistance efficiency level. (Southern, No. 50 at p. 4)

EEI stated that there is a Federal tax credit for heat pump water heaters. (EEI, Public Meeting Transcript, No. 34.4 at p. 60) AHRI stated that the ENERGY STAR program has been established since the previous rulemaking, creating greater recognition by all interested parties about the need to save energy. AHRI commented that every manufacturer is probably investigating whether it can maintain a feasible business providing heat pump water heaters. However, AHRI also commented that DOE should not consider heat pump water heaters as an energy conservation standard for 2015. According to the commenter, the water heater industry and American consumers are experiencing difficult economic conditions, and consumers are not likely to purchase heat pump water heaters that are expensive. AHRI also stated that resistance-type electric storage water heaters are near their maximum efficiencies and need to evolve. AHRI commented that current conditions prohibit setting an efficiency minimum that would require a heat pump water heater. (AHRI, Public Meeting Transcript, No. 34.4 at pp. 60–62)

AHRI stated that current market conditions and the introduction of heat pump water heater models by water heater manufacturers are allowing heat pump water heaters to take root in the market. Further, AHRI asserted that the heat pump water heater market needs to mature and that DOE should allow the market and consumers to respond to the availability of higher-technology electric storage water heaters that are reliable and meet consumer utility needs. (AHRI, Public Meeting Transcript, No. 34.4 at pp. 64–65)

ACEEE stated that ENERGY STAR's water heater program demonstrates that heat pump water heaters are viable. The commenter stated that three major manufacturers have announced or told ACEEE about a qualifying heat pump water heater to be marketed to consumers in 2009, which is more than 5 years before energy conservation standard would take effect. (ACEEE, No. 35 at pp. 4–5) ACEEE asserted that cost-effectiveness should be examined because profits are likely to be greater for more expensive heat pump water heaters, even in a very competitive market, and that these higher cost products may benefit the industry in the current economic conditions. According to ACEEE, consumer preference can be very strong, and market studies show that consumers have a very sophisticated understanding of the benefits of very expensive heat pump water heaters. ACEEE noted that consumer preference has been seen for gas-condensing furnaces and other high-priced products in other markets that are considered commodity markets. (ACEEE, Public Meeting Transcript, No. 34.4 at p. 66)

PG&E, SDGE, and SoCal Gas supported DOE's decision to include integral heat pump water heaters as a max-tech efficiency level for electric storage water heaters. PG&E, SDGE, and SoCal Gas believe the heat pump water heater technology has made important advances in recent years and pointed to the actions of General Electric as a major manufacturer speaking to the viability of this technology. (PG&E, No. 38 at p. 2) NEEA and NPCC also agreed with the inclusion of heat pump water heaters in the rulemaking analyses, while acknowledging the failures issues discussed in the preliminary analyses. (NEEA and NPCC, No. 42 at p. 5) The American Gas Association (AGA) commented that there appear to be no significant barriers to including heat pump water heaters in the design options under consideration for electric storage water heaters. (AGA, No. 44 at p. 2)

GE commented that heat pump water heaters have significant potential for increasing the energy efficiency of electric storage water heaters, but that shipments are currently very low (0.1 percent of all water heaters shipped). According to GE, heat pump water heaters should be encouraged through ENERGY STAR and other consumer incentives to allow time for heat pump water heaters to penetrate the market and prove themselves in terms of energy cost savings and reliability. GE stated that the heat pump water heater market is too new to consider establishing a minimum standard at a level that would require heat pump water heater technology at this time. (GE, No. 51 at pp. 1–2) Southern also commented that levels requiring heat pump water heater technology are not appropriate as an amended energy conservation standard level at this time. (Southern, No. 50 at p. 4)

DOE believes that the ENERGY STAR program and Federal tax credit program, along with recent developments in heat pump water heater technology due to manufacturers' efforts, have made heat pump water heaters a much more viable technology for improving energy efficiency. As such, DOE is tentatively proposing to consider heat pump water heaters in this analysis as a design option for improving the efficiency of conventional electric storage water heaters. DOE considers the possibility of fuel switching resulting from heat pump water heater standards for electric storage water heaters in its shipments analysis (see section IV.F.1).

The technologies evaluated in the screening analysis all have been used or are in use in commercially-available products, or exist in working prototypes. These technologies all incorporate materials and components that are commercially available in today's supply markets for the products covered by this NOPR. Therefore, DOE believes all of the efficiency levels evaluated in this notice are technologically feasible.

C. Engineering Analysis

The engineering analysis develops cost-efficiency relationships to show the manufacturing costs of achieving increased efficiency. DOE has identified the following three methodologies to generate the manufacturing costs needed for the engineering analysis: (1) The design-option approach, which provides the incremental costs of adding to a baseline model design options that will improve its efficiency; (2) the efficiency-level approach, which provides the relative costs of achieving increases in energy efficiency levels, without regard to the particular design options used to achieve such increases; and (3) the cost-assessment (or reverse-engineering) approach, which provides ''bottom-up'' manufacturing cost assessments for achieving various levels of increased efficiency, based on detailed data as to costs for parts and material, labor, shipping/packaging, and investment for models that operate at particular efficiency levels.

For the preliminary analysis, DOE conducted the engineering analysis using both the efficiency level approach to identify incremental improvements in efficiency for each product and the cost-assessment approach to develop a cost for each efficiency level. DOE identified the most common residential heating products on the market and determined their corresponding efficiency levels, the component specifications, and the distinguishing technology features associated with those levels. After identifying the most common products that represent a cross section of the market, DOE gathered additional information using reverse-engineering methodologies; product information from manufacturer catalogs; and discussions with manufacturers and other experts of water heaters, DHE, and pool heaters. This approach provided useful information, including identification of potential technology paths manufacturers use to increase energy efficiency.

DOE generated a bill of materials (BOM) by disassembling multiple manufacturers' products that span a range of efficiency levels for each of the three product categories. The BOMs describe the product in detail, including all manufacturing steps required to make and/or assemble each part. Subsequently, DOE developed a cost model that converted the BOMs and efficiency levels into manufacturer production costs (MPCs). By applying derived manufacturer markups to the MPCs, DOE calculated the manufacturer selling prices and constructed industry cost-efficiency curves.

DOE received several comments from interested parties on the approach to the engineering analysis. Rheem stated its support for DOE's product teardown plan and evaluation of insulations levels. (Rheem, No. 49 at p. 4) Southern agreed overall with the technical and engineering assumptions in the TSD. (Southern, No. 50 at p.1)

Because DOE did not receive any comments from interested parties opposing its general approach to the engineering analysis, DOE continued to use the same approach for the NOPR phase of this rulemaking. However, DOE did receive 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 DOE 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. Representative Products for Analysis

For the engineering analysis, DOE reviewed all of the product classes of residential water heaters (storage-type and instantaneous), DHE, and pool heaters. Since the storage volume and input capacity affect the energy efficiency of residential heating products, DOE examined each product type separately. Within each product type, DOE chose units for analysis that represent a cross section of the residential heating products market. The analysis of these representative products and product classes allowed DOE to identify specific characteristics that could be applied to all of the products across a range of storage and input capacities, as appropriate.

a. Water Heaters

For residential, storage-type water heaters, the volume of the tank significantly affects the amount of energy consumed, because it takes more energy to heat a larger volume of water from a given temperature to a higher temperature than it does to do the same for a smaller volume of water. Also, an increase in the tank volume can create an increase in the tank surface area, leading to higher standby losses of two otherwise identical tanks (*i.e.,* same insulation thickness, same materials). For the preliminary analysis, DOE examined specific storage volumes for gas-fired, oil-fired, and electric storage water heaters (referred to as representative storage volumes and shown in Table IV.9) because the energy efficiency equations for residential water heaters established by EPCA are a function of each product's storage volume. DOE reviewed the shipments data AHRI provided to determine the storage volume corresponding to the highest number of shipments for gas-fired water heaters, oil-fired water heaters, and electric water heaters. DOE conducted a similar review of shipment data for instantaneous gas-fired water heaters and determined the input rating corresponding to the highest number of shipments (*i.e.,* 199,000 Btu/h, as shown in Table IV.9) since storage volume does not vary for this product class.

DOE did not receive any comments in response to the preliminary analysis on the representative units for residential water heaters, and as such, used the same approach to determining representative units for the NOPR analysis. However, on review of the shipments for oil-fired storage water heaters for the NOPR analysis, DOE determined that oil-fired storage water heaters with 32 gallons of storage volume have a higher number of shipments than those with 30 gallons, and adjusted the representative unit accordingly.

TABLE IV.9—REPRESENTATIVE RESIDENTIAL WATER HEATERS ANALYZED

Residential water heater class	Representative storage volume (gallons)
Gas-Fired Storage Type	40
Electric Storage Type	50
Oil-fired Storage Type	32
Instantaneous Gas Fired	0 (199,000 Btu/h input capacity)

Once DOE conducted the primary analysis on the representative rated storage volumes for each of the product classes, DOE extended the analysis to other rated storage volumes using the cost model and the energy efficiency equations. See section IV.C.7 for additional details. For gas-fired instantaneous water heaters, DOE used the analysis for the 199 kBtu/h input capacity and applied it to all products within the product class.

b. Direct Heating Equipment

Current energy conservation standards for DHE are not determined by an equation, but by input capacity ranges. DOE examined one specific input capacity range for gas wall fan, gas wall gravity, gas floor, and gas room DHE in the preliminary analysis. In addition, DOE examined one specific input capacity range for gas hearth DHE in the NOPR analysis. The specific input ranges DOE analyzed are referred to as representative input rating ranges. DOE reviewed the DHE (including vented hearth products) shipment data AHRI and HPBA provided for this rulemaking and found the input rating range corresponding to the highest number of shipments for gas wall fan, gas wall gravity, gas floor, and gas room DHE. DOE did not receive any comments from interested parties in response to the preliminary analysis on the representative ranges for traditional DHE, and used the same approach to determine the ranges for the NOPR analysis. DOE did not receive shipments data categorized by capacity ranges for gas hearth DHE, and, therefore, determined the representative capacity range based on the number of models available on the market in each capacity range. DOE added a representative range for gas hearth DHE for the NOPR analysis. In addition, after reorganizing the DHE product classes, DOE reviewed gas room DHE shipments for the NOPR, and changed the representative input range for gas room DHE from over 46,000 Btu/h to between 27,000 and 46,000 Btu/h. DOE found the input range between 27,000 and 46,000 Btu/h contained the highest number of models for gas room DHE when the gas hearth DHE were removed from consideration. Table IV.10 presents the representative rated input rating ranges for residential DHE. For the remaining DHE product classes (*i.e.,* wall fan, wall gravity, and floor), DOE did not receive any comments in response to the preliminary analysis on the representative units, and, therefore, used the same units for the NOPR analysis.

TABLE IV.10—REPRESENTATIVE RESIDENTIAL DIRECT HEATING EQUIPMENT PRODUCTS AS DESCRIBED BY INPUT CAPACITY AND DEFINED BY BTU/H

Direct heating equipment design type	Representative input rating range (Btu/h)
Gas Wall Fan	Over 42,000.
Gas Wall Gravity	Over 27,000 and up to 46,000.
Gas Floor	Over 37,000.
Gas Room	Over 27,000 and up to 46,000.
Gas Hearth	Over 27,000 and up to 46,000.

After analyzing the representative product class (*i.e.,* input rating range), DOE applied the analysis to the remaining product classes for each residential DHE type. Unlike storage water heaters, an equation is not applied to relate the range of input ratings. Instead, DOE proposes to maintain the AFUE difference between each input rating range as established by EPCA. That is, if the amended energy conservation standard is increased by two AFUE percentage points for the representative product class, for example, the amended energy conservation standards for the other product classes within this product type would all rise by two AFUE percentage points. The stringency resulting from an amended standard is constant across the range of inputs for a given product type. This approach appears to be consistent with the relationship between input capacity and efficiency exhibited by models currently available on the market based on DOE's review of the AHRI directory for DHE. In addition, DOE notes that the larger DHE units usually contain larger heat exchangers to get higher efficiencies. These larger heat exchangers have increased surface area, which also increases the convected losses to the surroundings. The increased losses result in lower AFUEs. Based on the market assessment and engineering principles, DOE believes the approach for maintaining the AFUE difference between each input rating range is reasonable.

c. Pool Heaters

There is only one product class for residential gas-fired pool heaters, but this product class covers a wide range of input ratings. Although within the same product class, the variation in input rating is large enough to create variations in pool heater design (*e.g.,* large variations in input will vary material usage and MPC). Therefore, for the preliminary analysis, DOE reviewed the shipment data from AHRI and found the input rating corresponding to the highest number of shipments, which was 250,000 Btu/h input rating. Because DOE did not receive any comments on the representative input rating in the preliminary analysis, DOE used the same approach for the NOPR analysis. Consequently, DOE used 250,000 Btu/h as the representative input rating for residential pool heaters in the NOPR analysis.

The engineering analysis results for the representative product classes are used in the remaining DOE analyses, including the life-cycle cost analysis and the national impact analysis.

2. Ultra-Low NO_X Gas-Fired Storage Water Heaters

In the preliminary analysis, DOE did not address ultra-low NO_X gas-fired storage water heaters separately from gas-fired storage water heaters with standard burners (*i.e.,* non-ultra-low NO_X burner). DOE developed a single cost-efficiency curve for all gas-fired storage water heaters. However, DOE received several comments in response to the preliminary analysis on the cost of ultra-low NO_X gas-fired storage water heaters. As discussed in section IV.A.3.a above, several local air quality management districts (mostly in California) limit the allowable NO_X emissions from residential water heaters.

BWC commented that there is a substantial cost increase to comply with the ultra-low NO_X requirements. (BWC, No. 46 at p.1) Rheem commented that the MPC and MSP did not capture higher costs and prices associated with models that comply with ultra-low NO_X requirements. (Rheem, No. 49 at pp. 4, 7) Rheem stated that although DOE included the costs associated with Flammable Vapor Ignition Resistant (FVIR) technology, DOE did not, but should have, included the costs associated with ultra-low NO_X emissions requirements in its analysis. Further, Rheem stated that given the continued adoption of ultra-low NO_X requirements in highly-populated regions such as California and Texas, DOE should revise its baseline cost estimates and include weighting for the population subject to ultra-low NO_X regulations. (Rheem, No. 49 at p. 7)

A.O. Smith stated that the types of burners currently used to comply with the ultra-low NO_X requirements in an atmospheric water heater are much more restrictive (*i.e.,* produce higher pressure drops) than conventional burners. According to the commenter, since gas-fired storage water heaters complying with the ultra-low NO_X requirements also must comply with FVIR requirements, the units must also have flame arrestors on the air inlet, which further restricts the system. To boost the efficiency of ultra-low NO_X gas-fired storage water heaters, manufacturers typically make the flue baffle more effective. In certain instances, given these additional restrictions, the only way for some of these units to continue to meet the energy conservation standards is to add a blower and/or power burner to the heater, which would greatly increase the manufacturing and installation costs. (A.O. Smith, No. 37 at p. 9) SoCal Gas agreed with the storage manufacturers, stating that ultra-low NO_X requirements similar to those in the Southern California Air Quality Management District are being implemented in other regions. SoCal Gas stated that ultra-low NO_X requirements necessitate a different type of product, which creates a cost issue because product costs and cost increases are dramatically higher. (SoCal Gas, Public Meeting Transcript, No. 34.4 at pp. 41–42)

In response to the comments on the preliminary analysis, DOE developed a separate analysis for ultra-low NO_X gas-fired storage water heaters. DOE developed cost-efficiency curves for ultra-low NO_X gas-fired storage water heaters by performing a teardown analysis (section IV.C.4.a) of several ultra-low NO_X products from a variety of manufacturers at several efficiency levels. More specifically, DOE analyzed ultra-low NO_X gas-fired storage water heaters at a 40-gallon representative storage volume, as was done for gas-fired storage water heaters with a standard burner. DOE then compared the ultra-low NO_X gas-fired storage water heaters to the comparable gas-fired storage water heaters that use standard burner technology (*i.e.,* not ultra-low NO_X compliant). DOE also considered the impact of ultra-low NO_X regulations for the cumulative regulatory burden (see section V.B.2.f).

DOE used the cost-efficiency curves for ultra-low NO_X gas-fired storage water heaters in the downstream analysis, including the LCC. DOE distributed the costs based on those geographical areas with ultra-low NO_X regulations. See chapter 5 of the NOPR TSD for the cost-efficiency curves for ultra-low NO_X gas-fired storage water heaters.

3. Efficiency Levels Analyzed

For each of the representative products, DOE analyzed multiple efficiency levels and estimated manufacturer production costs at each efficiency level. The following subsections provide a description of the full efficiency level range DOE analyzed from the baseline efficiency level to the maximum technologically feasible (max-tech) efficiency level for each product class. In some cases, the highest efficiency level was identified through review of available product literature or prototypes for products not commercially available.

For each product class, DOE selected baseline units as reference points, against which DOE measured changes resulting from potential amended energy conservation standards. Generally, the baseline unit in each product class: (1) Represents the basic characteristics of equipment in that class; (2) just meets current Federal energy conservation standards; and (3) provides basic consumer utility.

DOE conducted a survey of the residential heating products market to determine what types of products are available to consumers and to identify the efficiency levels corresponding to the highest number of models. Then, DOE established intermediate energy efficiency levels for each of the product classes that are representative of efficiencies that are typically available on the market or correspond to voluntary program targets such as ENERGY STAR. DOE reviewed AHRI's product certification directory, manufacturer catalogs, and other publicly-available literature to determine which efficiency levels are the most prevalent for each representative product class.

DOE determined the maximum improvement in energy efficiency that is technologically feasible (max-tech) for water heaters, DHE, and pool heaters, as required by section 325(o) of EPCA. (42 U.S.C. 6295(o)). For the representative product within a given product class, DOE could not identify any working products or prototypes at higher efficiency levels that were currently available beyond the identified max-tech level at the time the analysis was performed. DOE seeks comment on its max-tech efficiency levels.

Rheem commented generally in response to the preliminary analysis about the water heater max-tech levels DOE identified. Rheem asserted that there is little to no presence of max-tech water heating products in the United States. Further, Rheem commented that it supports the growth of max-tech products through ENERGY STAR, which helps to distinguish top-performing products and to stimulate market transformation, but the commenter stated that max-tech should not be considered for a Federal minimum standard. (Rheem, No. 49 at p. 2)

NRDC commented that max-tech levels face issues that are similar for all emerging technologies. It noted that: (1) Max-tech products are only produced and deployed on small scales, thereby limiting available data; (2) reliability is a concern, possibly due to small scale production; (3) costs are high but projected to decrease as production increases, although timing is unknown; (4) consumer reaction to new technologies and their amenities is unknown; and (5) units are more useful only in certain applications due to size, venting, or other inherent attributes. NRDC notes that DOE must consider all of these concerns when making a decision. (NRDC, No. 48 at pp. 1–2)

As stated above, EPCA requires DOE to determine the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible for each class of covered products. (42 U.S.C. 6295(o)). Therefore, DOE must consider and include an analysis of max-tech levels for residential heating products in this rulemaking. However, DOE notes that consideration of the max-tech level does not necessarily mean that it will be adopted as the level in the energy conservation standard for that product, because DOE must consider, in turn, all of the other statutory factors under 42 U.S.C. 6295(o).

In addition to identifying efficiency levels for each product class, DOE identified a particular technology or combination of technologies associated with each efficiency level in order to make the engineering analysis more transparent to interested parties. For each efficiency level, DOE lists technology and design changes manufacturers could use to improve product energy efficiency to achieve the given efficiency level. These technologies provide methods to increase product energy and are representative of technologies found in a typical model at a given efficiency level. While DOE recognizes that manufacturers use many different technologies and approaches to increase the energy efficiency of residential heating products, the presented technologies and combinations of technologies and their ordering are simply possible paths manufacturers could use to reach higher efficiency levels.

a. Water Heaters

The current Federal minimum energy conservation standards define the baseline efficiencies for residential water heaters as measured by the energy factor. These standards became effective on January 20, 2004. (10 CFR Part 430.32(d)) For water heaters, DOE applied the representative storage capacity to the energy efficiency equations in 10 CFR Part 430.32(d) to calculate the EFs of the baseline units.

i. Gas-Fired Storage Water Heaters

As described in section IV.C.2, DOE performed a separate analysis for gas-fired water heaters with a standard burner and gas-fired water heaters with an ultra-low NO_X burner for this NOPR. Table IV.11 and Table IV.12 show the efficiency levels DOE considered for gas-fired storage water heaters, along with the technologies that manufacturers could use to achieve the listed efficiencies. The technologies for standard burner gas-fired water heaters and ultra-low NO_X gas-fired water heaters vary due to differences in the operating characteristics of the burners. Ultra-low NO_X burners typically reduce the pressure in the flue, which can create problems if the pressures required to properly vent combustion products are not maintained. To mitigate these problems, manufacturers may reduce the amount of baffling or other airflow restrictions to ensure proper venting, which in turn may result in decreased efficiency. To overcome these issues, manufacturers must use power venting technology to achieve energy factors that are comparable to what they would achieve with a standard burner gas-fired storage water heater that can contain more baffling. Therefore, the technologies associated with ultra-low NO_X gas-fired water heaters are implemented at lower efficiency levels and yield a lower energy factor than the same technologies associated with gas-fired storage water heaters that use a standard burner.

TABLE IV.11—FORTY-GALLON GAS-FIRED STORAGE WATER HEATER, STANDARD BURNER

Efficiency level (EF)	Technology
Baseline (EF = 0.59)	Standing Pilot and 1″ Insulation.
Efficiency Level 1 (EF = 0.62)	Standing Pilot and 1.5″ Insulation.
Efficiency Level 2 (EF = 0.63)	Standing Pilot and 2.0″ Insulation.
Efficiency Level 3 (EF = 0.64)	Electronic Ignition, Power Vent and 1″ Insulation.
Efficiency Level 4 (EF = 0.65)	Electronic Ignition, Power Vent and 1.5″ Insulation.
Efficiency Level 5 (EF = 0.67)	Electronic Ignition, Power Vent and 2″ Insulation.
Efficiency Level 6 – Max-Tech (EF = 0.80)	Condensing, Power Vent, 2″ Insulation.

TABLE IV.12—FORTY-GALLON GAS-FIRED STORAGE WATER HEATER, ULTRA-LOW NO_X BURNER

Efficiency level (EF)	Technology
Baseline (EF = 0.59)	Standing Pilot and 1″ Insulation.
Efficiency Level 1 (EF = 0.62)	Standing Pilot and 2″ Insulation.
Efficiency Level 2 (EF = 0.63)	Electronic Ignition, Power Vent, and 1″ Insulation.
Efficiency Level 3 (EF = 0.64)	Electronic Ignition, Power Vent and 1.5″ Insulation.
Efficiency Level 4 (EF = 0.65)	Electronic Ignition, Power Vent and 2″ Insulation.
Efficiency Level 5 (EF = 0.67)	Not Attainable (would go to condensing).
Efficiency Level 6 – Max-Tech (EF = 0.80)	Condensing, Power Vent, 2″ Insulation.

DOE found gas-fired storage water heaters capable of condensing operations at the highest efficiency level (*i.e.,* max-tech). More energy can be extracted by condensing the combustion products in the flue gas, which extracts more heat in the form of latent energy, leading to an increase in the thermal efficiency of the gas-fired storage water heater. In the preliminary analysis, DOE identified the max-tech EF for condensing gas-fired storage water heaters as 0.77. DOE received several comments from interested parties (discussed below) which have caused DOE to revise its estimate upwards to 0.80 EF for condensing units.

NRDC stated that condensing gas-fired water heaters are the future of gas-fired storage water heaters. (NRDC, No. 48 at p. 1) ACEEE commented that the max-tech efficiency level DOE considered for gas-fired storage water heaters is lower than the ENERGY STAR level for the condensing storage water heater category, which is set at 0.80 EF. ACEEE stated that selecting 0.77 EF from a range of identified energy factors for condensing gas-fired storage water heaters ranging from 0.77 to 0.82 EF will bias the results of the analysis and that the five percentage points of the energy factor correspond to less gas usage. ACEEE expressed concern with such a divergence between ENERGY STAR and the energy conservation standards rulemaking. (ACEEE, Public Meeting Transcript, No. 34.4 at p. 75–76) Further, ACEEE recommended that DOE analyze efficiency levels at 0.77 EF, 0.80 EF, and 0.82 EF for gas-fired storage water heaters (ACEEE, No. 35 at p. 3) ASAP stated that DOE's analysis may be missing some efficiency levels. For gas-fired storage water heaters in particular, ASAP commented that condensing units may span a range of efficiencies, and a 0.77 EF may be an intermediate level that is not max-tech. (ASAP, Public Meeting Transcript, No. 34.4 at p. 92)

A.O. Smith stated its support for the max-tech efficiency levels for water heaters as shown in the preliminary engineering analysis. Specifically, A.O. Smith supports a 0.77 EF for gas-fired condensing water heaters, which meets DOE's criteria of being technically feasible. (A.O. Smith, No. 37 at p. 3)

In selecting the efficiency level for the max-tech condensing gas-fired water heater for the NOPR analysis, DOE carefully considered all comments from interested parties regarding this issue. There are no products currently available on the residential gas-fired storage water heater market that can achieve the efficiencies that will be made possible by condensing technology, and, therefore, it is difficult to determine the highest possible EF that can be achieved using this technology. Although condensing gas-fired storage water heaters are not currently available on the market in residential sizes, they are available in commercial sizes that could be scaled down for residential use. Commercial condensing gas-fired storage water heaters have efficiencies of up to 96 percent thermal efficiency. There is no direct mathematical conversion that can be used to derive energy factor (the efficiency metric for residential water heaters) from thermal efficiency (the efficiency metric used for commercial water heaters). Therefore, in making the determination of a max-tech level for gas-fired storage water heaters, DOE considered feedback from interested parties, information gathered during manufacturer interviews, available reports and literature, and its own technical expertise. As a result, DOE has revised the max-tech water heater efficiency to 0.80 EF for the NOPR analysis. This level is cited as the max-tech for condensing water heaters in several reports reviewed by DOE (described in more detail below), and DOE believes it is the maximum possible energy factor that can possibly be achieved by a gas-fired storage water heater at this time. DOE notes that A.O. Smith presentation given at the 2009 ACEEE Hot Water Forum identifies 0.80 EF as the maximum possible EF for residential condensing gas-fired water heaters. For more information visit *http://www.aceee.org;* the presentation is available at: *http://www.aceee.org/conf/09whforum/PlenarySession1-AdamsPresentation.pdf.*

In addition, the Super Efficient Gas Water Heating Appliance Initiative (SEGWHAI) Final Project Report (April 2007) identified efficiency factors at 0.80 and above as achievable condensing efficiency levels for gas-fired storage water heaters, although these levels were based on theoretical modeling of gas-fired water heaters and have never been demonstrated in working prototypes. For more information, visit *http://www.segwhai.org.* A 0.80 EF level is also consistent with the max-tech level identified by ENERGY STAR in its determination of an appropriate efficiency level for gas-fired storage water heaters utilizing condensing technology. For more information, visit *http://www.energystar.gov.* As explained above, DOE seeks comment on the max-tech efficiency levels identified for the analyses, especially those for gas-fired water heaters. (See Issue 1 under ''Issues on Which DOE Seeks Comment'' in section VII.E of this NOPR.)

DOE received several comments about the other efficiency levels and technologies identified for the preliminary analysis.

Southern commented on the technologies for efficiency level 3 for gas-fired storage water heaters, stating its belief that adding electronic ignition would not require manufacturers to use power vent systems. (Southern, Public Meeting Transcript, No. 34.4 at p. 87)

DOE agrees with Southern's comment, because an assessment of the current market demonstrates that gas-fired storage water heaters using electronic ignition systems do not always include power vent technologies. However, DOE believes many manufacturers that use power vent technologies to reach efficiency level 3, 4, and 5 also use electronic ignition systems since the fan already requires electricity. Therefore, DOE paired electronic ignition and power venting technologies with one inch of insulation as a potential approach to achieving efficiency level 3. DOE believes that manufacturers implement designs that have both electronic ignition and power vent technology at this efficiency level. At efficiency levels 1 and 2, DOE used standing pilot systems for gas-fired storage water heaters, which do not require line electricity. Even though efficiency level 3 and above for gas-fired storage water heaters would require consumers to have an external electrical connection, DOE has determined that consumers would continue to have other non-electrical alternatives such as other types of gas-fired water heaters (*e.g.,* gas-fired instantaneous water heaters).

ACEEE stated that DOE should include an efficiency level that considers flue and vent damper technologies instead of power vent technology. The commenter stated that this may not significantly affect the energy factor because the test procedure does not account for the value of entrained bypass air. ACEEE asserted that flue and vent dampers may have much lower costs than power vents and may have less entrained air. Further, ACEEE stated that flue and vent dampers do not require exhaust temperatures to be reduced to a level that can be handled by PVC plastics. (ACEEE, Public Meeting Transcript, No. 34.4 at p. 88)

DOE focused its analysis on technologies that would impact efficiency, as measured by the DOE test procedure. DOE discussed its consideration of damper technologies as part of the screening analysis in section IV.B.1.a. For the engineering analysis, DOE examined the most common methods used by manufacturers to improve energy factor, as determined using DOE's test procedures specified in 10 CFR part 430, subpart B, appendix E. Through its reverse-engineering analysis, and review of manufacturer literature, DOE found that manufacturers most often use power vent technology to achieve higher efficiency for gas-fired storage water heaters. Thus, DOE considered efficiency levels that are typically achieved using a power vent design in the NOPR analysis.

Rheem commented that at the preliminary analysis efficiency level 5 (*i.e.,* 0.66 EF), gas-fired storage water heaters may require operation at and near condensing efficiency levels, which can be undesirable. (Rheem, No. 49 at p. 4)

DOE notes that several manufacturers already manufacture water heaters at 0.66 EF, making gas-fired storage water heaters at 0.66 EF practical to manufacture, install, and service, and technologically feasible. DOE is unaware of any adverse impacts to either product utility or health and safety that would result from a water heater at 0.66 EF. DOE reviewed the market for gas-fired water heaters at 0.66 EF and 0.67 EF. DOE did not find any products currently on the market, which incorporate features to accommodate condensing operation. Therefore, DOE sees no reason to eliminate that efficiency level from consideration. However, DOE did revise efficiency level 5 from 0.66 EF for the preliminary analysis to 0.67 EF for the NOPR analysis to maintain consistency with the ENERGY STAR Program. DOE notes there are also products currently offered with a 0.67 EF at the representative volume size.

Rheem also stated that the technologies identified to increase energy efficiency for gas-fired storage water heaters are appropriate. However, Rheem asserted that the insulation thicknesses that would be required to achieve efficiency levels 1, 2, and 3 are understated. Rheem commented that efficiency level 1 requires 2 to 2.5 inches of insulation, for example. (Rheem, No. 49 at p. 4)

DOE research suggests that the tank thicknesses listed at various efficiency levels are consistent with products available on the market. DOE reviewed manufacturer literature, which typically includes information on energy factor and insulation thicknesses. For the preliminary analysis, DOE reverse-engineered several gas-fired water heaters to verify the technologies used to improve energy efficiency, including insulation thicknesses. Since the preliminary analysis, DOE also hired an independent testing facility to determine the EF of a representative sample of water heaters across multiple efficiency levels for the NOPR. These water heaters were subsequently disassembled to verify the technologies used to increase energy efficiency. In the end, DOE came to the same conclusions as in the preliminary analysis regarding insulation thicknesses. Therefore, DOE believes the results of its assessment of insulation thicknesses at various efficiency levels are accurate.

Rheem also commented that baseline technologies for 40-gallon gas-fired storage water heaters do not apply uniformly for the entire range of rated storage volumes, and as such, DOE should account for the additional manufacturing, installation, and shipping costs for larger size water heaters. (Rheem, No. 49 at p. 4)

For the NOPR engineering analysis, DOE performed teardowns of models at multiple nominal capacities and noted any differences (including minor differences) that occurred. DOE used the knowledge gained from these teardowns when it extended the cost analysis to the other capacity (gallon) sizes. As part of its analysis, DOE accounted for additional installation costs and shipping costs of larger units (see sections IV.E.2.a and IV.C.4.f, respectively).

ii. Electric Storage Water Heaters

Table IV.13 shows the efficiency levels considered for electric storage water heaters, along with their corresponding potential technologies that could be used to achieve those levels.

TABLE IV.13—FIFTY-GALLON ELECTRIC STORAGE WATER HEATER

Efficiency level (EF)	Technology
Baseline (EF = 0.90)	1.5″ Foam Insulation.
Efficiency Level 1 (EF = 0.91)	2″ Foam Insulation.
Efficiency Level 2 (EF = 0.92)	2.25″ Foam Insulation.
Efficiency Level 3 (EF = 0.93)	2.5″ Foam Insulation.
Efficiency Level 4 (EF = 0.94)	3″ Foam Insulation.
Efficiency Level 5 (EF = 0.95)	4″ Foam Insulation.
Efficiency Level 6 (EF = 2.0)	Heat Pump Water Heater.
Efficiency Level 7 – Max-Tech (EF = 2.2)	Heat Pump Water Heater, More Efficient Compressor.

For electric storage water heaters, although no integrated heat pump water heaters were available on the market at the time the analysis was developed, such products had been developed and manufactured in the past, three models have been certified under the ENERGY STAR program, and others are currently under development by other water heater manufacturers. DOE found electric heat pump water heaters capable of obtaining EFs of 2.2 in the preliminary analysis and retained this level as the max-tech level in the NOPR analysis. DOE received several comments on the efficiency levels and technologies presented in the preliminary analysis.

NRDC commented that heat pump water heaters are the future of electric storage water heater technology. (NRDC, No. 48 at p. 1) ASAP stated that DOE may be missing some efficiency levels in its analysis. ASAP commented that an efficiency level between efficiency level 5 and the max-tech for electric storage water heaters may merit analysis, particularly if ENERGY STAR has a heat pump water heater at 2.0 EF. (ASAP, Public Meeting Transcript, No. 34.4 at p. 92) Similarly, ACEEE recommended DOE analyze levels at 1.7 EF, 2.0 EF, and 2.2 EF. (ACEEE, No. 35 at p. 3) Additionally, ACEEE stated that prior analyses have been conducted for heat pump water heaters at 2.5 EF, although further specifics were not provided. (ACEEE, Public Meeting Transcript, No. 34.4 at p. 94) BWC referred DOE to comments made during the previous residential water heater rulemaking on July 18, 1994. (BWC, No. 46 at p. 2) BWC asserted that the previous rulemaking stated a reasonable energy factor of 1.50, but that the current rulemaking does not. BWC stated its belief that 1.5 EF is still a reasonable EF for heat pump water heaters. (BWC, No. 46 at p. 2)

In response to these comments, DOE revised the efficiency levels considered for electric storage water heaters to include an intermediate heat pump water heater efficiency level at 2.0 EF for the NOPR analysis. This is not the max-tech level, but it does represent a significant change in technology and increase in efficiency over the traditional electric storage heater technology. This technology would also be easier for manufacturers to achieve than the max-tech 2.2 EF. DOE notes this efficiency level also corresponds to the level set forth by the ENERGY STAR program. DOE did not find any heat pump water heaters currently available or in the research stage with a 1.7 EF. In addition, DOE believes it is unlikely that manufacturers will offer products below the ENERGY STAR level, which is at 2.0 EF. Currently, there are also Federal tax credits for heat pump water heaters with an energy factor greater than or equal to 2.0 EF. Additionally, DOE maintained 2.2 EF as the max-tech efficiency level. Although ACEEE commented that analysis has been performed on heat pump water heaters with EFs of up to 2.5, ACEEE did not indicate the source of this analysis, and DOE could not identify any heat pump water heaters at 2.5 EF through its research efforts. The highest EF obtained in prototype designs currently being developed is 2.2 EF.

In response to the technology options presented in the preliminary analysis, AHRI stated that increasing the insulation on an electric storage water heater from 3 to 4 inches would not increase the energy factor of such magnitude by 0.01 EF point. AHRI does not believe that an increase in the energy factor would be seen using DOE's test procedure when only the insulation thickness is increased and no other design changes are made to eliminate many of the thermal short circuits present in a water heater. (AHRI, Public Meeting Transcript, No. 34.4 at pp. 90–91) Rheem also commented that DOE should recognize that there are diminishing returns for added foam insulation, adding that it is unclear how the efficiency levels for electric storage water heaters with 3 and 4 inches of insulation were evaluated to yield the proposed efficiency levels. (Rheem, No. 49 at p. 3)

DOE research determined the technology options manufacturers typically use to improve product efficiency, and was based on multiple data sources including manufacturer literature, which usually includes information on energy factor and insulation thicknesses. DOE also conducted a teardown analysis of electric storage water heaters for the preliminary analysis. For the NOPR analysis, DOE tested the EF of water heaters and then performed a teardown analysis on those water heaters across various EF ratings to confirm the technologies used for increasing efficiency. Although insulation thickness is not the only design change, DOE believes it is the driving factor in increasing the EF for electric storage water heaters, and, therefore, is listed as a commonly used technology option. For these reasons, DOE did not revise the technology options for EL4 and EL 5 for electric storage water heaters for the NOPR analysis.

iii. Oil-Fired Storage Water Heaters

Table IV.14 presents the efficiency levels DOE considered for oil-fired storage water heaters, along with the technology options that manufacturers could use to achieve the listed efficiency.

TABLE IV.14—THIRTY-TWO-GALLON OIL-FIRED STORAGE WATER HEATER WITH BURNER ASSEMBLY

Efficiency level (EF)	Technology
Baseline (EF = 0.53)	1″ Fiberglass Insulation.
Efficiency Level 1 (EF = 0.54)	1.5″ Fiberglass Insulation.
Efficiency Level 2 (EF = 0.56)	2″ Fiberglass Insulation.
Efficiency Level 3 (EF = 0.58)	2.5″ Fiberglass Insulation.
Efficiency Level 4 (EF = 0.60)	2″ Foam Insulation.
Efficiency Level 5 (EF = 0.62)	2.5″ Foam Insulation.
Efficiency Level 6 (EF = 0.66)	1″ Fiberglass Insulation, and Multi Flue Design.
Efficiency Level 7 – Max-Tech (EF = 0.68)	1″ Foam Insulation, and Multi Flue Design.

The most efficient residential oil-fired storage water heater on the market has an EF of 0.68 and includes electronic ignition, foam insulation, and enhanced flue baffles. DOE considered this efficiency level in the preliminary analysis and did not revise it for the NOPR analysis. However, DOE has determined that all oil-fired water heaters currently manufactured at the max-tech efficiency level incorporate a proprietary design. While DOE typically does not consider proprietary designs in its analysis due to impacts on competition likely to result from setting a minimum standard an efficiency level that is only achievable using a proprietary design, the agency has determined through discussions with manufacturers and its own technical expertise that the max-tech level for oil-fired storage water heaters is achievable using alternative approaches that are not proprietary. Therefore, DOE included this efficiency level in the NOPR analysis. DOE believes manufacturers of oil-fired storage water heaters could achieve an EF of 0.68 by using a multiple flue design consisting of several flues to increase the heat transfer area, instead of a single, central flue that is standard on nearly all residential gas-fired and oil-fired storage water heaters. DOE revised its cost analysis for a 0.66 EF and 0.68 EF to represent a non-proprietary, multiple flue design.

DOE did not receive any comments in response to the preliminary analysis on the max-tech efficiency level or the other efficiency levels DOE considered for oil-fired storage water heaters. See chapter 5 of the NOPR TSD for more information about the efficiency levels DOE analyzed for oil-fired storage water heaters.

iv. Gas-Fired Instantaneous Water Heaters

Table IV.15 presents the efficiency levels DOE considered for gas-fired instantaneous water heaters, along with their corresponding potential technologies.

TABLE IV.15—ZERO-GALLON GAS-FIRED INSTANTANEOUS WATER HEATER, 199,000 BTU/H INPUT CAPACITY

Efficiency level (EF)	Technology
Baseline (EF = 0.62)	Standing Pilot.
Efficiency Level 1 (EF = 0.69)	Standing Pilot and Improved Heat Exchanger Area.
Efficiency Level 2 (EF = 0.78)	Electronic Ignition and Improved Heat Exchanger.
Efficiency Level 3 (EF = 0.80)	Electronic Ignition and Power Vent.
Efficiency Level 4 (EF = 0.82)	Electronic Ignition, Power Vent, Improved Heat Exchanger Area.
Efficiency Level 5 (EF = 0.84)	Electronic Ignition, Power Vent, and Improved Heat Exchanger Area.
Efficiency Level 6 (EF = 0.85)	Electronic Ignition, Power Vent, Direct Vent, and Improved Heat Exchanger Area.
Efficiency Level 7 (EF = 0.92)	Electronic Ignition, Power Vent, Direct Vent, Condensing.
Efficiency Level 8 − Max Tech (EF = 0.95)	Electronic Ignition, Power Vent, Direct Vent, Condensing (Max-Tech).

For the preliminary analysis, DOE identified a gas-fired instantaneous water heater capable of condensing with an EF of 0.92 as the max-tech level. DOE did not receive any comments on the max-tech gas-fired instantaneous water heaters. However, on reviewing the gas-fired instantaneous water heater market, DOE identified a new max-tech level at 0.95 EF for instantaneous gas-fired water heaters that use condensing technology.

DOE received several comments on the potential technologies incorporated at each efficiency level for gas-fired instantaneous water heaters that were presented in its preliminary engineering analysis. For the preliminary analysis, DOE considered the baseline to be the current Federal minimum standard (*i.e.*, 0.62 EF). Also, DOE did not incorporate the need to handle condensate into the installed cost estimates until products reached the 0.92 efficiency level for the preliminary analysis.

A.O. Smith suggested using a higher EF as the baseline efficiency level for gas-fired instantaneous water heaters. A.O. Smith noted that the vast majority of models available (per the AHRI Directory) are already well above the Federal minimum energy conservation standards of 0.62 EF. Since the majority of shipments in the current market for tank-type water heaters are at the Federal minimum energy conservation standards, DOE should use the same logic in choosing the baseline efficiency levels. (A.O. Smith, No. 37 at p. 3)

In response, DOE defines the baseline efficiency level as representative of the basic characteristics of equipment in that class. The characteristics of a gas-fired instantaneous water heater that just meets the 0.62 EF requirement would be representative of the most basic design that could be used for a gas-fired instantaneous water heater. Therefore, DOE did not change the baseline efficiency level for gas-fired instantaneous water heaters in the NOPR analysis.

At the public meeting for the preliminary analysis, DOE sought comment on safety concerns for gas-fired instantaneous water heaters at near-condensing efficiency levels. Operating at near-condensing levels may result in corrosive condensation formation, which may occur when the combustion products (which include water vapor) cool and condense. Manufacturers stated during engineering interviews that there is a safety margin needed to account for variations due to manufacturing tolerances, gas quality, differences in venting configurations, altitude, ambient conditions, and installer experience. DOE specifically requested information about how manufacturers would change current designs to mitigate corrosive condensate formation at near-condensing EF levels that may be present in some installations. DOE also requested comment about how manufacturers would alter current designs of gas-fired instantaneous water heaters to achieve safe operation if a potential amended standard required all installations to operate at near-condensing EF levels.

In response, Noritz stated that 0.83 EF is generally the borderline between condensing and non-condensing, the point at which units begin operating in condensing mode in at least some applications. (Noritz, Public Meeting Transcript, No. 34.4 at p. 113) Noritz also stated that condensation may occur in the near condensing range, which includes 0.83, 0.84, and 0.85 EF, and that it would change the copper heat exchanger in its standard product to stainless steel or better to manage the acidic condensate. (Noritz, Public Meeting Transcript, No. 34.4 at pp. 108–109) Noritz recommends that contractors install a condensate collector for instantaneous gas-fired water heaters with energy factors at 0.82 and 0.83, but acknowledged that the condensate collector is not included in a large percentage of installations. Therefore, Noritz stated that it would include a stainless steel heat exchanger with the condensate collector on higher efficiency products because of the increased safety issues associated with condensate management. (Noritz, Public Meeting Transcript, No. 34.4 at pp. 111–112) Further, Noritz said it would use this stainless steel heat exchanger nationwide for cost considerations and to keep the product standard. (Noritz, Public Meeting Transcript, No. 34.4 at pp. 109–110) Noritz commented that it handles acidic condensation with a stainless steel heat exchanger for the condensing instantaneous gas-fired water heater that has an energy factor of 0.92 EF, and that the product uses a primary copper heat exchanger and a secondary stainless steel heat exchanger. Noritz commented that some companies may use titanium, but this may not be realistic for Noritz because of the cost. (Noritz, Public Meeting

Transcript, No. 34.4 at pp. 109–110) In written comments, Noritz suggested that DOE's cost-efficiency curve should be continuous from 0.62 to 0.82, at which point there should be a kink in the curve, and the cost of producing a product with an EF of 0.83 or higher would see a steep increase. According to the commenter, the delineation between condensing and non-condensing product gas-fired instantaneous water heaters is at an EF of 0.83, which is borderline. Noritz asserted that manufacturers making products with an EF of 0.83 or above would need to design these products to deal with condensate, thereby requiring more expensive heat exchanger materials, condensate drains, and some method of treating (*i.e.,* neutralizing) the condensate for safe disposal. (Noritz, No. 36 at pp. 1–2)

Similar to Noritz's comments, AHRI noted that the costs of gas-fired instantaneous water heaters at near-condensing efficiency levels (*i.e.,* an EF of 0.84 and 0.85) need to include the measures manufacturers would use to minimize problems associated with excessive condensate in the appliance or its venting system. Specifically, AHRI noted that manufacturers must build safety factors into their designs to address the wide scope of installation conditions, such as colder incoming water temperatures or various venting systems. AHRI recommended that DOE model the heat exchanger using more corrosive-resistant materials, specifying a venting system using stainless steel, and adding a means to collect and dispose of condensate. (AHRI, No. 43 at p. 2) Regarding manufacturing products that operate near their condensing levels, AHRI stated that manufacturers want to build products that can be sold anywhere in the United States. However, there are parts of the United States where the incoming water is colder than the water specified by the test procedure, and this may cause pre-condensing. AHRI asserted that efficiency levels at these levels create safety issues, and that manufacturers would have to rely on manufacturing and installation skills due to the small margin between condensing and non-condensing operation. (AHRI, Public Meeting Transcript, No. 34.4 at pp. 110–111)

DOE acknowledges that for efficiency levels associated with near-condensing operation, a portion of the flue products may condense, and this percentage may vary as a function of field conditions. Additionally, operation where a portion of the flue gases condense (*i.e.,* near-condensing operation) creates the same safety issues associated with fully condensing operation because corrosive condensate is introduced into the heat exchanger and venting system during both types of operation. Therefore, DOE determined that for instantaneous gas-fired water heater efficiency levels 5 and 6 (energy factors 0.84 and 0.85, respectively), the costs associated with condensing operation should be accounted for in the MPCs. DOE revised its costs for the NOPR phase of this analysis for gas-fired instantaneous water heaters to account for design changes necessary to handle condensate at these efficiency levels.

b. Direct Heating Equipment

The baseline efficiencies for DHE are defined by the current Federal minimum energy conservation standards and the representative characteristics for products on the market that just meet Federal minimum energy conservation standards, as measured by the AFUE, and effective on January 1, 1990. (10 CFR part 430.32(i)) For DHE, the AFUEs corresponding to the representative input ratings in 10 CFR 430.32(i) were assigned as the baseline unit AFUEs.

Table IV.16 through Table IV.20 show the efficiency levels DOE analyzed for each product class of DHE, along with technologies that manufacturers could use to reach that efficiency level.

In the preliminary analysis, DOE identified various efficiency levels for gas wall fan DHE, including max-tech levels that used electronic ignition and induced draft combustion systems. DOE did not receive any comments pertaining to its efficiency levels or technologies for the preliminary analysis. After reviewing the efficiency levels and technologies for the NOPR analysis, DOE determined that the same efficiency levels and technologies are still appropriate.

TABLE IV.16—GAS WALL FAN-TYPE DHE, OVER 42,000 BTU/H

Efficiency level (AFUE)	Technology
Baseline (AFUE = 74)	Standing Pilot.
Efficiency Level 1 (AFUE = 75)	Intermittent Ignition and Two-Speed Blower.
Efficiency Level 2 (AFUE = 76)	Intermittent Ignition and Improved Heat Exchanger.
Efficiency Level 3 (AFUE = 77)	Intermittent Ignition, Two-Speed Blower, and Improved Heat Exchanger.
Efficiency Level 4 – Max-Tech (AFUE = 80)	Induced Draft and Electronic Ignition.

In the preliminary analysis, DOE identified gas wall gravity efficiency levels and technology options, which included a 75-percent AFUE level as the max-tech that could be achieved using induced draft. DOE received several comments in response.

AHRI cautioned that adding too many electrical devices to gas wall gravity-type DHE will at some point remove those products from that product class, because they will get converted into gas wall fan-type DHE. (AHRI, Public Meeting Transcript, No. 34.4 at pp. 69–70) AHRI also stated that an external electrical supply is required at some of the higher efficiency levels. AHRI asserted that when this occurs, that product can no longer be classified as a gravity-type product, but instead would be a fan-type product. Therefore, AHRI stated that the efficiency levels presented in the preliminary analysis are unrealistic for gas wall gravity-type DHE. (AHRI, Public Meeting Transcript, No. 34.4 at pp. 114–115) Additionally, Bock commented that adding induced draft technology to a gas wall gravity-type unit would exclude it from this equipment class. (Bock, Public Meeting Transcript No. 34.4 at p. 119)

In response to these comments, DOE further reviewed the gravity-type wall DHE market and the available products and technologies for the NOPR analyses. A ''vented wall furnace'' (*i.e.,* gas wall fan-type or gravity-type DHE) is defined as a vented heater that furnishes heat air circulated either by gravity or by a fan. 10 CFR 430.2. Gravity-type and fan-type wall DHE are differentiated only by the inclusion (fan-type) or exclusion (gravity-type) of a fan from the design. DOE agrees with Bock that the addition of an induced draft fan (which forces the combustion products through the heat exchanger to increase turbulence and, thus, heat transfer) would cause those products to be excluded from the wall gravity product class. Thus, for the NOPR analysis, DOE removed the efficiency level at 75 AFUE that corresponded to induced draft technology. Instead, DOE identified 72 AFUE as the max-tech efficiency level, which can be attained using electronic ignition technology.

TABLE IV.17—GAS WALL GRAVITY-TYPE DHE, OVER 27,000 BTU/H AND UP TO 46,000 BTU/H

Efficiency level (AFUE)	Technology
Baseline (AFUE = 64)	Standing Pilot.
Efficiency Level 1 (AFUE = 66)	Standing Pilot and Improved Heat Exchanger.
Efficiency Level 2 (AFUE = 68)	Standing Pilot and Improved Heat Exchanger.
Efficiency Level 3 (AFUE = 71)	Standing Pilot and Improved Heat Exchanger.
Efficiency Level 4 – Max Tech (AFUE = 72)	Electronic Ignition.

In the preliminary analysis, DOE analyzed several efficiency levels for gas floor DHE, ranging from 57 AFUE up to 75 AFUE. DOE chose these levels based on the product availability listings contained in manufacturer specification sheets and DOE's previous analysis for direct heating equipment. However, for the NOPR, DOE conducted another review of the current market and determined that the market no longer offers models above 58 percent AFUE. This assessment was based on a review of updated information from AHRI Directory of Certified Products and manufacturer specification sheets. In its review, DOE identified heat exchanger improvements as a potential design approach to achieve the max-tech level 58 AFUE. DOE could not find any prototypes being developed above 58 percent AFUE. Accordingly, DOE based the efficiency levels for the NOPR analyses on those levels known to be technologically feasible for this product class and DOE only analyzed the baseline and max-tech efficiency levels, because no products are available at any other efficiency levels (See Table IV.18.).

TABLE IV.18—GAS FLOOR-TYPE DHE, OVER 37,000 BTU/H

Efficiency level (AFUE)	Technology
Baseline (AFUE = 57)	Standing Pilot.
Efficiency Level 1 – Max Tech (AFUE = 58)	Standing Pilot and Improved Heat Exchanger.

In the preliminary analysis, DOE included gas hearth DHE in the analysis for gas room DHE. For the NOPR analysis, DOE is establishing a separate product class for gas hearth DHE. Consequently, DOE revised the efficiency levels analyzed for gas room DHE to represent the market and technologies available for products, excluding those that are now gas hearth DHE, based upon the characteristics of the fireplace and DOE's proposed definition for ''gas hearth DHE.'' This resulted in the elimination of several efficiency levels that were considered in the preliminary analysis for gas room DHE. Also, the max-tech efficiency level has changed for the NOPR because of this restructuring of the DHE product classes. For room heaters, the use of electronic ignition and multiple heat exchangers has been identified as a possible approach to reach the max-tech efficiency level (AFUE = 83). These technologies are being used in room heaters that are currently on the market.

TABLE IV.19—GAS ROOM-TYPE DHE, OVER 27,000 BTU/H AND UP TO 46,000 BTU/H

Efficiency level (AFUE)	Technology
Baseline (AFUE = 64)	Standing Pilot.
Efficiency Level 1 (AFUE = 65)	Standing Pilot and Improved Heat Exchanger.
Efficiency Level 2 (AFUE = 66)	Standing Pilot and Improved Heat Exchanger.
Efficiency Level 3 (AFUE = 67)	Standing Pilot and Improved Heat Exchanger.
Efficiency Level 4 (AFUE = 68)	Standing Pilot and Improved Heat Exchanger.
Efficiency Level 5 – Max Tech (AFUE = 83)	Electronic Ignition and Multiple Heat Exchanger Design.

DOE did not analyze a gas hearth DHE product class separately in the preliminary analysis. Based upon public comment, for the NOPR analysis, DOE surveyed the residential gas hearth DHE market to identify technologies and efficiency levels common to gas hearth DHE. For gas hearth DHE, DOE identified products capable of condensing operations and rated at 93 AFUE as the max-tech level.

TABLE IV.20—GAS HEARTH DHE, OVER 27,000 BTU/H AND UP TO 46,000 BTU/H

Efficiency level (AFUE)	Technology
Baseline (AFUE = 64)	Standing Pilot.
Efficiency Level 1 (AFUE = 67)	Electronic Ignition.
Efficiency Level 2 (AFUE = 72)	Fan Assisted.
Efficiency Level 3 – Max Tech (AFUE = 93).	Condensing.

c. Pool Heaters

The baseline efficiencies for pool heaters were defined by the current Federal minimum energy conservation standards and the representative characteristics for products on the market that just meet Federal minimum energy conservation standards, as measured by thermal efficiency and effective on January 1, 1990. (10 CFR 430.32(k)) For pool heaters, the thermal efficiency corresponding to the baseline unit is 78 percent. *Id.*

DOE analyzed efficiency levels for pool heaters with standing pilot ignitions and pool heaters with electronic ignitions for the preliminary analysis. DOE distinguished between the two ignition systems because of the energy use difference between electronic ignition and standing pilot systems. The DOE test procedure does not fully include the energy use by a standing pilot systems in the thermal efficiency metric, but DOE accounted for the energy use difference between electronic ignition and standing pilot systems in its consumer LCC analysis. DOE did not receive any comments in response to the preliminary analysis that opposed this approach, and, therefore, DOE continues to use it for the NOPR analysis. After surveying the pool heater market, DOE determined that electronic ignition is offered in products covering the whole range of efficiencies, while standing pilot ignition systems are only offered in products corresponding to the first three intermediate efficiency levels. Consequently, DOE developed two baseline products and two efficiency pathways for efficiency levels 1 through 3.

For the NOPR analysis, DOE examined the same efficiency levels as it did in the preliminary analysis (see Table IV.21).

TABLE IV.21—GAS-FIRED POOL HEATER, 250,000 BTU/H

Efficiency level (thermal efficiency)	Technology
Baseline (Thermal Efficiency = 78) *	
Efficiency Level 1 (Thermal Efficiency = 79) *	Improved Heat Exchanger Design.
Efficiency Level 2 (Thermal Efficiency = 81) *	Improved Heat Exchanger Design.
Efficiency Level 3 (Thermal Efficiency = 82) *	Improved Heat Exchanger Design, More Effective Insulation (Combustion Chamber).
Efficiency Level 4 (Thermal Efficiency = 83)	Power Venting.
Efficiency Level 5 (Thermal Efficiency = 84)	Power Venting, Improved Heat Exchanger Design.
Efficiency Level 6 (Thermal Efficiency = 86)	Sealed Combustion, Improved Heat Exchanger Design.
Efficiency Level 7 (Thermal Efficiency = 90)	Sealed Combustion, Condensing.
Efficiency Level 8 – Max Tech (Thermal Efficiency = 95)	Sealed Combustion, Condensing, Improved Heat Exchanger Design.

* Technologies incorporating either a standing pilot or electronic ignition. Efficiency Levels above 3 include electronic ignition.

In the executive summary to the preliminary TSD, DOE sought comments on design changes manufacturers might use to mitigate the formation of corrosive condensation at 86 percent thermal efficiency for gas-fired pool heaters. DOE also sought comments on the changes manufacturers would make to the product design and the effects on MPC that would result if the amended energy conservation standards were at 86 percent thermal efficiency.

Raypak commented that Efficiency Level 6 (*i.e.,* 86 percent) requires sealed combustion, which will be a condensing system. (Raypak, Public Meeting Transcript, No. 34.4 at pp. 120–121) AHRI urged DOE to exclude near-condensing thermal efficiency levels from its analysis. AHRI pointed out that manufacturers would need to address a range of field installations and operating conditions if a minimum energy conservation standard level is set in the near-condensing range. (AHRI No. 43 at p. 5)

In response, DOE is aware of a pool heater model on the market at Efficiency Level 6. According to product literature, these models do not appear to incorporate condensate management. Therefore, DOE did not change the technology options at Efficiency Level 6 to represent a condensing pool heater. However, DOE's technology option for Efficiency Level 6 does include sealed combustion, as Raypak suggested.

4. Cost Assessment Methodology

At the start of the preliminary engineering analysis, DOE identified the energy efficiency levels associated with residential heating products on the market, as determined 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 above the baseline. Next, DOE selected products for the physical teardown analysis that corresponded to the representative rated storage volumes and input capacities. DOE gathered the information from the physical teardown analysis to create bills of materials using a reverse engineering methodology. After that, DOE used the physical teardown analysis to identify the design pathways manufacturers typically use to increase the EF of residential water heaters, the AFUE of residential DHE, or the thermal efficiency of residential pool heaters. DOE calculated the MPC for products spanning the full range of efficiencies from the baseline to the maximum technology available at various levels, and it also identified each technology or combination of technologies in each product that was responsible for improving the energy efficiency. DOE determined the cost-effectiveness of each technology by comparing the increase in MPC to the increase in energy efficiency. For the NOPR, DOE reexamined and revised several of the steps in its cost assessment methodology based on additional teardown analysis and in response to comments received on the preliminary analysis.

During the preparation and refining of the cost-efficiency comparison and MPCs for the NOPR, DOE also held interviews with manufacturers to gain insight into each of the water heating, direct heating, and pool heating industries and requested comments on the engineering approach DOE used. DOE used the information gathered from these interviews, along with the information gathered through additional teardown analysis and public comments, to refine efficiency levels and assumptions in the cost model. Next, DOE converted the MPCs into MSPs using publicly-available water heating, direct heating, and pool heating industry financial data, in addition to manufacturers' feedback. Further information on comments received and the revisions to the analysis methodology is presented in subsections a through g of this section. For additional detail, see chapter 5 of the NOPR TSD.

a. Teardown Analysis

To assemble bill of materials (BOMs) and to calculate the manufacturing costs of the different components in residential heating products, DOE disassembled multiple residential heating products 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 uses 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. DOE obtained information and data not typically found in catalogs and brochures, such as fan motor details, gas manifold specifications, or assembly details, from the physical teardowns of a similar product or through estimates based on industry knowledge. The teardown analysis for this engineering analysis included over 40 physical and virtual teardowns of water heaters, DHE, and pool heaters during the preliminary analysis and over 20 additional teardowns performed for the NOPR analysis. The additional teardowns performed for the NOPR analysis allowed DOE to further refine the product components and assumptions used to develop the MPCs.

The teardown analysis allowed DOE to identify the technologies that manufacturers typically incorporate into residential heating products, along with the efficiency levels associated with each technology or combination of technologies. DOE used the teardown analysis to create detailed BOMs for each product class. The BOMs from the teardown analysis were then placed into the cost model to calculate the MPC for the representative product in each product class. See chapter 5 of the NOPR TSD for more details on the teardown analysis.

b. Cost Model

The end result of each teardown is a structured BOMs. DOE developed structured BOMs 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 cost model is a Microsoft Excel spreadsheet that converts the materials and components in the BOMs into dollar values based on the price of materials, labor rates associated with manufacturing and assembling, and the cost of overhead and depreciation. To convert the information in the BOMs to dollar values for the preliminary analysis, 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 (*e.g.*, tube, sheet metal) are estimated on the basis of 5-year averages. The cost of transforming the intermediate materials into finished parts is estimated based on current industry pricing. For the NOPR analysis, DOE updated all of the labor rates, tooling costs, raw material prices, the costs of resins, and the purchased parts costs. Chapter 5 of the NOPR TSD describes DOE's cost model and definitions, assumptions, and estimates.

DOE received several comments on the material prices collected for use in the cost model, as discussed below.

Bock commented that manufacturer production costs were calculated approximately 2 years before the public meeting for the preliminary analysis. Bock noted that the price of steel has increased tremendously and that DOE should recalculate these costs. (Bock, Public Meeting Transcript, No. 34.4 at p. 27) In written comments, Bock reiterated that because material prices, particularly for steel, have increased significantly since DOE completed its analysis, DOE's estimated manufacturer production costs and selling prices should be adjusted to reflect this trend. (Bock, No. 53 at p. 1)

In contrast, ACEEE commented that DOE significantly overestimated the cost of compliance with amended standards to the consumer. ACEEE stated that this was due to the effects of changing material prices on products and suggested that it would be appropriate for DOE to review past rulemakings to determine the accuracy of DOE's analytical approaches. (ACEEE, Public Meeting Transcript, No. 34.4 at pp. 81–82) Southern Company disagreed with ACEEE regarding the cost to the consumer and referenced the most recent residential air conditioner rulemaking which was done when commodity prices were depressed. Southern stated that because of the depressed commodity prices, the actual costs were higher than DOE's projections. (Southern, Public Meeting Transcript, No. 34.4 at p. 82) Further, Southern commented that a 5-year rolling average of commodity prices would be appropriate for this rulemaking. (Southern, Public Meeting Transcript, No. 34.4 at p. 83) Rheem agreed with Southern regarding commodity prices. Regarding the residential central air conditioner rulemaking, Rheem stated that the results were devastating to the industry and domestic manufacturers, and the company urged DOE to be very careful in estimating the cost to consumers because of the potential for a significantly adverse impact on domestic manufacturing jobs. (Rheem, Public Meeting Transcript, No. 34.4 at pp. 83–84) In its written comments, Rheem noted that manufacturer production costs were derived from material prices that were based on 5-year averages from 2003 to 2007. Rheem urged DOE to revise material prices due to their drastic increases and volatility driven by global demand. (Rheem, No. 49 at pp. 2–3) A.O. Smith agreed that using material prices from 2003 through 2007 to determine a normalized average may be understating actual prices, which continued to fluctuate but generally increased in 2008. (A.O. Smith, No. 37 at p. 4)

Because all interested parties agreed with DOE's approach to use 5-year rolling average material prices in the engineering analysis, DOE used the same approach in the NOPR analysis. DOE acknowledges Bock's, Rheem's, and A.O. Smith's concerns about the timing of the production cost calculations because the majority of manufacturer production cost can typically be attributed to materials, which can fluctuate greatly from year to year. DOE uses a 5-year span to normalize the fluctuating prices experienced in the metal commodities markets to screen out temporary dips or spikes. DOE believes a 5-year span is the longest span that would still provide appropriate weighting to current prices experienced in the market. DOE updates the 5-year span for metal prices based on a review of updated commodity pricing data, which point to continued increases. Considering the significant amount of steel and copper in the different heating products at issue in this rulemaking, incorporating commodity prices that reflect 5-year average prices as close to current conditions would best reflect overall market conditions. Consequently, DOE calculated a new 5-year average materials price using the U.S. Department of Labor's Bureau of Labor Statistics (BLS) Producer Price Indices (PPIs) for various raw metal materials from 2005 to 2009 to calculate new averages, which incorporate the changes within each material industry and inflation. DOE also used BLS PPI data to update current market pricing for other input materials such as plastic resins and purchased parts. Finally, DOE adjusted all averages to 2008$ using the gross domestic product implicit price deflator.

c. Manufacturing Production Cost

Once the cost estimate for each teardown unit was finalized, DOE totaled the cost of materials, labor, and direct overhead used to manufacture a product in order to calculate the manufacturer production cost for the preliminary analysis. The total cost of the product was broken down into two main costs: (1) The full manufacturer production cost or MPC; and (2) the non-production cost, which includes selling, general, and administration (SG&A) costs, the cost of research and development, and interest. DOE estimates the MPC at each efficiency level considered for each product class, from the baseline through the max-tech. After DOE incorporates all of the assumptions into the cost model, DOE calculates the different percentages of each aspect of production cost (*i.e.* materials, labor, depreciation, and overhead) that make up the total production cost. The product cost percentages are used to validate the assumptions by comparing them to manufacturers' actual financial data published in annual reports, along with feedback from manufacturers during interviews. DOE uses these production cost percentages in the MIA (see section IV.H).

For the NOPR analysis, DOE revised the assumptions in the cost model based on additional teardown analysis, updated pricing, and additional manufacturer feedback, which resulted in revised MPCs and production cost percentages. DOE calculated the average product cost percentages by product type (*i.e.*, water heater, DHE, pool heater) as well as by product class (*e.g.*, gas-fired storage water heater, electric storage water heater) due to the large variations in production volumes, fabrication and assembly costs, and other assumptions that affect the calculation of the unit's total MPC. Chapter 5 of the NOPR TSD shows DOE's estimate of the MPCs for the NOPR phase of this rulemaking, along with the different percentages for each aspect of the production costs that make up the total product MPC.

DOE received various comments in response to the MPCs presented in its preliminary analysis, as discussed below.

For pool heaters, Raypak stated that the cost difference between the ignition systems of gas-fired pool heaters should be more than $3, because the electronic ignition controls cost more than $3. Raypak also commented that the materials used for Efficiency Level 6 must be suitable for condensing applications, which means that DOE's estimate for MPC for Efficiency Level 6 is understated. (Raypak, Public Meeting Transcript, No. 34.4 at pp. 120–121)

In response, DOE revised all of the MPCs for residential heating products for the NOPR analyses. In the case of pool heaters, DOE reexamined the component cost assumptions for electronic ignitions and revised the estimate of the cost to implement an electronic ignition design. The revised cost assumptions for an electronic ignition are documented in chapter 5 of the NOPR TSD. DOE also revised the costs for Efficiency Level 6, but did not consider the costs associated with condensate management at that efficiency level. Some residential pool heater designs currently on the market do not appear to accommodate condensing operations at 86 percent thermal efficiency, thereby suggesting that such costs need not be incurred to reach that efficiency level. Therefore, DOE did not account for condensate management in the cost of products at Efficiency Level 6.

Regarding gas-fired storage water heaters, Rheem stated that the MPC and MSP for Efficiency Level 6 should be higher. (Rheem, No. 49 at p. 4) A.O. Smith asserted that the estimated manufacturer production costs in DOE's preliminary analysis are too low for max-tech water heaters (*i.e.*, heat pump water heaters and condensing gas-fired water heaters). (A.O. Smith, No. 37 at p. 4) Additionally, A.O. Smith stated that the baseline MPCs are approximately 11 percent low for gas-fired storage water heaters and 13 percent low for electric storage water heaters. (A.O. Smith, No. 37 at p. 6)

On this point, DOE has revised its cost estimates for storage water heaters at all levels, including the baseline and the max-tech efficiency levels based on manufacturer feedback obtained during interviews performed for the MIA (see section IV.H.4). The resulting cost estimates for the NOPR analysis are higher than in the preliminary analysis. Chapter 5 of the NOPR TSD discusses DOE's cost estimates for max-tech storage water heaters.

BWC commented that the energy factor for condensing gas-fired storage water heaters (the max-tech level) was based on models on the market that are not classified as residential water heaters. BWC stated that it is unfair to use non-residential models to determine the cost of condensing water heaters, because non-residential models do not include components and the associated costs to make them compliant with other regulations, such as FVIR and ultra-low NO_X requirements. (BWC, No. 46 at p. 2).

For DOE's estimate of the manufacturing cost of condensing gas-fired storage water heaters, DOE did include the additional cost of FVIR in both the preliminary and NOPR analyses, which is not found in commercial water heaters currently on the market. DOE also based its condensing water heater design on one that would be more typical of residential applications (*i.e.*, 40-gallon storage volume and 40,000 Btu/h input capacity). In addition, DOE developed separate manufacturer production costs for gas-fired storage water heaters with standard burners and for gas-fired storage water heaters with ultra-low NO_X burners (section IV.C.2), including those gas-fired water heaters that would have been at the max-tech efficiency level.

d. Cost-Efficiency Curves

The result of the engineering analysis is a set of cost-efficiency curves. DOE created 11 curves representing each product class examined for this NOPR. For storage water heaters, the cost-efficiency curves show the representative rated storage volumes in addition to the other storage volumes analyzed.

Chapter 5 of the NOPR TSD contains the 11 cost-efficiency curves in the form of energy efficiency (*i.e.*, EF, AFUE, or thermal efficiency) versus MPC. The results show that the cost-efficiency curves are nonlinear. As efficiency increases, manufacturing becomes more difficult and more costly. Large jumps are evident when efficiencies approach levels where electronic ignition, blower motors, power vent, and condensing operation are included in designs. Additionally, MPC increases greatly when heat pump technology is used as an alternative to resistive heating for electric storage water heaters.

The non-linear relationship is common across all product types. In addition, DHE and high-efficiency pool heaters see larger increases in MPC due to lower production volumes than water heaters.

In response to the cost-efficiency curves developed for the preliminary analysis, ACEEE asserted that DOE's cost-efficiency relationship ignores the potential ''learning-by-doing'' effects that have driven down the costs of technologies for almost all regulated goods. The commenter argued that more stringent standards lead to product redesigns that almost inevitably result in lower consumer prices for more-efficient goods after the amended standards have become effective. ACEEE recommended that DOE balance the current cost-efficiency development approach with the historical results of rulemakings on manufacturer production costs. (ACEEE, No. 35 at p. 5)

Similarly, NRDC questioned DOE predictions that more-efficient products result in escalating costs and stated that DOE should re-analyze these projections. NRDC also commented that this rulemaking addresses products previously covered and analyzed in other rulemakings, and asserted that DOE should evaluate previous analyses by reviewing its predictions versus the realized effects of standards so that costs are not overestimated for this rulemaking. NRDC stated that an overestimation of the cost to improve efficiency could cause DOE to set standards below the levels that would be justified if DOE were to determine costs by more accurate methods, a result which would fail to meet the requirements of the statute. (NRDC, No. 48 at p. 4)

DOE does not agree with ACEEE or NRDC for the following reasons. DOE recognizes that every change in minimum energy conservation standards is an opportunity for manufacturers to make investments beyond what would be required to meet the new standards in order to minimize costs or to respond to other factors. However, DOE's manufacturing cost estimates seek to gauge the most likely industry response to meet the requirements of proposed energy conservation standards. DOE's analysis of manufacturing cost must be based on currently-available technology that would provide a nonproprietary pathway for compliance with a standard once it becomes effective, and, thus, DOE cannot speculate on future product and market innovation. In response to a change in energy conservation standards, manufacturers have made a number of changes to reduce costs in the past. For example, DOE understands manufacturers have re-engineered products to reduce cost, made changes to manufacturing process to reduce labor costs, and moved production to lower-cost areas to reduce labor costs. However, these are individual company decisions, and it is impossible for DOE to forecast such decisions. DOE does not know of any data that would allow it to determine the precise course a manufacturer may take. Furthermore, while manufacturers have been able to reduce the cost of products that meet previous energy conservation standards, there are no data to suggest that any further reductions in cost are possible. Therefore, it would not be appropriate to speculate about cost reduction based upon prior actions of manufacturers of either the same or other products. Setting energy conservation standards upon relevant data is particularly important given EPCA's anti-backsliding provision at 42 U.S.C. 6295(o)(1).

e. Manufacturer Markup

DOE applies a non-production cost multiplier (the manufacturer markup) to the full MPC to account for corporate non-production costs and profit. The resulting manufacturer selling price 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 often introduce design changes to their product lines that result in increased 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 customers 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 pass through the increased variable costs and some of the capital and product conversion costs (the one-time expenditures). 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 for the preliminary analysis, DOE used 10–K reports from publicly-owned residential heating products companies. (SEC 10–K reports can be found using the search database at: *http://www.sec.gov/edgar/searchedgar/webusers.htm*.) The financial figures necessary for calculating the manufacturer markup are net sales, costs of sales, and gross profit. For the preliminary analysis, DOE averaged the financial figures spanning 2000 to 2006 and then calculated the markups. For the NOPR analysis, DOE updated the financial figures using 10–K reports spanning 2003 to 2008. To calculate the time-average gross profit margin for each firm, DOE summed the gross profit for all the years and then divided the result by the sum of the net sales for those years. DOE presented the calculated markups to manufacturers during the interviews for the NOPR (see section IV.H.4). DOE considered the feedback from manufacturers in order to supplement the calculated markup, and refined the markup to better reflect the residential heating products market. DOE developed the manufacturer markup by weighting the feedback from manufacturers on a market share basis, since manufacturers with larger market shares more accurately represent a greater portion of the market. DOE used a constant markup to reflect the MSPs of the baseline products as well as more-efficient products. DOE took this approach because amended standards may make high-efficiency products, which currently are considered premium products, and make them the baselines. See chapter 5 of the NOPR TSD for more details about the markup calculation.

In response to the preliminary analysis, Bock commented on the MPC and MSP for oil-fired storage water heaters at Efficiency Level 6. Bock stated that the MPC is reasonable in terms of considering increased material costs, but that the MSP is much too low (implying that DOE's markup for oil-fired storage water heaters is too low). The commenter stated that the distribution chain is flawed for some manufacturers and that, unlike gas-fired and electric storage water heaters, oil-fired storage water heaters require an oil burner that adds approximately $400 to the MSP. Based upon the above reasoning, Bock stated that the MSP for Efficiency Level 6 is approximately $1,400. (Bock, No. 53 at p. 1)

The MSP, as defined by DOE, is the selling price from the manufacturer to the first step in its distribution chain (*e.g.*, a wholesaler, a distributor, or a national retailer). The MSP does not include any further markups for the rest of the distribution chain, but the MPC for oil-fired storage water heaters includes the price of the burner. Therefore, the MSP as defined by DOE can be significantly lower than the purchase price for an end-consumer, which is what DOE believes Bock is referring to. The purchase price would depend on the typical markups in each step of the distribution chain as well as the number of layers of distribution the product has to clear before reaching the end-consumer. Section IV.D of this notice describes the distribution chain markups in further detail.

f. Shipping Costs

For the preliminary analysis, DOE accounted for the shipping costs for residential heating products as part of the non-production costs that comprise the manufacturer markup. This approach is typical of energy conservation standards rulemakings for residential products.

Following the preliminary analysis, DOE received several comments about the impact of an amended energy conservation standard on shipping (*i.e.*, freight) costs for storage water heaters. A.O. Smith commented that freight is not a manufacturing cost, but it is a substantial cost incurred for water heaters, especially tank-type models. Water heater manufacturers generally pay for shipping to most customers; therefore, this cost is added in the manufacturer's gross margin calculation. A.O. Smith noted that an increase in water heater size will add cost to the overall manufacture/purchase transition. (A.O. Smith, No. 37 at p. 4) Similarly, BWC commented that DOE underestimated the increase in freight costs as overall dimensions increase when larger cavity sizes are used. (BWC, No. 46 at p. 2).

Although the non-production costs typically account for freight in the manufacturer markup, DOE responded to these comments by separating the shipping costs from the markup multiplier for storage water heaters for the NOPR analysis in order to make the MSP calculation more transparent. DOE calculated the MSP for storage water heaters by multiplying the MPC determined from the cost model by the manufacturer markup and adding shipping costs. More specifically, DOE calculated shipping costs based on a typical 53-foot straight frame trailer with a storage volume of 4,240 cubic feet. DOE examined the average sizes of representative water heaters and determined the number of units that would fit in each trailer, based on assumptions about the arrangement of water heaters in the trailer. Finally, DOE calculated the average cost for each unit shipped based on an average cost of $4,000 per trailer load. See chapter 5 of the NOPR TSD for more details about DOE's shipping cost assumptions and the shipping costs per unit for each storage water heater product class.

g. Manufacturer Interviews

Throughout the rulemaking process, DOE seeks feedback and insight from interested parties to improve the information used in its analyses. DOE interviewed manufacturers as a part of the NOPR manufacturer impact analysis (see section IV.H.4). During the interviews, DOE sought feedback on all aspects of its analyses for residential heating products. For the engineering analysis, DOE discussed the analytical assumptions and estimates, cost model, and cost-efficiency curves with manufacturers of water heaters, DHE, and pool heaters. DOE considered all the information manufacturers provided when refining the cost model and assumptions. DOE incorporated equipment and manufacturing process figures into the analysis as averages 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. The interview guides DOE distributed to manufacturers are contained in appendix 12–A of the NOPR TSD.

5. Results

The results from the engineering analysis were used in the LCC analysis to determine consumer prices for residential heating products at the various potential standard levels. Using the manufacturer markup, DOE calculated the MSPs of the representative water heaters, DHE, and pool heater from the MPCs developed using the cost model. Chapter 5 of the NOPR TSD provides the full list of MPCs and MSPs at each efficiency level for each analyzed representative product.

6. Scaling to Additional Rated Storage Capacities for Water Heaters

To account for the large variation in the rated storage volumes of residential storage water heaters and differences in both usage patterns and first cost to consumers of water heaters larger or smaller than the representative capacity, DOE scaled its MPCs and efficiency levels at the representative capacities to several discrete rated storage volumes at capacities higher and lower than the representative storage volume for each storage water heater product class. DOE developed the MPCs for water heaters at each of the rated storage volumes shown in Table IV.22. These storage volumes were determined to be the most prevalent storage volumes available on the market during the market analysis (see Chapter 3 of the TSD). The MPCs developed for this analysis were used in the downstream LCC analysis, where a distribution of MPCs was used based on the estimated market share of each rated storage volume (see Section IV.E).

TABLE IV.22—ADDITIONAL WATER HEATER STORAGE VOLUMES ANALYZED

Water heater product class	Storage volumes analyzed (gallons, U.S.)
Gas-fired Storage	30, 50, 65, 75.
Electric Storage	30, 40, 66, 80, 119.
Oil-fired Storage	50.

To develop the MPCs for the analysis of additional storage volumes, DOE developed a cost model based on teardowns of representative units from a range of nominal capacities and multiple manufacturers. Whenever possible, DOE maintained the same product line that was used for the teardown at the representative storage volume to allow for a direct comparison between models at the representative storage volume and models at higher and lower storage volumes. The cost model accounts for changes in the size of water heater components that would scale with tank volume (*e.g.*, tank dimensions, wrapper dimensions, wall thicknesses, insulation thickness, anode rod(s), flue pipe(s)). Components that typically do not change based on tank volume (*e.g.*, gas valves, thermostats, controls) were assumed to remain largely the same across the different storage volume sizes, while accounting for price differences due to changes in insulation thickness. DOE estimated the changes in material and labor costs that occur at volume sizes higher and lower than the representative capacity based on observations made during teardowns and professional experience. Performing teardowns of models outside of the representative capacity allowed DOE to accurately model certain characteristics (such as tank wall thickness and wrapper thickness) that are not identifiable in manufacturer literature.

While DOE was able to receive feedback from manufacturers regarding the manufacturing costs of storage water heaters at representative storage capacities, DOE was unable to solicit manufacturing cost feedback from manufacturers regarding the additional water heaters shown above. However, DOE was able to finely tune the performance of the cost model to accurately predict the weights of non-representative units via the additional teardowns. For example, DOE observed that the tank wall thickness increases as a function of tank diameter. Based on the feedback received from manufacturers for representative units and the accuracy of the material predictions for non-representative units, DOE believes that its scaling is accurate. In addition to comparing model output to actual teardowns, model outputs were also compared to published catalog data.

The results of DOE's analysis for the additional storage volumes are presented in chapter 5 of the NOPR TSD (engineering analysis). Chapter 5 of the NOPR TSD also contains additional details about the calculation of MPCs for storage volumes outside of the representative capacity. DOE is seeking comment its MPC estimates at the additional storage volumes outside of the representative storage volumes, as well as on its approach to developing these MPCs. (See issue number 12 under Section VII.E ''Issues on Which DOE Seeks Comment'').

7. Energy Efficiency Equations

As part of the engineering analysis for residential water heaters, DOE reviewed the energy efficiency equations that define the existing Federal energy conservation standards for gas-fired and electric storage water heaters. The energy efficiency equations allow DOE to expand the analysis on the representative rated storage volume to the full range of storage volumes covered under the existing Federal energy conservation standards.

DOE uses energy efficiency equations to characterize the relationship between rated storage volume and energy factor. The energy efficiency equations allow DOE to account for the increases in standby losses as tank volume increases. As the tank storage volume increases, the tank surface area increases. The larger surface area results in higher heat transfer rates that result in higher jacket losses. Other losses to consider are the feed-through losses and flue losses (for gas-fired water heaters). The current energy efficiency equations show that for each water heater class, the minimum energy factor decreases as the rated storage volume increases.

After reviewing market data and product literature for gas-fired and electric storage water heaters, DOE presented two approaches for amending the existing energy efficiency equations for storage water heaters. One approach was to maintain the same slope used in the existing equations, but to incrementally increase the intercepts. This created energy efficiency equations with the same slope to define EF across the entire range of storage volumes for each efficiency level. The advantage of this approach would be to maintain the same slopes established in NAECA and used in the 2001 rulemaking, which have historically characterized the water heater market.

A second approach was to adjust the slope of the energy efficiency equations based on the review of the storage water heater models currently on the market. The advantage of this approach is the acknowledge the changes in the product efficiencies offered over time and account for these changes. DOE examined the efficiencies of models with varying storage volumes, but with the same or similar design features. DOE varied the slope of the line to maximize the number of models in the series that meet the efficiency levels DOE is considering in the full range of rated storage volumes. DOE sought comments on approaches to develop the energy efficiency equations for all storage volumes and all efficiency levels of gas-fired and electric storage water heaters. Specifically, DOE sought comment on an alternative approach based on model series that incorporate current market data from AHRI's Consumers' Directory to generate revised equation slopes that minimize the number of models that would become obsolete. DOE received feedback from several interested parties, as discussed immediately below.

ACEEE commented that the alternative energy efficiency equations appear to relax the energy factor requirements for smaller capacity water heaters while making the energy factor requirements more stringent for larger capacity water heaters. (ACEEE, Public Meeting Transcript, No. 34.4 at p. 100) AHRI stated that there are more options for saving energy at higher capacities. AHRI further stated that additional energy may be saved by using an alternative energy efficiency equation and that there may be two equations that define the energy conservation standard across the range of rated volumes. (AHRI, Public Meeting Transcript, No. 34.4 at pp. 101–102) Rheem argued that size constraints must be considered when determining alternative energy efficiency equations and efficiency levels for replacement water heaters. Rheem stated that there are certain doorways and attics where installations will not be possible due to size constraints. (Rheem, Public Meeting Transcript, No. 34.4 at p. 104)

Rheem expressed concern that changes to the energy efficiency equations may result in the elimination of certain capacities. However, Rheem stated that the current slope is inappropriate as it would set unattainable levels for small and large capacity water heaters. Rheem commented that the proposed alternative equations disproportionately affect gas-fired storage water heaters, especially large-storage-volume products. In sum, Rheem recommended that DOE should revisit the current equations to determine whether energy factors across the full range of rated storage volumes are still appropriate. (Rheem, No. 49 at p. 6)

EEI expressed support for DOE's decision to update the energy efficiency equations for storage-type water heaters. However, EEI cautioned DOE to avoid eliminating certain storage volumes from the market. Therefore, EEI suggested that DOE develop a two-slope approach for smaller and larger water heaters to ensure competition in the marketplace. (EEI, No. 40 at p. 4)

In response, DOE agrees that the alternative slopes examined at each efficiency level for the preliminary analysis were not as stringent for the lower storage volume models and were more stringent for higher storage volume models when compared to the slope defining existing standards. DOE presented such slopes because many models at lower storage volumes have already reached close to the maximum possible efficiency with conventional technologies, while there is more potential for increased energy efficiency for models with larger storage volumes. However, DOE also notes that this increased stringency may discourage manufacturers from continuing to develop larger storage volume models. To attempt to mitigate these issues, DOE is proposing ''two-slope'' energy efficiency equations to better define the relationship between storage volume and energy factor across the range of covered storage volumes.

ACEEE stated its support for modifying the energy efficiency equations for electric and gas-fired storage water heaters if the effect would be to increase the EF for larger units (*i.e.*, those units with a higher rated storage volume). For electric storage water heaters, ACEEE supported capping the EF requirement at 0.95, even for the smaller rated storage types. (ACEEE, No. 35 at p. 6) NEEA and NPCC agreed with DOE's intention to adjust the slopes of the energy efficiency equations for gas-fired and electric storage water heaters. Specifically, NEEA and NPCC stated their support for the recommended approach by fitting the energy efficiency equations to actual product lines on the market. NEEA and NPCC recommended a further lessening of the slope than the examples shown in the preliminary analysis to preserve at least one model offered on the current market over the range of storage volumes. (NEEA and NPCC, No. 42 at p. 6) BWC commented that the energy efficiency equations for water heaters should be changed, arguing that as amended standards increase energy efficiency, it becomes increasingly difficult for units with larger gallon capacities to comply. (BWC, No. 46 at p. 1)

In contrast, A.O. Smith stated that the existing energy efficiency equations should not be changed. While A.O. Smith acknowledged some of the points DOE made in the preliminary analyses regarding the existing energy efficiency equations, A.O. Smith stated it would take a much more detailed investigation than DOE has used to validate the points raised. (A.O. Smith, No. 37 at p. 8)

While DOE acknowledges that A.O. Smith does not support changing the energy-efficiency equations for gas-fired and electric storage water heaters, DOE believes that the slopes of the energy efficiency equations can be revised to more accurately characterize the relationship between storage volume and energy factor for the current storage water heater market.

For this NOPR, DOE reviewed AHRI's March 2009 Consumers' Directory and developed a database of products that includes all gas-fired and electric storage water heater models subject to this rulemaking. DOE also reviewed manufacturers' catalogs to gather information on the design characteristics of each water heater model. The manufacturers' catalogs include information on efficiency ratings, product series descriptions, jacket insulation thicknesses, ignition types, and drafting methods (*i.e.*, natural or power vented drafting). To further investigate the relationship between EF and rated storage volume, DOE conducted testing according to the water heater test procedure specified in 10 CFR 430, subpart B, appendix E (the same test procedure manufacturers use to certify products in AHRI's Consumers' Directory) to verify the EF values. DOE tested model series with similar design characteristics and volumetric designs to isolate how EF changes with rated storage volume. DOE performed this testing for a number of model series at various efficiencies and for a variety of manufacturers. DOE chose models to test by selecting product series from multiple major manufacturers that span the range of rated volumes within each product class and that span the range of efficiency levels. After completion of testing, DOE conducted a teardown analysis of the tested models and confirmed the specific technologies that affect energy efficiency and the volumetric characteristics of the tank. DOE used the results of this analysis to adjust the energy efficiency equations.

Using the information gathered from product catalogs, independent testing results, and product teardowns, DOE developed an alternative approach for revising the energy efficiency equations based on three constraints. DOE applied the following constraining criteria to the development process:

- For gas-fired water heaters, each energy efficiency equation must include units with the specified efficiency level at 40-gallon rated storage volume.
- For electric storage water heaters, each energy efficiency equation must include units with the specified efficiency level at 50-gallon rated storage volume.
- The energy efficiency equations cannot result in a standard that falls below current standards over the entire rated volume range.

DOE chose this approach because it takes into account the models currently on the market, considers the technologies incorporated into those models, and attempts to optimize the number of models across the entire rated volume range that would meet the efficiency levels DOE is considering. The approach also attempts to minimize the number of models that would be eliminated from the market by the efficiency levels DOE is considering across the entire range of storage volumes.

In examining the market data to develop the energy efficiency equations, DOE noted a trend of greater decline in energy efficiency at higher rated storage volumes than at lower storage volumes. As a result, DOE developed energy efficiency equations with varying slopes at several of the efficiency levels analyzed for the NOPR analysis. These equations maintain one slope from the minimum covered rated storage volume up to a certain rated storage volume (*i.e.*, 60 gallons for gas-fired storage water heaters and 80 gallons for electric storage water heaters), and then maintain a different slope over the remaining range of covered storage volumes. DOE selected 60-gallon and 80-gallon storage volumes as the point where the change in slope of the energy efficiency equations for gas-fired and electric storage water heaters, respectively, should occur, because the market data suggested a natural break in the available products at those points. Models with gallon sizes above 60 gallons for gas-fired units and 80 gallons for electric units typically experienced reduced efficiencies more rapidly as a function of increasing storage volume, as compared to units with lower volume sizes. The higher ends of the residential storage capacities also have a lower volume of shipments.

Based upon the above approach, for gas-fired storage water heaters, DOE did not change the slope of the energy efficiency equation for storage volumes above 60 gallons across efficiency levels (*i.e.*, DOE kept the same slope above 60 gallons at each efficiency level). Few gas-fired storage water heaters exist with storage volumes greater than 60 gallons, and, therefore, the market data were very limited. Due to the lack of data for the efficiency at larger gas-fired water heater storage volumes, DOE used the slope defining the current standard for residential gas-fired storage water heaters, as listed in DOE's regulations at 10 CFR 430.32(d). In other words, DOE maintained the same slope for Efficiency Level 1 through Efficiency Level 5 for gas-fired storage water heaters above 60 gallons.

For the max-tech efficiency levels considered for gas-fired storage water heaters and electric storage water heaters, DOE also did not change the slope of the energy efficiency equations. Because there are no products currently available on the market meeting the max-tech efficiency levels, DOE could not perform an analysis or come to any definitive conclusion about the effect of storage volume on energy factor at these efficiency levels. However, DOE does recognize that with any storage water heater, the standby losses will increase with storage volume due to increased tank surface area. Because there is no data that DOE can use to make a determination of an appropriate slope at these levels, DOE maintained the relationship between storage volume and energy factor developed previously for water heaters. Therefore, the energy efficiency equations for the max-tech levels exhibit the same slopes used for the gas-fired storage water heater and electric storage water heaters in the current energy conservation standards at 10 CFR 430.32(d). Table IV.23 and Table IV.24 show the energy efficiency equations developed for the NOPR for gas-fired and electric storage water heaters, respectively.

TABLE IV.23—NOPR ENERGY EFFICIENCY EQUATIONS FOR GAS STORAGE WATER HEATERS

Efficiency level	20 to 60 gallons	Over 60 and up to 100 gallons
Baseline Energy Efficiency Equation	EF = −0.00190(V_R) + 0.670	EF = −0.00190(V_R) + 0.670.
EL 1 Energy Efficiency Equation	EF = −0.00150(V_R) + 0.675	EF = −0.00190(V_R) + 0.699.
EL 2 Energy Efficiency Equation	EF = −0.00120(V_R) + 0.675	EF = −0.00190(V_R) + 0.717.
EL 3 Energy Efficiency Equation	EF = −0.00100(V_R) + 0.680	EF = −0.00190(V_R) + 0.734.
EL 4 Energy Efficiency Equation	EF = −0.00090(V_R) + 0.690	EF = −0.00190(V_R) + 0.750.
EL 5 Energy Efficiency Equation	EF = −0.00078(V_R) + 0.700	EF = −0.00190(V_R) + 0.767.
EL 6 Energy Efficiency Equation	EF = −0.00078(V_R) + 0.8312	EF = −0.00078(V_R) + 0.8312.

TABLE IV.24—NOPR ENERGY EFFICIENCY EQUATIONS FOR ELECTRIC STORAGE WATER HEATERS

Efficiency level	20 to 80 gallons	Over 80 and up to 120 gallons
Baseline Energy Efficiency Equation	EF = −0.00132(V_R) + 0.97	EF = −0.00132(V_R) + 0.97.
EL 1 Energy Efficiency Equation	EF = −0.00113(V_R) + 0.97	EF = −0.00149(V_R) + 0.999.
EL 2 Energy Efficiency Equation	EF = −0.00095(V_R) + 0.967	EF = −0.00153(V_R) + 1.013.
EL 3 Energy Efficiency Equation	EF = −0.00080(V_R) + 0.966	EF = −0.00155(V_R) + 1.026.
EL 4 Energy Efficiency Equation	EF = −0.00060(V_R) + 0.965	EF = −0.00168(V_R) + 1.051.
EL 5 Energy Efficiency Equation	EF = −0.00030(V_R) + 0.960	EF = −0.00190(V_R) + 1.088.
EL 6 Energy Efficiency Equation	EF = −0.00113(V_R) + 2.057	EF = −0.00113(V_R) + 2.057.
EL 7 Energy Efficiency Equation	EF = −0.00113(V_R) + 2.257	EF = −0.00113(V_R) + 2.257.

DOE seeks comment on the energy efficiency equations for gas-fired and electric storage water heaters developed for the NOPR. In particular, DOE seeks comment on its approach to developing the energy efficiency equations, the appropriate slope of energy efficiency equations at each efficiency level analyzed, and the appropriate storage volumes for changing the slope of the line. DOE is also interested in alternatives to the energy efficiency equations that DOE should consider for the final rule. (See Issue 7 under ''Issues on Which DOE Seeks Comment'' in section VII.E of this NOPR.)

There are very few models of oil-fired storage water heaters on the market. The lack of data to correlate storage volume and energy factor for oil-fired water heaters makes it difficult for DOE to conclude that an alternative approach is needed for the energy efficiency equations. In the preliminary analysis, DOE presented energy efficiency equations for oil-fired storage water heaters that were developed by maintaining the same slope used in the existing Federal requirements found in 10 CFR 430.32(d). DOE did not present any alternative method to establishing energy efficiency equations for oil-fired storage water heaters.

In response, AHRI stated its support for using the current energy efficiency equations for oil-fired storage water heaters. (AHRI, No. 43 at p. 5)

Because DOE did not receive any comments in opposition to using the same slopes for oil-fired storage water heaters that currently define the existing Federal standards, DOE is continuing to use the same methodology for the NOPR.

AHRI also recommended that DOE remove the volume adjustment term from the energy efficiency equations for gas-fired instantaneous water heaters and specify a minimum EF applicable to all sizes of residential instantaneous water heaters. (AHRI, No. 43 at p. 5) Additionally, A.O. Smith stated that because gas-fired instantaneous water heaters have no volume correction, an EF level for all sizes would be appropriate. (A.O. Smith, No. 37 at p. 7)

DOE acknowledges that nearly all are rated at 0 gallons of storage volume. Because the volume adjustment term is multiplied by storage volume, this will by default eliminate the volume adjustment term from the energy efficiency equation used for gas-fired instantaneous water heaters with a rated storage volume of 0 gallons. However, by definition, gas-fired instantaneous water heaters may have a rated storage volume of up to 2 gallons. Therefore, DOE is proposing to maintain the volume adjustment factor for consistency with the other energy-efficiency equations.

See chapter 5 of the NOPR TSD for additional information about the energy efficiency equations for residential water heaters.

D. Markups To Determine Product Price

By applying markups to the manufacturer selling prices estimated in the engineering analysis, DOE estimated the amounts consumers would pay for baseline and more-efficient products. At each step in the distribution channel, companies mark up the price of the product to cover business costs and profit margin. The appropriate markups for determining the consumer product price depend, therefore, on the type of distribution channels through which products move from manufacturer to consumer.

Bock stated that DOE needs to consider that manufacturers sell to their representatives, who sell water heaters to distributors. (Bock, No. 53 at p. 2) DOE's information indicates that manufacturer representatives work on commission to facilitate sales from manufacturers to both distributors and retailers, but they do not mark up the products. The commission is part of the manufacturers' costs.

The distribution channel for water heaters differs for replacement versus new applications, resulting in different markups. For replacement applications, manufacturers sell to either plumbing distributors or large retail outlets (typically large home-supply stores). Products destined for replacement applications follow one of two paths: (1) A retail outlet sells a unit to the consumer, who either installs it or hires someone to install it; or (2) a plumbing distributor sells a unit to a contractor, who then sells it to a consumer and installs it. Bock suggested modifying the first distribution channel to include a contractor-installer. (Bock, Public Meeting Transcript, No. 34.4 at pp. 140–141) DOE agrees that a contractor-installer may be involved in the first path, but because the consumer purchases the product directly, the contractor does not mark up the cost of the unit. Thus, DOE did not include a contractor-installer in the first distribution path.

AHRI disagreed with the analytical results that indicate higher markups for new construction than for replacement applications. (AHRI, No. 33 at p. 1) DOE's markup for new construction is higher because it includes a markup for builders. Because builders incur the cost of a water heater or direct heating equipment installed in a new home, DOE finds it appropriate to include a markup for this cost. To estimate a builder markup, DOE calculated an average markup that applies to all costs builders incur (based on Census data).

NEEA and NPCC stated that DOE should repeat the process used to determine markups for the 2001 water heater rulemaking so that costs including markups align with the marketplace. They also stated that DOE's method for validating calculated markups is insufficient, although further explanation was not provided. (NEEA and NPCC, No. 42 at pp. 6–7)

The 2001 water heater rulemaking used data on retail prices to estimate markups. DOE did not use the same markup process as in the current rulemaking, however, because commenters on the previous rulemaking stated that DOE provided no consistency checks to determine the method's validity, and it did not account for the differences in price associated with different technologies. In addition, DOE has adopted a different approach to estimate markups in all of its rulemakings conducted in recent years that DOE believes is appropriate because it provides consistent estimates based on publicly-available statistics. DOE collected retail price data for water heaters to provide a check on its estimated markups. DOE's average calculated retail price for water heaters is close to the average Internet retail price for typical electric and oil-fired storage water heaters, 7 percent lower for gas-fired instantaneous water heaters, and 11 percent lower for gas-fired storage water heaters. Given the uncertainty regarding the representativeness of the retail price data that DOE collected, DOE considers that its markup method provides reasonably good agreement with prices in the market.

E. Life-Cycle Cost and Payback Period Analyses

DOE conducted LCC and PBP analyses to evaluate the economic impacts on individual conducted LCC and PBP analyses to evaluate the economic impacts on individual consumers of potential amended energy conservation standards for the three types of residential heating products. The LCC represents total consumer expenses during the life of an appliance, including purchase and installation costs plus operating costs (expenses for energy use, maintenance, and repair). To compute LCCs for the three heating products, DOE discounted future operating costs to the time of purchase, then summed those costs over the life of the appliances. The PBP is calculated using the change in purchase cost (normally higher) that results from an amended efficiency standard, divided by the change in annual operating cost (normally lower) that results from the standard.

DOE measures the changes in LCC and PBP associated with a given efficiency level relative to an estimate of base-case appliance efficiencies. The base-case estimate reflects the market in the absence of amended mandatory energy conservation standards, including the market for products that exceed the current standards.

For each set of heating products, DOE calculated the LCC and PBP for a nationally representative set of housing units, which were selected from EIA's Residential Energy Consumption Survey (RECS). The preliminary analysis used the 2001 RECS. The analysis for today's proposed rule uses the 2005 RECS. (See *http://www.eia.doe.gov/emeu/recs/*.) For each sampled household, DOE determined the energy consumption and energy price for the heating product. By developing a representative sample of households, the analysis captured the variability in energy consumption and energy prices associated with the use of residential heating products. DOE determined the LCCs and PBPs for each sampled household using a heating product's unique energy consumption and the household's energy price, as well as other variables. DOE calculated the LCC associated with the baseline heating product in each household. To calculate the LCC savings and PBP associated with equipment that meets higher efficiency standards, DOE's analysis replaced the baseline unit with a range of more-efficient designs.

EEI stated that not all residential water heaters are installed in homes, and thus DOE should modify its analysis to account for product usage and energy pricing in commercial establishments. (EEI, No. 40 at p. 5) DOE is unaware of data that show the percentage of residential water heater shipments that go to the commercial sector or how those products are used in the commercial sector, and the commenter did not provide such data. Therefore, DOE did not undertake a separate analysis for such installations.

Inputs to the calculation of total installed cost include the cost of the product—which includes manufacturer costs, manufacturer markups, retailer or distributor markups, and sales taxes—and installation costs. Inputs to the calculation of operating expenses include annual energy consumption, energy prices and price projections, repair and maintenance costs, product lifetimes, discount rates, and the year that proposed standards take effect. DOE created distributions of values for some inputs to account for their uncertainty and variability. Probabilities are attached to each value. As described above, DOE used samples of households to characterize the variability in energy consumption and energy prices for heating products. For the inputs to installed cost, DOE used probability distributions to characterize sales taxes. DOE also used distributions to characterize the discount rate and product lifetime that are inputs to operating cost.

The computer model DOE uses to calculate LCC and PBP, which incorporates Crystal Ball (a commercially available software program), relies on a Monte Carlo simulation to incorporate uncertainty and variability into the analysis. The Monte Carlo simulations randomly sampled input values from the probability distributions and household samples. The model calculated the LCC and PBP for products at each efficiency level for 10,000 housing units per simulation run.

Table IV.25 summarizes the approach and data DOE used to derive inputs to the LCC and PBP calculations. The table provides the data and approach DOE used for the preliminary TSD, as well as the changes made for today's NOPR. The following subsections discuss the initial inputs and the changes DOE made to them.

TABLE IV.25—SUMMARY OF INPUTS AND KEY ASSUMPTIONS IN THE LCC AND PBP ANALYSES*

Inputs	Preliminary TSD	Changes for the proposed rule
Installed Costs		
Product Cost	Derived by multiplying manufacturer cost by manufacturer, retailer and distributor markups and sales tax, as appropriate.	No change.
Installation Cost	Water Heaters: Based on data from RS Means and other sources.	Applied additional cost for space constraints and other installation situations.
	DHE: Based on data from RS Means and DOE's furnace installation model.	No change.
	Pool Heaters: Based on data from RS Means	No change.
Operating Costs		
Annual Energy Use	Water Heaters: Used hot water draw model to calculate hot water use for each household in the sample from RECS 2001. Calculated energy use using the water heater analysis model (WHAM).	No change in approach; sample and data updated using RECS 2005.
	DHE: Based on sample and data from RECS 2001.	No change in approach; sample and data updated using RECS 2005.
	Pool Heaters: Based on sample and data from RECS 2001.	No change in approach; sample and data updated using RECS 2005.
Energy Prices	Electricity: Based on EIA's 2006 Form 861 data	Electricity: Updated using data from EIA's 2007 Form 861 data and EIA's Form 826.
	Natural Gas: Based on EIA's 2006 *Natural Gas Navigator*.	Natural Gas: Updated using EIA's 2007 *Natural Gas Navigator.*
	Variability: Regional energy prices determined for 13 regions.	Variability: No change.
Energy Price Trends	Forecasted using EIA's *AEO2008*	Forecasts updated using EIA's *AEO2009.*
Repair and Maintenance Costs	Water Heaters: Based on RS Means and other sources.	Updated various repair costs.
	DHE: Based on RS Means and other sources	Updated various repair costs.
	Pool Heaters: Based on RS Means and other sources.	Updated various repair costs.
Present Value of Operating Cost Savings		
Product Lifetime	Water Heaters: Based on range of lifetimes from various sources. Variability and uncertainty: characterized using Weibull probability distributions.	Revised average lifetimes for gas-fired and electric storage water heaters. Set lifetime of oil-fired storage water heater equal to that of gas-fired storage water heater.
	DHE: same as for water heaters	No change.
	Pool Heaters: same as for water heaters	Average lifetime increased from 6 years to 8 years
Discount Rates	Approach based on the cost to finance an appliance purchase. Primary data source was the Federal Reserve Board's SCF** for 1989, 1992, 1995, 1998, 2001, and 2004.	No change in approach; added data from 2007 SCF.**
Compliance Date of New Standard	Water heaters: 2015	No change.
	DHE and Pool Heaters: 2013	

* References for the data sources mentioned in this table are provided in the sections following the table or in chapter 8 of the NOPR TSD.
** Survey of Consumer Finances.

1. Product Cost

To calculate consumer product costs, DOE multiplied the manufacturer selling prices developed in the engineering analysis by the supply-chain markups described above (along with sales taxes). DOE used different markups for baseline products and higher-efficiency products, because the markups estimated for incremental costs differ from those estimated for baseline models.

2. Installation Cost

The installation cost is the total cost to the consumer to install the equipment, excluding the marked-up consumer product price. Installation costs include labor, overhead, and any miscellaneous materials and parts.

a. Water Heaters

In its preliminary analysis, DOE included several installation costs that reflect the space constraints on water heaters having thicker insulation. DOE assumed that major modifications for replacement installations would occur 40 percent of the time for water heaters with 3 inches or greater insulation. The analysis included costs for modifications such as removing door jams or incorporated strategies such as installing a smaller tank plus a tempering valve. To estimate the fraction of households that would require various modifications, DOE used the water heater location determined for each sample household. DOE determined the location using information from the 2005 RECS, which reports whether the house has a basement, whether the basement is heated or unheated, and the presence or absence of a garage, crawlspace, or attic.

DOE received several comments on the space constraints for water heaters with increased insulation thicknesses. AHRI stated that the analysis does not fully recognize the size constraints on water heaters that have increased insulation. (AHRI, No. 33 at p. 2) For example, AHRI questioned DOE's assumption that space constraints do not apply if the floor area of a house is more than 1,000 square feet. (AHRI, No. 43 at p. 4) Rheem and AHRI stated that DOE should consider the space constraints of water heaters installed in attics. (Rheem, No. 49 at p. 2; AHRI, No. 43 at p. 4) Rheem stated that space constraints render larger products economically and technically infeasible. (Rheem, No. 49 at p. 1) EEI stated that DOE should consider the effect of adding insulation to electric storage water heaters and the issue of space constraints in replacement situations. (EEI, No. 40 at p. 4) PG&E, San Diego Gas and Electric (SDG&E), and SoCal Gas stated that if the diameter of a water heater is increased by 2 inches, installation becomes unworkable in highly constrained spaces. (PG&E, SDG&E, and SoCal Gas, No. 38 at p. 3)

A.O. Smith stated that many closets and cabinets do not have adequate clearance to accommodate larger-diameter water heaters. It stated that many electric storage water heaters cannot accept larger-diameter tanks without modifying the installation. A.O. Smith added that in the South, many water heater installations are in attics, and larger water heaters may not fit between the two ceiling joists in the pull-down staircase to the attic. A.O. Smith suggested that DOE's analysis should increase the number of installations that would require modification or the use of a small water heater with a tempering valve. (A.O. Smith, No. 37 at pp. 1–2)

In response to the above comments, for the NOPR analysis, DOE further investigated the issue of space constraints for water heaters with insulation thickness of 2 inches and above. Based upon the results of this inquiry, DOE expanded the percentage of installations that may have space constraints, including houses having a floor area of more than 1,000 square feet. For approximately 20 percent of replacement installations, DOE applied major modifications (removal of door jamb at an average cost of $191) for water heater designs with 2-inch insulation. For another 20 percent of replacement installations, DOE assumed that the household would install a smaller water heater and use tempering and check valves (at an average cost of $142). DOE also added a cost for extra labor needed to install water heaters in attics, and for installing larger water heaters (66 gallon and larger).

AHRI stated that the additional cost of $22 for tempering and check valves associated with installing an electric water heater is significantly understated. (AHRI, No. 43 at p. 4) In clarification, DOE incorporated an average cost of $142 for tempering and check valves for homes where they would be needed. The value of $22 is an average over all homes, including those where tempering and check valves are not necessary.

AHRI stated that a survey conducted by the SEGWHAI project in California determined that the average installation cost for a standard gas-fired storage water heater approached $1,000, which is higher than DOE's estimated average. (AHRI, Public Meeting Transcript, No. 34.4 at pp. 84–85) DOE used RS Means and installation cost data to derive a nationally-representative range of installation costs, whereas the SEGWHAI data pertain only to California. Because of the need to set a national standard, DOE has continued to rely on RS Means as a recognized and commonly used source for estimating such costs.

AHRI also stated that DOE underestimated the cost of condensing gas-fired storage water heaters. AHRI said that SEGWHAI estimated an installed cost of $4,000, compared to DOE's estimate of $1,782. The SEGWHAI estimate refers to a large-capacity commercial condensing unit having an EF of 0.84. For a condensing gas-fired storage water heater having an EF of 0.82 (a more appropriate comparison for the residential units at issue here), SEGWHAI proposes a $1,700 Tier 2 cost, which is comparable to the estimated installed cost of the 0.77 EF unit considered in DOE's analysis.

NEEA and NPCC questioned why DOE included the cost of installing an electrical outlet in the cost of gas-fired storage water heaters. (NEEA and NPCC, No. 42 at p. 8) In response, DOE understands that the baseline gas-fired water heater requires no electricity. If such a model is replaced with a higher-efficiency unit, however, an electrical outlet installation may be required.

The American Gas Association (AGA) stated that the installation costs for gas-fired storage water heaters having an EF greater than 0.62 need to include the cost of stainless steel vent connectors. (AGA, No. 44 at p. 3) DOE agrees that some models having an EF greater than 0.62 will require stainless steel vent connectors, but only if the recovery efficiency (RE) is 78 percent or higher. For the NOPR analysis, DOE added the cost of stainless steel vent connectors for all natural draft gas-fired water heaters that have an RE of 78 percent or higher.

A.O. Smith stated that the installation costs for electric storage water heaters at all efficiency levels are overstated by a factor of two. (A.O. Smith, No. 37 at p. 6) In response, DOE acknowledges that the average installation costs for electric storage water heaters presented in the preliminary TSD were too high. Consequently, for the NOPR analysis, DOE updated the labor cost. Instead of using national-average costs, DOE used region-specific costs, which yield a lower national-average cost for electric water heaters. DOE also reduced the labor time by one half hour. The result is that the average installation cost for electric storage water heaters is approximately half as much as the cost estimated in the preliminary analysis.

AGA stated that DOE's cost estimate for providing electrical supply to water heaters that incorporate electronic ignition is too low. AGA stated that DOE should use the cost estimates in other rulemakings for installations where electrical service is needed. (AGA, No. 44 at pp. 3–4) DOE's estimated cost for adding electrical supply for water heaters requiring electronic ignition, which is based on RS Means, is similar to the costs DOE used in the rulemaking for cooking products (74 FR 16040 (April 8, 2009)) and other rulemakings for installations that require electrical service.

Rheem stated that the cost of installing gas-fired, electric storage, and low-boy electric water heaters in manufactured housing units, where water heaters are typically installed under a counter, would be affected at higher efficiency levels. (Rheem, No. 49 at p. 2) As discussed previously, DOE considered and accounted for the cost of accommodating space constraints that may arise in some replacement applications when higher-efficiency units with thicker insulation are installed. In the specific case of manufactured homes, for the NOPR DOE increased the fraction of installations assumed to have space constraints by two-fold.

Table IV.26 shows the average installation costs used in the NOPR analysis for selected efficiency levels considered for gas-fired and electric storage water heaters. (Installation costs for electric storage water heaters with heat pump design are further discussed below.) The costs vary with the location of the water heater. For electric resistance water heaters, the average installation costs at different efficiency levels are similar for basement and garage locations, but they are higher for water heaters of 0.95 EF for indoor and attic locations. For gas-fired water heaters, the average installation cost is much higher for 0.67 EF and 0.80 EF units because thereis a change from metal Category I vents to plastic Category IV vents.

TABLE IV.26—AVERAGE AND INCREMENTAL INSTALLATION COSTS FOR ELECTRIC AND GAS-FIRED STORAGE WATER HEATERS

Electric				Gas-fired			
EF	Description	Average installation cost (2008$)*	Incremental installation cost (2008$)	EF	Description	Average installation cost (2008$)*	Incremental installation cost (2008$)
0.90	1.5 in (Baseline)	$222		0.59	Pilot, 1 in	$576	
0.91 and 0.92	2 and 2.25 in	241	$19	0.62	Pilot, 1.5 in	595	$19
0.93 and 0.94	2.5 and 3 in	259	36	0.63	Pilot, 2 in	621	46
0.95	4 in	282	60	0.67	Power vent, 2 in	808	233
				0.80	Condensing, 2 in	828	252

* Average installation cost represents the weighted average cost for replacement and new construction applications.

DOE received several comments on installation costs for heat pump water heaters. In its preliminary analysis, DOE applied a distribution of costs for heat pump water heater installations in enclosed spaces, including situations where modifications would be required. In its comments on the preliminary analysis, GE stated that in general, heat pump water heaters should be no more difficult or expensive to install than standard electric storage water heaters, because they will require the same electrical and plumbing connections. GE noted that its heat pump water heater occupies *a* footprint similar to that of a standard unit. GE stated, however, that it may be difficult to install a heat pump water heater in a confined space that lacks ventilation. (GE, No. 51 at p. 2) A.O. Smith commented that the requirements for providing adequate air flow for a heat pump water heater may be higher than DOE estimated. (A.O. Smith, No. 37 at p. 1) NEEA and NPCC stated that DOE should use a distribution of costs to encompass heat pump water heater installations that require building modifications. (NEEA and NPCC, No. 42 at p. 8)

DOE agrees that installation of heat pump water heaters in enclosed spaces may require modifications to allow for adequate ventilation. Accordingly, for half of indoor replacement installations, DOE added a cost for installing a fully-louvered closet door to permit adequate air flow for the operation of the unit. It used a distribution of costs that averages $344. In addition, DOE assumed that the household facing space constraints would install a smaller water heater and use tempering and check valves in 20 percent of replacement installations.

DOE's preliminary analysis considered the fact that heat pump water heaters draw heat from the space in which they are located and release cooled air. Thus, when such a water heater is located in a conditioned space, its use affects the load that the home's space heating and air conditioning equipment must meet. DOE accounted for the additional energy costs that affected households would incur.

Southern commented that DOE had not adequately considered the issues Southern previously raised regarding installing heat pump water heaters to replace existing electric water heaters, which included the need to provide venting of cooled air released by such units. The commenter also stated that for new construction installations in multifamily housing units, interior locations are preferred for installing mechanical systems. Southern commented that a heat pump water heater could be installed indoors, but it would be costly to provide supply and return vents to the exterior. (Southern, No. 50 at pp. 2–3)

In the NOPR analysis, DOE continued to assume that many households that would be affected by indoor operation of a heat pump water heater would not want to incur the cost of a venting system, and would instead operate their heating and cooling systems to compensate for the effects of the heat pump water heater. However, DOE agrees that some households would prefer to install a venting system. DOE estimated that those households that would experience significant indoor cooling due to operation of the heat pump water heater in the heating months (i.e., the heat pump cooling load is greater than 10 percent of the space heating load) would have a venting system installed to exhaust and supply air. Using calculations specific to each household in the subsample for electric water heaters, DOE estimated that 40 percent of replacement installations would incur this cost, which averages $460.

Table IV.27 shows the average additional installation costs that DOE applied for heat pump water heaters (relative to the baseline electric storage water heater), along with the fraction of installations receiving each specific cost.

TABLE IV.27—ADDITIONAL INSTALLATION COSTS FOR HEAT PUMP WATER HEATERS

Installation cost description	Assignment to installations	Share of installations impacted (percent)	Average cost*
Additional Labor	All installations	100	$69
Closet Door Redesign due to Space Constraints	50 of indoor and heated basement replacement installations.	16	344
Tempering Valve Addition due to Space Constraints	20 of all replacement installations	16	142

TABLE IV.27—ADDITIONAL INSTALLATION COSTS FOR HEAT PUMP WATER HEATERS—Continued

Installation cost description	Assignment to installations	Share of installations impacted (percent)	Average cost *
Condensate Pump	25 of all replacement installations	20	154
Venting Adder **	40 of replacement installations with significant cooling load effects.	10	460
Larger Drain Pan	All installations	100	2

* Labor cost hours from 2008 RS Means; material cost from 2008 RS Means; condensate pump from retailer web sites; drain pan from 2001 TSD.

** All households experiencing significant cooling load effects in the heating season are either assigned the venting adder or the extra cost for space heating is included in the energy use calculations.

In summary, for the NOPR analysis, DOE used a distribution of installation costs for heat pump water heaters ranging from $213 to $1,918. The estimated average installation cost for a heat pump water heater (at 2.00 EF), weighted over replacement and new construction applications, is $446. This compares to average costs of $222 for a baseline (0.9 EF) electric storage water heater and $282 for a 0.95 EF electric storage water heater. For further details on DOE's derivation of installation costs for electric storage water heaters, please see chapter 8 of the NOPR TSD. DOE requests comments on its analysis of installation costs for water heaters; it is particularly interested in comments on its analysis of installation costs for heat pump water heaters. This is identified as issue 13 under ''Issues on Which DOE Seeks Comment'' in section VII.E of this NOPR.

Regarding installation of gas-fired instantaneous water heaters, A.O. Smith questioned whether DOE considered the need for the pressure relief valve and drain pans that manufacturers and codes require. (A.O. Smith, No. 37 at p. 6) Noritz stated that gas-fired instantaneous water heaters that achieve an EF of 0.83 or higher require condensate drains and some method of treating the condensate so that it can be disposed of, further adding to the installation cost. (Noritz, No. 36 at pp. 1–2) For the NOPR analysis, DOE included the cost and installation of a drain pan and pressure relief valve, as well as a filter for treating the condensate for units with an EF of 0.83 or higher.

A.O. Smith questioned whether DOE included the cost to replace a gas line with a larger line when installing gas-fired instantaneous water heaters in replacement applications. (In some cases the existing gas line is not adequate to accommodate the higher gas input required by the instantaneous water heaters.) A.O. Smith also stated that the analysis should include the costs related to extreme installation situations for gas-fired instantaneous water heaters, as DOE did for the costs of adding tempering valves or modifying door jams for electric storage water heaters. (A.O. Smith, No. 37 at p. 6) In response, DOE did not include the costs of such measures for gas-fired instantaneous water heaters, because in those cases where these measures would be required, the extremely high cost would likely lead households to purchase a storage water heater instead.

AHRI stated that DOE should reconcile its cost estimates for installing instantaneous water heaters with the SEGWHAI estimate, which is at least $200 to $300 more than DOE's estimate. (AHRI, Public Meeting Transcript, No. 34.4 at p. 168) As noted above, the SEGWHAI data pertain only to California, where labor costs are higher than the national average. For the NOPR, DOE used RS Means and installation cost data to derive region-specific installation costs.

b. Direct Heating Equipment

DOE used the approach in the 1993 TSD to calculate installation costs for baseline direct heating equipment for its preliminary analysis, as it believes that the factors affecting DHE installation are largely unchanged, and more recent data are not available. For gas wall gravity, floor, and room direct heating equipment, DOE increased installation costs for designs that require electricity. DOE made this adjustment for the replacement market only, because wiring is considered part of the general electrical work in new construction. DOE did not receive comments on the installation costs for direct heating equipment, so it maintained the same approach for the NOPR analysis. For further details on DOE's derivation of installation costs for direct heating equipment, please see chapter 8 of the NOPR TSD.

c. Pool Heaters

DOE developed installation cost data for the baseline pool heater in its preliminary analysis using RS Means and information in a consultant's report. DOE incorporated additional installation costs for designs involving electronic ignition and/or condensing. DOE did not receive comments on the installation costs for pool heaters, so it maintained this earlier approach for the NOPR analysis. For further details on DOE's derivation of installation costs for pool heaters, please see chapter 8 of the NOPR TSD.

3. Annual Energy Consumption

DOE determined the annual energy use in the field for the three types of heating products based on data obtained from RECS. DOE supplemented this data as required for each heating product, as discussed below.

a. Water Heaters

DOE calculated the annual energy consumption of water heaters in the sample households by considering the primary factors that determine energy use: (1) Hot water use per household; (2) energy efficiency of the water heater; and (3) operating conditions other than hot water draws. DOE used a hot water draw model to calculate hot water use for each household in the sample. The characteristics of each water heater's energy efficiency were obtained from the engineering analysis. DOE developed water heater operating conditions (other than hot water draws) from weather data and other relevant sources. DOE used a simplified energy equation, the water heater analysis model (WHAM), to calculate the energy use of water heaters. WHAM accounts for a range of operating conditions and energy efficiency characteristics. DOE's approach is explained in further detail in chapter 7 of the NOPR TSD.

To estimate hot water use by each sample household, DOE used a hot water draw model that accounts for the key factors that determine such use, such as the number and ages of the people who live in the household, the way they consume hot water, the presence of hot-water-using appliances, the tank size and thermostat set point of the water heater, and the climate in which the residence is situated. In general, households with higher hot water use have water heaters with larger storage volume.

DOE received several comments on hot water use. ACEEE stated that the hot water draw model is insufficiently supported by field data. (ACEEE, Public Meeting Transcript, No. 34.4 at p. 178) NEEA and NPCC stated that DOE should provide more detail on the draw model and explain how it has been validated and calibrated. (NEEA and NPCC, No. 42 at p. 7) DOE acknowledges that insufficient field data are currently available to fully validate the draw model. However, Electric Power Research Institute (EPRI) developed the draw model based on a nationally representative sample of households. It is DOE's understanding that this widely-used model, which has been updated several times to account for changes in household hot water use, is the most credible tool available for modeling daily hot water use. The draw model is described in detail in appendix 7–B of this NOPR's TSD, as well as in the reports referenced in chapter 7 of the TSD.

NEEA and NPCC stated that current estimates of hot water use in the Pacific Northwest are about 20 percent higher than DOE's estimate of national-average daily use. (NEEA and NPCC, No. 42 at p. 7) Household hot water use differs among geographic regions for various reasons. DOE's analysis for Census Division 9 (which includes the Pacific Northwest) shows average hot water use by electric water heaters (47.9 gal/day) as being higher than the average national value (41.9 gal/day). Therefore, DOE believes that the estimates used in its analysis are reasonable.

EEI stated that DOE should consider the effects on hot water use of smaller households and the lower hot water use of new dishwashers and clothes washers, which are installed in both new and existing homes. (EEI, No. 40 at p. 6) For the NOPR, DOE used the most recent data available regarding household characteristics (from the 2005 RECS). In addition, DOE modified the hot water draw model to account for the impact of the efficiency standards that recently became effective for dishwashers and clothes washers.

BWC commented that hot water usage for gas-fired instantaneous water heaters may be different than for storage water heaters, although it has no evidence to support this idea. (BWC, No. 46 at p. 1) GE and Noritz stated that they are unaware of any data that support the assumption that consumers use more hot water with a gas-fired water heater. (GE, No. 51 at p. 3; Noritz, No. 36 at p. 2) Because DOE found no usable data showing greater or lesser hot water use for instantaneous water heaters than for storage water heaters, it estimated that households use the same volume of hot water with both types of water heaters.

Commenting on the calculation of energy use, Bock stated that WHAM does not accurately estimate energy consumption. (Bock, No. 53 at p. 2) In response, DOE notes that the WHAM equation has been validated against field data and that the comparison shows that WHAM results correlate well.

NEEA and NPCC stated that the estimated energy use results could be verified with sub-metered (*i.e.,* measured) field data. (NEEA and NPCC, No. 42 at p. 7) DOE found that the sub-metered field data for water heaters are insufficient to represent the range of national water heater energy use patterns. Therefore, DOE did not undertake such verification of its energy use estimates.

AHRI and Bock stated that the estimates of annual energy consumption for gas- and oil-fired water heaters are about 65 percent of test procedure usage specifications, whereas for electric water heaters it is 55 percent. AHRI questioned why the analysis appears to be using different field use assumptions for electric water heaters. (AHRI, No. 33 at p. 2; Bock, No. 53 at p. 2) In response, DOE's analysis used 2005 RECS data to estimate the energy consumption of water heaters in use by U.S. households. DOE's analysis thereby incorporates assumptions about operating conditions that are appropriate for each water heater type. For example, DOE determined that the average annual ambient temperature is higher for the stock of electric water heaters than for the stock of gas-fired water heaters. This difference contributes to the lower average energy use for electric water heaters.

A.O. Smith stated that the analysis of ambient air temperature effects does not include water heaters installed in attics in the South, and that the temperature derivation formulas are not applicable to attic installations, where solar gain can bring temperatures to ambient plus 40 °F in summer. (A.O. Smith, No. 37 at pp. 5–6) DOE's analysis included water heaters installed in attics and accounted for the range of temperatures found in such locations.

The energy efficiency and consumption of heat pump water heaters depend on ambient temperature. The equation DOE used to determine the energy consumption of heat pump water heaters is similar to the WHAM equation, but it modulates the recovery efficiency by applying a performance adjustment factor that is a function of the average ambient temperature. GE stated that because lower ambient temperatures will affect the performance of both heat pump and storage water heaters, DOE should use universally applied conditions to compare products. (GE, No. 51 at p. 2) DOE's energy calculations for heat pump and storage water heaters accounted for the effects of lower ambient temperatures. Heat pump water heaters are more affected by air temperature because the air provides the heat to warm the water.

As stated previously, DOE assumed that many households that would be affected by indoor operation of a heat pump water heater would not want to incur the cost of a venting system, and would instead operate their space heating or cooling system to compensate for the effects of the heat pump water heater. For each such home, DOE estimated the impact on space heating only during heating months (*i.e.,* when indoor temperature is at least 10 degrees greater than the average outdoor temperature), and the impact on air conditioning only during cooling months (*i.e.,* when indoor temperature is at least 5 degrees less than the average outdoor temperature). For each affected household in the electric water heater sub-sample, DOE included such indirect energy use in its calculation of the energy consumption of a heat pump water heater.

BWC stated that the assumed rated capacity (Pon) of 500 watts and cooling capacity of 3,500 Btu/h are not correct for all heat pump water heaters. (BWC, No. 46 at p. 2) For the preliminary analysis, DOE based those values on information available in AHRI's 2007 Consumers' Directory. For the NOPR, DOE created a distribution of values for Pon and cooling capacity that represent a range of heat pump water heater designs.

To calculate the energy use of gas-fired instantaneous water heaters, DOE used the same approach as for storage water heaters, modified to account for the absence of a tank. For the preliminary analysis, DOE applied a performance adjustment factor to account for evidence that the rated energy efficiency of instantaneous water heaters overstates actual performance, as reported in a study of instantaneous water heater installations conducted for the California Energy Commission (CEC). See Davis Energy Group. *Measure Information Template: Tankless Gas Water Heaters* (May 18, 2006); *http://*

www.energy.ca.gov/title24/2008standards/prerulemaking/documents/2006–05–18_workshop/2006–05–11_GAS_WATER.PDF. The adjustment factor effectively increases the calculated energy use of a gas-fired instantaneous water heater by 8.8 percent.

A.O. Smith noted its strong support for incorporating results from the CEC study to account for performance drop-off at small draw volumes. Because it requires 5 to 20 seconds for a gas-fired instantaneous water heater to heat up, 1 gallon of cold water can be wasted at the beginning of every water draw. (A.O. Smith, No. 37 at pp. 1, 5) ACEEE, PG&E, SDG&E, SoCal Gas, and AGA also support applying a performance adjustment. (ACEEE, No. 35 at p. 7; PG&E, SDG&E, and SoCal Gas, No. 38 at p. 4; AGA, No. 44 at p. 3) BWC expressed support for applying the 8.8-percent adjustment factor to gas-fired instantaneous water heaters, noting that its testing indicates that this number may be a little low. (BWC, No. 46 at p. 1) AHRI disagreed with applying an 8.8-percent factor. AHRI stated that the CEC study obtained its field data from one two-person household, which does not support a technically sound analysis. (AHRI, No. 33 at p. 2) Bock, GE, Noritz, and Rheem agreed. (Bock, No. 53 at p. 2; GE, No. 51 at p. 3; Noritz, No. 36 at p. 2; Rheem, No. 49 at pp. 6–7)

For the NOPR analysis, the performance adjustment factor DOE developed to capture the field energy use of gas-fired instantaneous water heaters is a probability distribution. The factor changes based on household hot water consumption, rather than on a fixed value that may represent only a fraction of households. The 8.8-percent adjustment factor DOE used for the preliminary analysis became the upper value in the distribution DOE used for the NOPR. The rest of the range was derived from a Gas Technology Institute (GTI) study that calculated an energy use reduction (adjustment) factor as a function of the volume of water gas-fired instantaneous water heaters use daily.

Southern stated that the draws in the hot water draw model should ideally be shorter for instantaneous water heaters. (Southern, Public Meeting Transcript, No. 34.4 at p. 194) ACEEE stated that PG&E and Consumers Union have performed studies on alternative draw patterns for gas-fired instantaneous water heaters that are more reflective of daily use. (ACEEE, Public Meeting Transcript, No. 34.4 at pp. 195–196) In response, DOE's performance adjustment factor accounts for a range of draw patterns associated with gas-fired instantaneous water heaters. Accordingly, DOE maintains its existing approach.

b. Direct Heating Equipment

For the preliminary analysis of LCC and PBP, DOE estimated energy consumption of direct heating equipment in functioning housing units. To represent actual households likely to purchase and use direct heating equipment, DOE developed a household sample from the 2001 RECS. DOE did not receive any comments on its approach for estimating energy consumption of direct heating equipment. Therefore, for the NOPR, DOE used the same approach, but it used a household sample drawn from the 2005 RECS.

c. Pool Heaters

For the preliminary analysis of LCC and PBP, DOE estimated energy consumption of pool heaters at functioning housing units. To represent actual households likely to purchase and use pool heaters, DOE used a household sample from the 2001 RECS. For the NOPR, DOE used a household sample drawn from the 2005 RECS.

AHRI stated that DOE's estimate of the annual energy use of a typical residential pool heater is overestimated by a factor of two. It said that DOE's estimated annual energy use of 53.6 MBtu [one thousand British thermal units] based on an energy use of 250 kBtu/h at 78 percent thermal efficiency (a baseline unit) represents 214 hours of operation annually. AHRI mentioned a CEC study that determined that gas pool heaters were used on average 104 hours per year, and it commented that the LCC should be recalculated based on that value. (AHRI, No. 43 at p. 5)

In response, DOE notes that the CEC study mentioned is based on a single study conducted in the early 1990s. For the NOPR, DOE did revise the range of operating hours used its analysis, although it relied on more recent data than the referenced CEC study. Instead, DOE calculated the pool heater operating hours using the estimated pool heater heating load for each sample household from the 2005 RECS. The average hours of operation in the NOPR analysis is 149 per year, which results in an annual energy use of 38 MBtu for a 250 kBtu/hr baseline unit operating at 78 percent thermal efficiency.

d. Rebound Effect

A rebound effect refers to increased energy consumption resulting from actions that increase energy efficiency and reduce consumer costs. For its preliminary analysis, DOE searched the literature on the rebound effect related to the three types of heating products, and also considered how EIA's NEMS incorporates a rebound effect.

For water heaters, DOE reviewed a summary of studies on the rebound effect, which concluded that ''technical improvements for residential hot water heating will be between 60 and 90 percent effective in reducing energy consumption for this service'' (implying a rebound effect of 10 to 40 percent). See L.A. Greening, D.L. Greene, C. Difiglio, Energy Efficiency and Consumption: The Rebound Effect, *Energy Policy,* 28(6–7): pp. 389–401. DOE found that NEMS does not incorporate a rebound factor, however. Balancing these findings from the literature with the zero rebound effect used in NEMS, DOE decided that a rebound effect of 10 percent was reasonable for water heaters.

A.O. Smith supported the use of a 10-percent rebound effect for water heaters. (A.O. Smith, No. 37 at p. 2) It added that there is an additional rebound effect for gas-fired instantaneous water heaters because of the promotion of ''unlimited'' or ''endless'' hot water. (A.O. Smith, No. 37 at p. 7) NEEA and NPCC suggested that DOE ignore the rebound effect except in the case of the highest candidate standard levels, as adoption of the lower efficiency levels would not provide consumers with noticeable savings in energy bills. (NEEA and NPCC, No. 42 at p. 8) ACEEE stated that it does not believe that the peer-reviewed literature supports assertions of large rebound effects, and the more conservative approach is to ignore them for these products. (ACEEE, No. 35 at p. 7)

As stated above, the literature does indicate the presence of a rebound effect of 10 to 40 percent for water heaters. Given that NEMS does not incorporate a rebound effect for water heating, and that the comments received on the preliminary analysis support a rebound effect of 10 percent or lower, DOE believes that using a value at the lower end of the range found in the literature (*i.e.,* 10 percent) is reasonable and has incorporated such an effect in its analyses for this NOPR.

4. Energy Prices

For the LCC and PBP, DOE derived average energy prices for 13 geographic areas consisting of the nine U.S. Census divisions, with four large States (New York, Florida, Texas, and California) treated separately. For Census divisions containing one of these large States, DOE calculated the regional average excluding the data for the large State.

DOE estimated residential electricity prices for each of the 13 geographic areas based on data from EIA Form 861, ''Annual Electric Power Industry Database,'' and EIA Form 826, ''Monthly Electric Utility Sales and Revenue Data.'' DOE calculated an average annual regional residential electricity price by: (1) Estimating an average residential price for each utility (by dividing the residential revenues by residential sales); and (2) weighting each utility by the number of residential consumers served in that region (based on EIA Form 861). DOE calculated an average monthly regional electricity price by first calculating monthly prices for each State, and then calculating a regional price by weighting each State in a region by the number of consumers in that State using EIA Form 826. For the preliminary TSD, DOE used EIA data from 2006. The NOPR analysis used the data from 2007.

DOE estimated average residential natural gas prices in each of the 13 geographic areas based on data from EIA's Natural Gas Navigator. See Energy Information Administration, *Natural Gas Navigator,* 2009; *http://tonto.eia.doe.gov/dnav/ng/ng_pri_sum_dcu_nus_m.htm.* DOE calculated an average natural gas price by first calculating the price for each State, and then calculating a regional price by weighting each State in a region by the number of consumers in that State. This method differs from the method DOE used to calculate electricity prices, because EIA does not provide utility-level data on gas consumption and prices. For the preliminary TSD, DOE used EIA data from 2006. For today's proposed rule, DOE used the data from 2007.

DOE estimated average residential prices for liquefied petroleum gas (LPG) in each of the 13 geographic areas based on data from EIA's State Energy Consumption, Price, and Expenditures Estimates. See Energy Information Administration, *2007 State Energy Consumption, Price, and Expenditure Estimates (SEDS); http://www.eia.doe.gov/emeu/states/_seds.html.* For the preliminary TSD, DOE used data from 2005. For today's proposed rule, DOE used the data from 2006.

DOE estimated average residential prices for oil in each of the 13 geographic areas based on data from EIA's Petroleum Navigator. See Energy Information Administration, *Petroleum Navigator, December, 2009; http://tonto.eia.doe.gov/dnav/pet/pet_cons_821dsta_a_EPD0_VAR_Mgal_a.htm.* For the preliminary TSD, DOE used data from 2006. For today's proposed rule, DOE used the data from 2007.

To estimate the trends in energy prices for the preliminary TSD, DOE used the price forecasts in *AEO2008.* To arrive at prices in future years, DOE multiplied current average regional prices by the forecast of annual average price changes in *AEO2008.* Because *AEO2008* forecasts prices to 2030, DOE followed past guidelines that EIA provided to the Federal Emergency Management Program. DOE used the average rate of change from 2020 to 2030 to estimate the price trend for electricity after 2030, and the average rate of change from 2015 to 2030 to estimate the price trend after 2030 for natural gas, LPG, and oil. For today's proposed rule, DOE used the same approach, but updated its energy price forecasts using *AEO2009.* DOE intends to update its energy price forecasts for the final rule based on the latest available *AEO.* In addition, the spreadsheet tools that DOE used to conduct the LCC and PBP analyses allow users to select price forecasts from either *AEO*'s high-growth scenario or low-growth scenario to estimate the sensitivity of the LCC and PBP to different energy price forecasts.

Earthjustice stated that DOE must quantify the effect of a CO_2 emissions cap on energy prices in the LCC analysis. (Earthjustice, No. 47 at p. 4) DOE believes that it would be inappropriate to speculate on the form of any Federal carbon control legislation, and the ensuing impacts on residential energy prices. Therefore, DOE does not incorporate such impacts into the energy price forecasts that DOE used for the NOPR analysis.

5. Repair and Maintenance Costs

Repair costs are associated with repairing or replacing components that have failed in the appliance, whereas maintenance costs are associated with maintaining the operation of the equipment. Determining the repair cost involves determining the cost and the service life of the components that are likely to fail. Discussion of repair and maintenance costs for the three types of heating products is provided below, along with a summary of public comments on this topic. For more information on DOE's development of repair and maintenance cost estimates, see chapter 8 of the NOPR TSD.

a. Water Heaters

The repair cost for a water heater reflects the cost for a service call when the product fails. There are four design options considered for the gas-fired water heater analysis that may encounter repair cost during the lifetime of the water heater: (1) Pilot ignition; (2) electronic ignition; (3) power vent; and (4) condensing design. The energy efficiency levels that include power vent or condensing design encounter both power vent as well as electronic ignition repair costs. For each of the above four design options, DOE estimated both an average cost and the year in which the repair would, on average, be most likely to occur.

AHRI stated that DOE's analysis of gas-fired water heaters ignored the introduction of FVIR designs that require maintenance. (AHRI, No. 43 at pp. 1–2) For the NOPR, DOE added a cost for maintaining the FVIR for all gas-fired storage water heaters.

For the preliminary analysis, DOE determined that there is virtually no maintenance or repair associated with conventional electric resistance water heaters. For a heat pump water heater, maintenance includes annual cleaning of the air filter and a preventive maintenance cost to check the evaporator and refrigeration system. Although the literature suggests that no professional help is necessary for this maintenance, DOE believes there are instances in which such help is needed. For some locations where the heat pump water heater might be more exposed to the outdoor environment, such as garages and crawlspaces, DOE applied a 5-year preventative maintenance cost based on experience with heat pump water heater outdoor installations in Australia, which has roughly comparable conditions as much of the United States. See Rheem Manufacturing Company (Australia), Owners Guide and Installation Instruction: Air Sourced Heat Pump Water Heater, 2006; *http://www.rheem.com.au/images/pdf/owners_heatpump_126524B_0610.pdf.* DOE estimated that 27 percent of these exposed installations would require this maintenance, based on a survey conducted for central air conditioners, which include heat exchangers that operate similarly as the evaporator heat exchanger in a heat pump water heater.

ACEEE recommended that DOE use refrigerator maintenance costs for heat pump water heaters because of similarities in the components and operation. (ACEEE, No. 35 at p. 6) A.O. Smith stated that the cost for regular and routine maintenance on heat pump water heaters must be considered. It added that it is inaccurate to compare a heat pump water heater to a refrigerator due to the much longer duty cycle on a heat pump water heater, the slow recovery time, the need for frequent cleaning, and the scale build-up on the water side, which is not an issue with refrigerators. (A.O. Smith, No. 37 at p. 8) GE stated that DOE ascribed inappropriate maintenance costs to heat pump water heaters, which require no more attention than a standard room air conditioner. (GE, No. 51 at p. 2)

In response, DOE notes that it based its maintenance costs for heat pump water heaters on experience in Australia, so it is not necessary to use another appliance as a proxy. DOE acknowledges that many heat pump water heaters may require little or no maintenance. However, DOE believes that because the field experience with heat pump water heaters is limited, it is reasonable to apply a maintenance cost for some installations. As described above, DOE applied a 5-year preventative maintenance cost for 27 percent of the installations in garages and crawlspaces.

Regarding repair of conventional electric resistance water heaters, ACEEE stated that data may be available on the number of resistive elements that need to be replaced. (ACEEE, Public Meeting Transcript, No. 34.4 at p. 211) Based on this comment, for the NOPR, DOE added a cost for replacing resistive elements at least once during the lifetime for one-fourth of installations.

For heat pump water heaters, DOE considered the cost of replacing the compressor and the evaporator fan and the year in which, on average, they would be expected to fail. DOE used a lifetime distribution for the compressor and evaporator fan with an average lifetime of 19 years. For the majority of households, the compressor and evaporator fan would likely not fail during the water heater's lifetime. However, because there is some overlap between the lifetime distribution used for the compressor and evaporator fan and the lifetime distribution used for electric water heaters (see below), DOE included a compressor and evaporator fan repair cost in the appropriate year for some households. DOE requests comments on its analysis of repair and maintenance costs for heat pump water heaters. This is identified as issue 14 under ''Issues on Which DOE Seeks Comment'' in section VII.E of this NOPR.

Regarding repair costs of gas-fired instantaneous water heaters, AGA stated that DOE needs to account for incremental design options, particularly electronic ignition maintenance and replacement. (AGA, No. 44 at p. 4) In its preliminary analysis, DOE already applied a distribution of costs for electronic ignition repair based on RS Means. It maintained the same approach for the NOPR analysis.

For the preliminary analysis, DOE applied a maintenance cost for some gas-fired instantaneous water heaters to address the fouling of the heat exchanger from hard water, periodic sensor inspections, and filter changes. A.O. Smith stated that $85 per year is too low for annual maintenance (de-liming) for gas-fired instantaneous water heaters. (A.O. Smith, No. 37 at p. 7) In response, for the NOPR, DOE used a distribution of costs for maintenance of gas-fired instantaneous water heaters, not a single cost of $85, and also applied no cost for some installations.

Noritz stated that the basis for including de-liming costs for gas-fired instantaneous water heaters is clauses in the warranty, which is standard for all water heaters, so de-liming costs should not be included only for gas-fired instantaneous water heaters. (Noritz, No. 36 at p. 2) Noritz stated that the necessity for de-liming varies, so it would be best not to include the cost for any class of water heater, but if it is included for gas-fired instantaneous water heaters, DOE should account for the fact that it is not necessary for every installation. (Noritz, No. 36 at pp. 2–3) DOE agrees that de-liming is not necessary for every installation, so in the NOPR analysis, it assigned zero cost to a fraction of households.

For the preliminary analysis, DOE determined that maintenance for oil-fired water heaters is most frequently performed under annual maintenance contracts, which typically include repair of failed components. DOE estimated the average cost of separate maintenance/repair contracts only for water heaters as $153 per year. This mean value comes from a collection of annual maintenance contract prices, which were gathered from web sites that represent oil-fired product suppliers in the eastern U.S. The same maintenance cost applies to all energy efficiency levels. DOE did not receive any comments on this topic, so it maintained the same approach for the NOPR analysis.

Bock stated that DOE did not include the cost of annually flushing oil-fired storage water heaters. (Bock, No. 53 at p. 2) For the NOPR, DOE included a cost for flushing the tanks of all storage water heaters, including oil-fired storage water heaters.

b. Direct Heating Equipment

For the preliminary analysis, DOE determined that maintenance cost data for gas-fired furnaces provide a reasonable approximation of maintenance costs for DHE because of the similarity in design and operation. DOE derived the costs from a field survey sponsored by several gas utilities that estimated the average total service charge (parts, labor, and other charges). See Jakob, F. E., *et al.,* Assessment of Technology for Improving the Efficiency of Residential Gas Furnaces and Boilers, 1994. Gas Research Institute. Chicago, IL. Report No. GRI–94/0175. DOE used a maintenance frequency of once every 5 years for all direct heating equipment.

DOE determined the repair costs for DHE using an approach that reflects the cost and the service life of the components that are likely to fail. The non-condensing designs DOE considered that may encounter repair costs during the lifetime of the product include pilot ignition, electronic ignition, circulating blower, and induced draft. The repair cost of the condensing design includes electronic ignition, circulation blower, and induced draft components. DOE did not receive comments on maintenance and repair costs for DHE, so it continued to use the existing approach for its NOPR analysis.

c. Pool Heaters

For the preliminary analysis, DOE determined that most pool owners do not perform any pool heater maintenance except when the heater does not come on. In such situations, the maintenance work includes checking controls, cleaning burners, cleaning the heat exchanger, starting the heater, and measuring water temperature rise. DOE used an average cost of $351. For units employing power vent and condensing design options, maintenance also includes measuring combustion differential pressure. For these units, DOE used an average cost of $491 and estimated that the maintenance occurs on average in the fifth year of the pool heater lifetime. Raypak stated that pool heaters need maintenance more than every 5 years due to outdoor installation. (Raypak, Public Meeting Transcript, No. 34.4 at p. 215) DOE applied a distribution ranging from 3 to 6 years for pool heater maintenance. Thus, some applications would receive maintenance more than once every 5 years.

Pool heater design options that may encounter repair cost during the lifetime of the pool heater include pilot ignition, electronic ignition, and power vents. For each of these, DOE estimated the average repair cost and when in the product lifetime such repair would be likely to occur. DOE continued to use the above approach for the NOPR analysis.

6. Product Lifetime

For the preliminary analysis, DOE used a variety of sources to establish minimum, average, and maximum values for the lifetime of each of the three types of heating products. For each product class, DOE characterized the product lifetime using a Weibull probability distribution that ranged from minimum to maximum lifetime estimates. See chapter 8 of the NOPR TSD for further details on the sources DOE used to develop product lifetimes.

For the preliminary TSD, DOE chose average lifetimes for gas-fired and electric storage water heaters based on the values in the middle of each range: 12 years for gas units and 14 years for electric units. In the NOPR analysis, DOE found that applying the above values to historic shipments resulted in estimates of the stock of gas-fired and electric storage water heaters that did not match the data on the stock reported in the Census Bureau's 2007 American Housing Survey (AHS), which covers all housing units in the United States. The estimated stock is too small for gas-fired water heaters and too large for electric water heaters. Using an average lifetime of 13 years for both gas-fired and electric storage water heaters produces stock estimates for 2007 that are close to the stock numbers from the AHS. Furthermore, several sources report a lifetime of 13 years. (See chapter 8 of the NOPR TSD.) Therefore, DOE used an average lifetime of 13 years for both gas-fired and electric storage water heaters in its NOPR analysis.

DOE evaluated whether electric heat pump water heaters have a different lifetime from the baseline products. An accelerated durability test of heat pump water heaters conducted by Oak Ridge National Laboratory suggests that these units have similar lifetime as standard electric resistance storage water heaters. Therefore, DOE used the same lifetime for all efficiency levels considered for this product class.

For gas-fired instantaneous water heaters, DOE used a distribution with 20 years as the average lifetime for these units in its preliminary analysis. A.O. Smith stated that a 20-year lifetime for gas-fired instantaneous water heaters is too long, and there is not adequate data to backup this claim. (A.O. Smith, No. 37 at p. 2) BWC stated that DOE's average lifetime for gas-fired instantaneous water heaters is derived from manufacturer literature and it suggested that DOE instead use an independent source for this information. (BWC, No. 46 at p. 2) DOE is not aware of and the commenters did not provide any other source of data on the lifetime of gas-fired instantaneous water heaters, so it used the same distribution as in the preliminary analysis.

For oil-fired storage water heaters, DOE used 9 years as the average lifetime. Bock stated that oil-fired storage water heaters should have the same lifetime as gas-fired storage water heaters because they are identical in material, construction, volume, and storage temperature. (Bock, No. 53 at p. 2) For the NOPR analysis, DOE used the same lifetime for oil-fired storage water heaters as for gas-fired storage water heaters (*i.e.,* 13 years).

For direct heating equipment, DOE used the average, minimum, and maximum lifetime values from its 1993 TSD for direct heating equipment because it did not find more recent representative data. The average lifetime DOE used for each of the product classes was 15 years. DOE did not receive any comments on DHE lifetime, so it continued to use the above values for the NOPR.

For pool heaters, DOE used 8 years as an average lifetime based on the available data. DOE did not receive any comments on pool heater lifetime, so it continued to use the above value for the NOPR.

7. Discount Rates

To establish discount rates for the heating products in the preliminary analysis, DOE derived estimates of the finance cost of purchasing these appliances. Because the purchase of equipment for new homes entails different costs for consumers than the purchase of replacement equipment, DOE used different discount rates for new construction and replacement. See chapter 8 of this NOPR's TSD for further details on the development of discount rates for heating products.

DOE estimated discount rates for appliance purchases in new housing using the effective real mortgage rate for homebuyers, which accounts for deducting mortgage interest for income tax purposes, and an adjustment for inflation. DOE developed a distribution of mortgage interest rates using data from the Federal Reserve Board's ''Survey of Consumer Finances'' (SCF) for 1989, 1992, 1995, 1998, 2001, and 2004. For today's NOPR, DOE added data from the 2007 SCF. Because the mortgage rates carried by households in these years were established over a range of time, DOE believes they are representative of rates that may apply when amended standards take effect. The effective real interest rates on mortgages across the six surveys averaged 3.0 percent.

DOE's approach for deriving discount rates for replacement purchases involved identifying all possible debt or asset classes that might be used to purchase replacement products, including household assets that might be affected indirectly. DOE used data from the surveys mentioned above to estimate the average percentages of the various debt and equity classes in the average U.S. household portfolios. DOE used SCF data and other sources to develop distributions of interest or return rates associated with each type of equity and debt. For today's NOPR, DOE added data from the 2007 SCF. The average rate across all types of household debt and equity, weighted by the shares of each class, is 4.8 percent.

8. Compliance Date of the Amended Standards

In the context of EPCA, the compliance date is the future date when parties subject to the requirements of a new standard must begin to comply. As described in DOE's semi-annual implementation report for energy conservation standards activities submitted to Congress pursuant to section 141 of EPACT 2005, a final rule for the three types of heating products that are the subject of this rulemaking is scheduled to be completed by March 2010. Compliance with amended energy efficiency standards for direct heating equipment and pool heaters is required three years after the final rule is published in the **Federal Register** (in 2013); compliance with amended standards for water heaters is required five years after the final rule is published (in 2015). DOE calculated the LCC for the three types of heating products as if consumers would purchase new products in the year compliance with the standard is required.

Earthjustice stated that DOE assumes a 5-year lead time to be consistent with the requirements in 42 U.S.C. 6295(e)(4)(B), which requires that DOE ''publish a final rule no later than January 1, 2000 to determine whether standards in effect * * * should be amended,'' and that ''any such amendment shall apply to products manufactured on or after January 1, 2005.'' The commenter stated that this assumption is contrary to the structure and purpose of the statute. It also declared that there is no statutory language to deal with the current situation, which involves determining a compliance date for a standard that DOE was required to adopt nearly 10 years ago. Earthjustice stated that the required publication date and compliance dates have passed, and that it is unreasonable to apply the 5-year lead time specified in 42 U.S.C. 6295(e)(4)(B). (Earthjustice, No. 47 at p. 5) ASAP stated that DOE's compliance date of 2015 is arbitrary because the law states that compliance with the standard is required by 2005. ASAP stated that DOE is obligated to use time as a variable and look at a range of implementation dates for all of the standard levels to determine the standard that would best meet the statutory criteria. ASAP suggested that DOE analyze a range of compliance dates from 18 months to 8 years after publication of the final rule. (ASAP, Public Meeting Transcript, No. 34.4 at pp. 57–58) AHRI stated that DOE is obligated to allow five years between the final rule and the compliance date for the requirements for water heater products. (AHRI, Public Meeting Transcript, No. 34.4 at pp. 60–61)

In response, DOE notes that the language in 42 U.S.C. 6295(e)(4) specifically states that amended standards, if any, shall apply to products manufactured on or after the 36-month period beginning on the date such a final rule is published for the first iteration of rulemaking and on or after the 60-month period beginning on the date such a final rule is published for the second iteration of rulemaking. (42 U.S.C. 6295(e)(4)(A)–(B)) The language of 42 U.S.C. 6295(e)(4)(B) anticipates that a standard will be in place for covered water heaters that are manufactured precisely five years after publication of the final rule and prospectively thereafter. DOE believes that the time differential, as specified in EPCA, between the publication of the final rule and the compliance deadline reflects Congress's judgment as to what constitutes adequate lead time.

9. Product Energy Efficiency in the Base Case

To accurately estimate the percentage of consumers who would be affected by a particular standard level, DOE's analysis considered the projected distribution of product efficiencies that consumers purchase under the base case (*i.e.,* the case without new energy efficiency standards). DOE refers to this distribution as a base-case efficiency distribution. Using the projected distribution of product efficiencies for each heating product, DOE randomly assigned a specific product efficiency to each sample household. If a household was assigned a product efficiency greater than or equal to the efficiency of the standard level under consideration, the LCC calculation shows that this household is not affected by that standard level. Each of the three types of heating products is addressed below, including relevant public comments and DOE's response. For further information on DOE's estimation of base-case market shares, see chapter 8 of the NOPR TSD.

a. Water Heaters

In its preliminary analysis, DOE estimated the base-case market shares of various energy efficiency levels for water heaters in the effective year. DOE began with data on shipments for 2002–2006 from AHRI, supplemented with data on the number of water heater models at different energy efficiency levels reported in AHRI directories and the Federal Trade Commission directory. (See chapter 8 of the NOPR TSD for citations for these data sources.) For gas-fired and electric storage water heaters, DOE then estimated the future market impact of the ENERGY STAR program. Effective in 2010, the minimum efficiency for the ENERGY STAR designation will be 0.67 EF for non-condensing gas-fired storage water heaters, 0.80 EF for condensing gas-fired storage water heaters, and 2.0 EF for heat pump water heaters. To estimate the base-case market shares of these products, DOE considered the market penetration goals set by the ENERGY STAR program.

For gas-fired instantaneous water heaters, DOE estimated that the base-case market shares in 2015 would be equivalent to current shares. In the case of this product, the majority of the market (approximately 85 percent of shipments) is already at the ENERGY STAR level, so there is limited room for the shares of ENERGY STAR products to increase in the near future. For oil-fired storage water heaters, DOE also estimated that the market shares in 2015 would be equivalent to current shares, as there has been little change in the past decade.

Southern and EEI stated that the 5-percent market share DOE projected for heat pump water heaters under the base case seems too high. (Southern, Public Meeting Transcript, No. 34.4 at p. 186; EEI, No. 40 at p. 5) GE stated that based on the expansion of the market for front-loading clothes washers, which was a new higher-efficiency product in the U.S. market with higher first cost but much lower operating costs, the predicted 5-percent market share for heat pump water heaters is not unreasonable. (GE, Public Meeting Transcript, No. 34.4 at pp. 188–189) In response, DOE notes that, consistent with manufacturer predictions, heat pump water heaters entered the mass market in 2009. Given the high level of interest in promoting ENERGY STAR-qualified appliances, DOE believes that its projection was reasonable, and it used the same market share for the NOPR analysis.

For oil-fired storage water heaters, Bock stated that the market shares for Efficiency Level 5 and 6 are much higher than indicated in the preliminary TSD. (Bock, No. 34.4 at pp. 187–188) For the NOPR, DOE updated its base-case efficiency distribution to reflect data from the March 2009 AHRI directory of certified products, which resulted in a higher market share at levels 5 and 6.

DOE's projected base-case energy efficiency market shares are shown in Table IV.28. These market shares represent the products that households would purchase in 2015 in the absence of revised energy conservation standards.

TABLE IV.28—WATER HEATERS: BASE-CASE ENERGY EFFICIENCY MARKET SHARES

Gas storage		Electric storage		Oil storage		Gas-fired instantaneous	
EF	Market share (%)	EF	Market share (%)	EF	Market share (%)	EF	Market share (%)
0.59	87.2	0.90	36.2	0.53	22.2	0.62	0.3
0.62	3.0	0.91	25.6	0.54	0.0	0.69	1.8
0.63	0.9	0.92	8.7	0.56	0.0	0.78	1.0
0.64	1.2	0.93	19.5	0.58	0.0	0.80	12.2
0.65	1.4	0.94	2.5	0.60	11.1	0.82	62.9
0.67	5.3	0.95	2.5	0.62	16.7	0.84	2.8
0.80	1.0	2.0	4.0	0.66	40.0	0.85	3.8
		2.2	1.0	0.68	10.0	0.92	9.5

TABLE IV.28—WATER HEATERS: BASE-CASE ENERGY EFFICIENCY MARKET SHARES—Continued

Gas storage		Electric storage		Oil storage		Gas-fired instantaneous	
EF	Market share (%)	EF	Market share (%)	EF	Market share (%)	EF	Market share (%)
						0.95	5.7
	100		100		100		100

b. DHE

Little is known about the efficiency distribution of direct heating equipment that consumers in the United States currently purchase. For the preliminary analysis, DOE estimated the market shares of different energy efficiency levels within each product class in the base case using data in the March 2007 GAMA directory. DOE did not receive any comments on its estimation of base-case market shares for DHE. It employed the same approach for its NOPR analysis, but used more recent GAMA data on the number of models at different energy efficiency levels. See Gas Appliance Manufacturers Association, *Consumer's Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment* (March 2008); *http://www.gamanet.org/gama/inforesources.nsf/vAllDocs/Product+Directories?OpenDocument.*

c. Pool Heaters

No shipments data are available on the distribution of gas-fired pool heaters by energy efficiency level. For the preliminary TSD, DOE estimated the market shares of different energy efficiency levels in the base-case by using data from the FTC on the number of gas-fired pool heater models at different energy efficiency levels as a proxy for shipments. DOE did not receive any comments on its estimation of base-case market shares for pool heaters. It employed the same approach for the NOPR analysis, but used more recent FTC data on the numbers of models at various energy efficiency levels.

10. Inputs to Payback Period Analysis

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

The inputs to the PBP calculation are the total installed cost of the equipment to the customer for each efficiency level and the annual (first-year) operating expenditures for each efficiency level. The PBP calculation uses the same inputs as the LCC analysis, except that energy price trends and discount rates are not needed.

NEEA and NPCC stated that that they are concerned about how the payback period was calculated for efficiency level 3 for gas-fired instantaneous water heaters (0.80 EF) because of the lengthy payback period. (NEEA & NPCC, No. 42 at p. 2) In response, DOE notes that almost the entire market is at CSL 3 or higher. Therefore, the PBP that DOE calculated applies only to the very few households that would be affected by a standard at this level. There is a significant cost differential in going from CSL 1 and 2 to CSL 3, which leads to very high PBPs for the affected households.

11. Rebuttable-Presumption Payback Period

The PBP analysis helps to determine whether the 3-year rebuttable presumption of economic justification applies—that is, whether the purchaser will recover the higher installed cost of more-efficient equipment through lowered operating costs within 3 years. (42 U.S.C. 6295(o)(2)(B)(iii)) For each efficiency level it considered, DOE determined the value of the first year's energy savings by calculating the quantity of those savings in accordance with DOE's test procedure, and multiplying that amount by the average energy price forecast for the year in which a new standard is expected to take effect. Section V.B.1.c of this notice and chapter 8 of the NOPR TSD present the rebuttable presumption PBP results.

Earthjustice stated the DOE must justify any refusal to adopt standard levels at least as strong as those that satisfy the rebuttable presumption payback period. (Earthjustice, No. 47 at p. 3) The LCC and PBP analyses generate values that calculate the payback period for consumers of potential energy conservation standards; these include, but are not limited to, the 3-year payback period contemplated under the rebuttable presumption test discussed above. However, DOE routinely conducts an 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) and 42 U.S.C. 6316(e)(1)). 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.

F. National Impact Analysis—National Energy Savings and Net Present Value Analysis

The national impact analysis assesses the national energy savings and the net present national impact analysis assesses the national energy savings and the net present value of total product costs and savings expected to result from standards at specific efficiency levels. DOE used the NIA spreadsheet to calculate energy savings and NPV, using the annual energy consumption and total installed cost data from the LCC analysis. DOE forecasted the energy savings, energy cost savings, product costs, and NPV for each product class from 2013 (or 2015) through 2043 (or 2045). The forecasts provided annual and cumulative values for the above output parameters. In addition, DOE used its NIA spreadsheet to analyze scenarios that used inputs from the *AEO2009* Low Economic Growth and High Economic Growth cases. These cases have higher and lower energy price trends compared to the Reference case, as well as higher and lower housing starts, which result in higher and lower appliance shipments to new homes.

Earthjustice stated that DOE needs to consider the impact of increased employment and reduced emissions in its national impact analysis. (Earthjustice, No. 47 at p. 1) NRDC stated that DOE failed to include the benefits of avoided carbon emissions in the NIA. (NRDC, No. 48 at p. 5) In response, DOE accounts for the impacts on employment in the employment impact analysis (section IV.I), and it quantifies avoided carbon emissions in the environmental assessment (section IV.K).The NIA primarily considers the national energy savings and the NPV from a national perspective of total appliance consumer costs and savings expected to result from standards, and it also evaluates the benefits to the economy of reduced energy prices due to standards. Even though employment and reduced emissions are separately addressed outside the NIA, DOE thoroughly considers these issues when conducting its analyses in the context of standard setting.

Table IV.29 summarizes the approach and data DOE used to derive the inputs to the NES and NPV analyses for the preliminary analysis and the changes to the analyses for the proposed rule. A discussion of these inputs and changes follows. See chapter 10 of the NOPR TSD for further details.

TABLE IV.29—APPROACH AND DATA USED FOR NATIONAL ENERGY SAVINGS AND CONSUMER NET PRESENT VALUE ANALYSES

Inputs	Preliminary TSD	Changes for the proposed rule
Shipments	Annual shipments from shipments model	See IV.F.1.a through IV.F.1.d.
Compliance Date of Standard	Water Heaters: 2015. DHE and Pool Heaters: 2013.	No change.
Base-Case Forecasted Efficiencies	Efficiency market shares estimated for compliance year. SWEF * remains constant except for gas and electric water heaters, for which SWEF increases slightly over forecast period.	No change in approach; updated efficiency market shares estimated for compliance year.
Standards-Case Forecasted Efficiencies	“Roll-up” scenario used for determining SWEF in 2013 (or 2015) for each standards case. SWEF remains constant except for gas and electric water heaters, for which SWEF increases slightly over forecast period.	No change in approach; updated efficiency market shares estimated for compliance year.
Annual Energy Consumption per Unit	Annual weighted-average values as a function of SWEF.	No change.
Rebound Effect	Water heaters: 10%. DHE: 15%. Pool Heaters: 10%.	No change.
Total Installed Cost per Unit	Annual weighted-average values as a function of SWEF.	No change.
Energy Cost per Unit	Annual weighted-average values as a function of the annual energy consumption per unit and energy (and water) prices.	No change.
Repair Cost and Maintenance Cost per Unit.	Annual values are a function of efficiency level	No change.
Escalation of Energy Prices	*AEO2008* forecasts (to 2030) and extrapolation to 2043 (and 2045).	Updated using *AEO2009* forecasts.
Energy Site-to-Source Conversion Factor	Varies yearly and is generated by DOE/EIA's NEMS.	No change.
Discount Rate	Three and seven percent real	No change.
Present Year	Future expenses are discounted to 2007	Future expenses are discounted to 2010, when the final rule will be published.

* Shipments-Weighted Energy Factor.

1. Shipments

The shipments portion of the NIA spreadsheet is a model that uses historical data as a basis for projecting future shipments of the appliance products that are the subject of this rulemaking. In projecting shipments for water heaters and pool heaters, DOE accounted for two market segments: (1) New construction and (2) replacement of failed equipment. Data were unavailable to develop separate forecasts of direct heating equipment shipments for replacement and new home installations, so the forecast was based on the time series of historical total shipments developed for each product class.

Table IV.30 summarizes the approach and data DOE used to derive the inputs to the shipments analysis for the preliminary analysis, and the changes DOE made for today's proposed rule. A discussion of these inputs and changes follows. For details on the shipments analysis, see chapter 9 of the NOPR TSD.

TABLE IV.30—APPROACH AND DATA USED FOR THE SHIPMENTS ANALYSIS

Inputs	Preliminary analysis	Changes for the proposed rule
Historical Shipments	Water Heaters: Data provided by AHRI	Water Heaters: Used updated data from AHRI.
	DHE: Data provided by AHRI and DOE estimates	DHE: Used data from manufacturers and HPBA * for hearth products.
	Pool Heaters: Data from 1993 TSD and DOE estimates.	Pool Heaters: Used inputs from manufacturers.
New Construction Shipments	For water heaters and pool heaters, determined by multiplying housing forecasts by forecasted saturation of products in new housing.	No change in approach. New housing forecast updated with *AEO2009* projections.

TABLE IV.30—APPROACH AND DATA USED FOR THE SHIPMENTS ANALYSIS—Continued

Inputs	Preliminary analysis	Changes for the proposed rule
	Housing forecasts based on *AEO2008* projections. New housing product saturations based on AHS for water heaters, consultant data for pool heaters.	
Replacements	For water heaters and pool heaters, determined by tracking total product stock by vintage and establishing the failure of the stock using retirement functions from the LCC and PBP analysis.	No change for water heaters. For pool heaters, included estimated non-replacement of some pool heaters.
First-Time Owners	Included for pool heaters	No change.

* Hearth, Patio & Barbecue Association.

To determine new construction shipments, DOE used forecasts of housing starts coupled with estimates of product market saturation in new housing. For the preliminary analysis, DOE used actual data for 2007 for new housing completions and mobile home placements and adopted the projections from *AEO2008* for 2008 to 2030. DOE updated its new housing projections for today's proposed rule using *AEO2009.* DOE estimated replacements using historical shipments data and product retirement functions that it developed from product lifetimes.

AHRI stated that shipments for all of the products dropped considerably in 2008, and this drop will change the forecast since today's new house installation is tomorrow's replacement installation. (AHRI, No. 33 at p. 2) In response, DOE's NOPR analysis used actual shipments data for 2008, so any such changes are captured in DOE's analysis.

a. Water Heaters

For the preliminary analysis, DOE used information on choice of water heater products in recently-built housing to estimate shipments to the new construction market. DOE assumed the market shares of water heaters using a particular fuel follow the average pattern in new homes for 2000 to 2006 throughout the forecast period. The shipments model assumes that when a unit using a particular fuel is retired, it generally is replaced with a unit that uses the same fuel. Section IV.F.1.d discusses the potential effects of energy conservation standards on choice of water heater product in the new construction and replacement markets.

For its shipments forecast for gas-fired storage water heaters and electric storage water heaters, DOE assumed that the current market shares of small-volume and large-volume products would remain the same throughout the forecast period.

Within the category of gas-fired water heaters, DOE disaggregated the shares of gas storage water heaters and gas-fired instantaneous water heaters based on projections of total shipments of gas-fired instantaneous water heaters. Because there is much uncertainty about the future growth of gas-fired instantaneous water heaters, DOE modeled three scenarios for their market penetration. The scenarios are based on experience with gas-fired instantaneous water heaters in Australia, where the proportion of instantaneous water heaters in total gas-fired storage water heater shipments has grown considerably in the past decade. (See Syneca Consulting, Cost-Benefit Analysis: Proposal to Introduce a Minimum Energy Performance Standard for Gas Water Heaters, 2007, Australian Greenhouse Office: Equipment Energy Efficiency Gas Committee.) Residential water heating services and technology in Australia are roughly comparable to those in the United States. Storage water heaters have somewhat lower volume capacities in Australia, but end-use hot water demand also may be lower. Prices of gas-fired instantaneous water heaters in Australia are roughly comparable to prices of gas-fired storage water heaters (excluding installation costs). In the United States, gas-fired instantaneous water heaters currently cost about twice as much as typical 40-gallon gas storage water heaters. Although the price differential in the United States likely will decrease, the specifics of the United States market probably will not duplicate the market in Australia. Nonetheless, DOE believes that the market evolution in Australia provides the most similar model for scenarios for the United States.

AHRI stated that the Australian water heater market has significant differences from the U.S. market because in Australia: (1) Gas water heaters are not the prevalent residential option; (2) many gas water heaters are installed outside; and (3) prices of gas storage water heaters and gas-fired instantaneous water heaters are practically equal. (AHRI, No. 43 at p. 2) Rheem stated that in Australia, most water heaters are installed outdoors, which makes a difference in terms of the venting and total installation cost. (Rheem, Public Meeting Transcript, No. 34.4 at p. 241) A.O. Smith commented that the scenario for low market penetration of gas-fired instantaneous water heaters may be reasonable, but the other two scenarios over-predict the market penetration. (A.O. Smith, No. 37 at p. 7) Noritz stated that Australia is the only market it has identified that could provide any insight into the adoption of gas-fired instantaneous water heaters in the United States. (Noritz, No. 36 at p. 3)

In response, DOE acknowledges the uncertainty associated with basing forecasted market penetration of gas-fired instantaneous water heaters on the Australian experience, but it agrees with Noritz (the largest manufacturer of these products) that there is no other market that could provide a model for forecasting U.S. market penetration. In making use of the Australian experience, DOE took into account some of the differences between the two markets that would tend to cause shipments growth to be lower in the U.S. For further details on the shipments forecast for gas-fired instantaneous water heaters, see chapter 9 of the NOPR TSD.

b. Direct Heating Equipment

To estimate historical shipments of direct heating equipment for the preliminary analysis, DOE used two sets of data from AHRI and information from the 1993 TSD. Data were unavailable to develop separate forecasts of direct heating equipment shipments for replacement and new home installations, so DOE based the forecast on the time series of historical total shipments developed for each product class. To forecast shipments of gas room DHE, shipments of room heaters were held constant at the average level from

2002 to 2005, and gas fireplace shipments (referred to as hearth products DHE in this NOPR) assigned to gas room DHE were held constant at the average from 2002 to 2004. Forecasted floor furnaces shipments follow the downward trend from 2000 to 2007. Total combined shipments of gas wall gravity and gas wall fan DHE were held constant at the average volume from 2002 to 2006. The upward trend seen from 2002 to 2006 was extrapolated into the future for gas wall fan DHE. DOE derived future shipments of gas wall gravity DHE based on the combined shipments of gas wall gravity and gas wall fan DHE and the forecast shipments for the latter. Shipments of gas fireplaces assigned to gas wall fan DHE were kept constant at the average from 2002 to 2004.

Commenting on DOE's forecast, HPBA stated that gas fireplace shipments will likely decrease as opposed to staying level. (HPBA, Public Meeting Transcript, No. 34.4 at p. 258) Apart from a decrease due to the 2008–2009 economic recession, DOE is not aware of reasons why gas fireplace (hearth products) shipments would be expected to decrease, given that the number of U.S. households will continue to increase. However, based on its review of market information, DOE modified its forecast of gas hearth products shipments. The forecast used for the NOPR accounts for the sharp decline in shipments in 2007–2008, but assumes that shipments in the future will approximately follow the trend seen in 1998–2007.

In addition, DOE modified its forecast of gas wall gravity and gas wall fan DHE to better reflect current information. Instead of having different trends for each of these product classes, as in the preliminary analysis, DOE assumed that shipments of each class would stay constant at the 2008 level during the forecast period.

c. Pool Heaters

To forecast pool heater shipments for new construction for the preliminary analysis, DOE multiplied the annual housing starts forecasted for single-family and multi-family housing by the estimated saturation of gas-fired pool heaters in recently built new housing. For replacement pool heaters, DOE used a survival function based on its distribution of product lifetimes to determine when a unit fails. DOE also introduced a market segment representing purchases by existing households that had not owned a pool heater. These first-time owners include existing households that have a pool and those that install one.

In the preliminary analysis, DOE's projected that pool heater shipments would grow significantly from 0.28 million in 2006 to over 0.7 million by 2040. Raypak stated that the slope of the shipments forecast for pool heaters should be consistent with the past 10 years of data, which show that the slope is either constant or decreasing due to economic reasons. It also stated that pool heater new construction shipments are declining because of lot size issues and other restrictions. (Raypak, No. 34.4 at p. 247) EEI stated that projected pool heater shipments are overstated and that DOE should obtain more recent numbers to develop more realistic projections for shipments. (EEI, No. 40 at pp. 5–6) In response, DOE revised the NOPR analysis to account for those households that are not likely to replace their pool heater when it fails due to cost. As a result, the shipments projection shows only modest growth over the analysis period.

d. Impacts of Standards on Shipments

In some of its energy conservation standard rulemakings, DOE has used elasticities to estimate the response of appliance demand (shipments) to changes in the installed cost and operating costs associated with more-efficient appliances. Typically, higher installed costs of more-efficient appliances are projected to cause some consumers to forego purchase of a new product.

In the case of water heaters, however, DOE believes that this approach would not be appropriate because the consumer (or home builder) decision is usually not whether to purchase the product or not, but rather what type of water heater to buy. A water heater is generally not a discretionary purchase. However, to the extent that energy conservation standards result in an increase in the price of a specific type of water heater compared to a competing product, some consumers (or home builders in the case of shipments for new construction) may purchase the competing product. The consumer or builder decision is not solely based on economic factors, as the availability of natural gas plays a key role. Evaluation of this decision requires an assessment of the specific factors that influence it in the context of the two main markets for water heaters, replacements and new homes.

In the preliminary analysis, DOE determined that the greatest potential for product switching would exist in the case of a standard that effectively required an electric heat pump water heater. This type of product often has a substantially higher installed cost than a typical electric resistance storage water heater and is relatively new to consumers and builders. Because the product choice decision partially depends on the relative costs of competing products, DOE considered the following potential combinations of electric and gas-fired storage water heaters that could result from standards: (1) Electric heat pump water heater and a gas-fired storage water heater using natural draft; (2) electric heat pump water heater and a gas-fired storage water heater using a power vent; and (3) electric heat pump water heater and a gas-fired storage water heater using condensing technology. DOE used data from the 2001 RECS to estimate the percentage of households expected to purchase an electric water heater in the base case that could switch to a gas-fired water heater because they had the necessary infrastructure. To estimate how many households that could switch to gas-fired water heaters would do so, DOE considered the difference in installed cost between the gas-fired storage water heater and an electric heat pump water heater in each of the combinations listed above.

DOE did not quantify the potential for switching to gas water heating in the case of a standard that requires 0.95 EF for electric water heaters, as the installed cost is only moderately higher than the baseline electric water heater (0.90 EF), and DOE judged that this would not be sufficient to prompt consumers to consider switching to gas water heating.

ACEEE stated that because builders make the choices that lock in subsequent energy source decisions at the time of construction, converting to a different energy source for water heating is too costly. However, it added that a few consumers in existing houses would choose gas conversion over installing a heat pump water heater. (ACEEE, No. 35 at pp. 6–7) NEEA and NPCC commented that most water heater replacements are on an emergency basis and that there is no convincing argument to include fuel switching in the analysis. (NEEA and NPCC, No. 42 at p. 9)

DOE agrees with the comment from ACEEE but it also notes that not all water heater replacements are on an emergency basis. DOE believes that the cost differential estimated in its analysis suggests that a small fraction of consumers would be likely to switch. For the NOPR, DOE used a similar approach as for the preliminary analysis using data from the 2005 RECS.

Southern stated that many consumers would switch to a gas-fired storage water heater instead of installing a heat pump water heater even if the installed cost is more, especially if the heat pump water heater would need to be installed in an enclosed interior location. (Southern, No. 50 at p. 4) DOE's approach took detailed account of those situations in which consumers with a failed electric storage water heater would find it less expensive to switch to a gas-fired storage water heater instead of installing a heat pump water heater. In determining which households would switch to a gas-fired storage water heater, the analysis considered the installed costs that consumers might incur if they replaced an electric storage water heater located indoors with a heat pump water heater. (Refer to the discussion of installation costs for heat pump water heaters in section IV.E.2.a.) Given that an interior location may not easily allow the venting required with installing a gas-fired storage water heater, DOE does not believe consumers would switch to a gas-fired storage water heater instead of installing a heat pump water heater if the installed cost of the gas-fired product is higher.

In the NOPR analysis, the fraction of households using an electric storage water heater estimated to switch to a gas-fired storage water heater instead of installing a heat pump water heater ranges from zero with a standard level for gas-fired storage water heaters that requires condensing technology, to 9 percent with a standard level for gas-fired storage water heaters that requires power vent technology.

In the preliminary analysis, DOE concluded that builders who planned to install an electric storage water heater would not switch to gas-fired storage water heaters in the event of a standard that effectively requires heat pump technology. A.O. Smith stated that builders would be unlikely to switch from a heat pump water heater to a gas-fired storage water heater due to the cost of adding gas to the house, and if gas were already supplied to the house, a heat pump water heater would not have been installed. (A.O. Smith, No. 37 at p. 8) DOE agrees that availability of natural gas is the key determining factor for builders. Accordingly, DOE's analysis for the NOPR shows negligible switching in new homes.

EEI stated that there may be a switch from electric storage to electric instantaneous water heaters if DOE adopts a standard level that would require use of heat pump technology for electric storage water heaters. (EEI, No. 40 at p. 5) DOE acknowledges that some households facing extreme structural modifications to accommodate a heat pump water heater may purchase an electric instantaneous water heater instead. However, because such switching requires expensive electrical modification to the home's electrical circuits to accommodate the higher electrical demand of instantaneous water heaters, DOE believes it is an unlikely choice for most households with electric water heating.

With respect to the new construction market, in the preliminary analysis, DOE concluded that builders who planned to install an electric storage water heater would not switch to gas-fired storage water heaters in the event of a standard that effectively requires heat pump technology. A.O. Smith commented that builders would be unlikely to switch from a heat pump water heater to a gas-fired storage water heater due to the cost of adding gas to the house, and if gas had been already supplied to the house, a heat pump water heater would not have been installed. (A.O. Smith, No. 37 at p. 8) DOE agrees that availability of natural gas is the key factor determining water heater choice for home builders. Accordingly, DOE's analysis for the NOPR shows negligible switching in new homes.

Regarding potential switching from gas-fired water heaters to electric water heaters, DOE determined that the cost of replacing an existing gas-fired storage water heater with an electric one is substantial due to the complexity of the installation. Because it takes longer for an electric storage water heater to recover heated capacity, a larger electric tank may be necessary to replace a gas unit. In new construction, if natural gas is available, builders generally will install a gas-fired water heater. Given the above considerations, in both new construction and the replacement market, a large increase in the price of a gas storage water heater compared to an electric storage water heater likely would be necessary to motivate consumers to replace a gas water heater with an electric unit, or to motivate builders to install an electric water heater instead of a gas unit. Because DOE does not envision such a price differential resulting from this rulemaking, it concluded that amended standards would not induce switching from a gas storage water heater to an electric storage water heater.

In its preliminary analysis, DOE did not quantify the potential for switching away from oil-fired water heaters. Bock and EEI stated that DOE should consider fuel and equipment switching impacts of standards on oil-fired equipment. (Bock, No. 53 at p. 1; EEI, No. 40 at pp. 4–5) In response, DOE believes that the price of the oil-fired storage water heater is a minor factor in the fuel choice decision for households with such a water heater. In most cases, a household with an oil-fired storage water heater needing replacement would switch to a gas-fired water heater if gas is available because of the greater convenience and lower cost of gas water heating. Therefore, DOE believes that the moderately higher equipment price that might result from the proposed standard level (5 percent) would have a negligible impact on fuel switching for oil-fired storage water heaters, and DOE did not include such switching in its NOPR analysis.

In its preliminary analysis, DOE did not quantify the potential for switching away from gas-fired instantaneous water heaters due to lack of quantitative information about the factors that shape the purchase decision for this product. However, given that the vast majority of the market (85 percent) is already at the proposed standard level (0.82 EF), there is little reason to expect any switching to storage water heaters as a result of the proposed standard.

For DHE and pool heaters, DOE did not find any data it could use to estimate the extent of switching away from the gas-fired products subject to this rulemaking if energy conservation standards were to result in a significant increase in installed costs. DOE did not receive any comments on its approach for these products, and it maintained the same approach for the NOPR analysis.

In summary, DOE projects that no fuel switching would occur for gas-fired storage, oil-fired storage, and gas-fired instantaneous water heaters. For electric storage water heaters, DOE estimated that a standard that effectively requires heat pump water heaters would result in a decline in shipments ranging from zero to 9 percent, depending on the standard level for gas-fired storage water heaters.

DOE requests comments on its analysis of fuel switching that may result from the proposed standards on water heaters and the other heating products. In particular, DOE requests comments on (1) its general approach, which does not involve price elasticities; (2) its analysis of switching to gas-fired storage water heaters in the case of a standard that effectively requires an electric heat pump water heater; (3) its conclusion that the proposed standards would not induce switching from a gas storage water heater to an electric storage water heater; and (4) its conclusion that the proposed standards would not induce switching for gas-fired instantaneous water heaters, DHE, and pool heaters.

This is identified as issue 15 under ''Issues on Which DOE Seeks Comment'' in section VII.E of this NOPR.

2. Other Inputs

The following is a discussion of the other inputs to the NIA and any revisions DOE made to those inputs for today's proposed rule.

a. Base-Case Forecasted Efficiencies

A key input to DOE's estimates of NES and NPV is the energy efficiencies that DOE forecasts over time for the base case (without new standards) and each of the standards cases. The forecasted efficiencies represent the annual shipment-weighted energy efficiency of the products under consideration over the forecast period.

For the preliminary analysis, DOE used the SWEFs for 2013 or 2015 as a starting point to forecast the base-case energy efficiency distribution for each product class. To represent the distribution of product energy efficiencies in those years, DOE used the same market shares as in the base case for the LCC analysis. For gas storage water heaters and electric storage water heaters, DOE estimated the distribution of product energy efficiencies in 2015 by accounting for the estimated market impact of the newly established ENERGY STAR efficiency levels for water heaters (see section IV.9.a). The projected trend to 2015 represents an average annual increase in energy efficiency of 0.27 percent for gas-fired storage water heaters and 0.55 percent for electric storage water heaters. DOE applied the above values to estimate the increase in average energy efficiency until the end of the forecast period.

DOE found no quantifiable indications of change in energy efficiencies over time for oil-fired and gas-fired instantaneous water heaters, direct heating equipment, or pool heaters, and it did not receive any comments on this topic. Therefore, for these products, DOE estimated that energy efficiencies remain constant at the 2015 or 2013 level until the end of the forecast period.

For today's proposed rule, DOE maintained the approach described above.

b. Standards-Case Forecasted Efficiencies

For its determination of standards-case forecasted efficiencies, DOE used a ''roll-up'' scenario in the preliminary analysis and the NOPR to establish the SWEF for the year that standards would become effective and subsequent years. In this approach, product energy efficiencies in the base case that do not meet the standards level under consideration would roll up to meet the new standard level. The market share of energy efficiencies that exceed the standard level under consideration would be the same in the standards case as in the base case. Changes over the forecast period match those in the base case. For today's proposed rule, DOE maintained this approach.

c. Annual Energy Consumption

The inputs for determining NES are annual energy consumption per unit, shipments, equipment stock, national annual energy consumption, and site-to-source conversion factors. Because the annual energy consumption per unit depends directly on efficiency, DOE used the SWEFs associated with the base case and each standards case, in combination with the annual energy use data, to estimate the shipment-weighted average annual per-unit energy consumption under the base case and standards cases. The national energy consumption is the product of the annual energy consumption per unit and the number of units of each vintage. This calculation accounts for differences in unit energy consumption from year to year. For today's proposed rule, DOE maintained this approach.

d. Site-to-Source Energy Conversion

To estimate the national energy savings expected from appliance standards, DOE uses a multiplicative factor to convert site energy consumption (at the home or commercial building) into primary or source energy consumption (the energy required to deliver the site energy). These conversion factors account for the energy used at power plants to generate electricity and losses in transmission and distribution, as well as for natural gas losses from pipeline leakage and energy used for pumping. For electricity, the conversion factors vary over time due to projected changes in generation sources (*i.e.,* the power plant types projected to provide electricity to the country). The factors that DOE developed are marginal values, which represent the response of the system to an incremental decrease in consumption associated with appliance standards.

In the preliminary analysis, DOE used annual site-to-source conversion factors based on the version of NEMS that corresponds to *AEO2008.* For today's NOPR, DOE updated its conversion factors based on *AEO2009.* The *AEO* does not provide energy forecasts beyond 2030; DOE used conversion factors that remain constant at the 2030 values throughout the remainder of the forecast period.

In response to a request from the DOE's Office of Energy Efficiency and Renewable Energy (EERE), the National Research Council (NRC) appointed a committee on ''Point-of-Use and Full-Fuel-Cycle Measurement Approaches to Energy Efficiency Standards'' to conduct a study called for in section 1802 of EPACT 2005. The fundamental task before the committee was to evaluate the methodology used for setting energy efficiency standards and to comment on whether site (point-of-use) or source (full-fuel-cycle) measures of energy efficiency better support rulemaking to achieve energy conservation goals. The NRC committee defined site (point-of-use) energy consumption as reflecting the use of electricity, natural gas, propane, and/or fuel oil by an appliance at the site where the appliance is operated. Full-fuel-cycle energy consumption was defined as including, in addition to site energy use, the following: Energy consumed in the extraction, processing, and transport of primary fuels such as coal, oil, and natural gas; energy losses in thermal combustion in power generation plants; and energy losses in transmission and distribution to homes and commercial buildings. (See The National Academies, Board on Energy and Environmental Systems, Letter to Dr. John Mizroch, Acting Assistant Secretary, U.S. DOE, Office of EERE from James W. Dally, Chair, Committee on Point-of-Use and Full-Fuel-Cycle Measurement Approaches to Energy Efficiency Standards, May 15, 2009.)

In evaluating the merits of using point-of-use and full-fuel-cycle measures, the NRC committee noted that DOE uses what the committee referred to as ''extended site'' energy consumption to assess the impact of energy use on the economy, energy security, and environmental quality. The extended site measure of energy consumption includes the generation, transmission, and distribution but, unlike the full-fuel-cycle measure, does not include the energy consumed in extracting, processing, and transporting primary fuels. A majority of members on the NRC committee concluded that extended site energy consumption understates the total energy consumed to make an appliance operational at the site. As a result, the NRC committee's primary general recommendation is for DOE to consider moving over time to use of a full-fuel-cycle measure of energy consumption for assessment of national and environmental impacts, especially levels of greenhouse gas emissions, and to providing more comprehensive information to the public through labels and other means, such as an enhanced Web site. For those appliances that use multiple fuels (*e.g.,* water heaters), the NRC committee believes that measuring full-fuel-cycle energy consumption would provide a more complete picture of energy used, thereby allowing comparison across many different appliances as well as an improved assessment of impacts. The NRC committee also acknowledged the complexities inherent in developing a full-fuel-cycle measure of energy use and stated that a majority of the committee recommended a gradual transition to that expanded measure and eventual replacement of the currently used extended site measure.

DOE acknowledges that its site-to-source conversion factors do not capture all of the energy consumed in extracting, processing, and transporting primary fuels. DOE also agrees with the NRC committee's conclusion that developing site-to-source conversion factors that capture the energy associated with the extraction, processing, and transportation of primary fuels is inherently complex and difficult. However, DOE has performed some preliminary evaluation of a full-fuel-cycle measure of energy use.

Based on two studies completed by the National Renewable Energy Laboratory (NREL) in 1999 and 2000, DOE estimated the ratio of the energy used upstream to the energy content of the coal or natural gas delivered to power plants. For coal, the NREL analysis considered typical mining practices and mine-to-plant transportation distances, and used data for the State of Illinois. Based on data in this report, the estimated multiplicative factor for coal is 1.08 (*i.e.,* it takes approximately 1.08 units of coal energy equivalent to provide 1 unit of coal to a power plant). A similar analysis of the energy consumed in upstream processes needed to produce and deliver natural gas to a power plant yielded a multiplicative factor of 1.19. (For further information on the NREL studies, please see: Spath, Pamela L., Margaret K. Mann, and Dawn Kerr, Life Cycle Assessment of Coal-fired Power Production, NREL/TP–570–25119, June 1999; and Spath, Pamela L. and Margaret K. Mann, Life Cycle Assessment of a Natural Gas Combined-Cycle Power Generation System, NREL/TP–570–27715, September 2000.)

While the above factors are indicative of the magnitude of the impacts of using full-fuel-cycle measures of energy use, there are two aspects of the problem that warrant further study. The first is the refinement of the estimates of the multiplicative factors, particularly to incorporate regional variation. The second is development of forecasts of the multiplicative factors over the time frames used in the rulemaking analyses, typically ten to fifty years. The second issue, of forecasting how the efficiency factors for various fuels may change over time, has the potential to be quite significant. The existing NEMS forecast of power plant electricity generation by fuel type can be used to estimate the impact of a changing mix of fuels. However, currently NEMS provides no information on potential changes to the relative ease with which the different fuels can be extracted and processed. DOE intends to further evaluate the viability of using full-fuel-cycle measures of energy consumption for assessment of national and environmental impacts of appliance standards.

e. Total Installed Costs and Operating Costs

The total annual installed cost increase is equal to the annual difference in the per-unit total installed cost between the base case and standards cases multiplied by the shipments forecasted in the standards case.

The annual operating cost savings per unit reflect differences in energy, repair, and maintenance costs between the base case and the various standard levels DOE considered. DOE forecasted energy prices for the preliminary analysis are based on *AEO2008.* DOE updated the energy prices for today's proposed rule using forecasts from *AEO2009.*

f. Discount Rates

DOE multiplies monetary values in future years by the discount factor to determine the present value. For the preliminary analysis and today's NOPR, DOE estimated the NPV of appliance 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 (OMB Circular A–4 (Sept. 17, 2003), section E, ''Identifying and Measuring Benefits and Costs''). NRDC stated that a discount rate below 3 percent is warranted for societal benefits. (NRDC, No. 48 at p. 5) OMB Circular A–4 states that when regulation primarily and directly affects private consumption, a lower discount rate is appropriate. ''The alternative most often used is sometimes called the social rate of time preference * * * the rate at which 'society' discounts future consumption flows to their present value.'' (p. 33) It suggests that the real rate of return on long-term government debt may provide a fair approximation of the social rate of time preference, and states that over the last 30 years, this rate has averaged around 3 percent in real terms on a pre-tax basis. It concludes that ''for regulatory analysis, [agencies] should provide estimates of net benefits using both 3 percent and 7 percent.'' (p. 34) DOE finds that the guidance from OMB is reasonable, so it is continuing to use a 3-percent and a 7-percent discount rate for estimating net benefits.

3. Other Inputs

a. Effects of Standards on Energy Prices

In the preliminary analysis, DOE analyzed the potential impact on natural gas prices resulting from amended standards on water heaters and the associated benefits for all natural gas consumers in all sectors of the economy. (DOE did not include natural gas savings from amended standards on DHE and pool heaters in this analysis because they are not large enough to have a noticeable impact.) DOE used NEMS–BT to account for the natural gas savings associated with two scenarios of possible standards, including max-tech efficiency levels. Like other widely used energy-economic models, NEMS incorporates parameters to estimate the changes in energy prices that would result from an increase or decrease in energy demand. The response of price to a decrease in demand is termed the ''inverse price elasticity.'' The overall inverse price elasticity observed in NEMS changes over the forecast period based on the model's dynamics of natural gas supply and demand. DOE calculated the nominal savings in total natural gas expenditures in each year by multiplying the estimated annual change in the average end-user natural gas price by the annual total U.S. natural gas consumption associated with each scenario. DOE then calculated the NPV of the savings in natural gas expenditures for 2015 to 2045 using 3- and 7-percent discount rates for each scenario.

For the NOPR, DOE used the same approach to estimate the benefits of reduced natural gas prices as in the preliminary TSD. However, it analyzed the potential impact on natural gas prices, and the associated benefits for natural gas consumers, resulting from the proposed water heater standards (TSL 4), as well as the other TSLs considered.

NRDC stated that DOE must consider the benefit of reduced natural gas and electricity prices and include it in the NIA. (NRDC, No. 48 at p. 5) ACEEE stated that DOE must incorporate the impacts of gas and electricity consumption reductions resulting from the standards on energy prices in the primary economic analysis, rather than simply note side studies that DOE did not incorporate into the decision-making process. (ACEEE, No. 35 at p. 8)

DOE reports the results of its analysis of the benefits of reduced natural gas prices associated with standards in chapter 10 of the NOPR TSD, National Impacts Analysis. As discussed therein, when gas prices drop in response to a lower output of existing natural gas production capacity, consumers benefit but producers suffer. In economic terms, the situation represents a benefits transfer to consumers (whose expenditures fall) from producers (whose revenue falls equally). When prices decrease because extraction costs decline, however, consumers and producers both benefit, and the change in natural gas prices represents a net gain to society. Consumers benefit from the lower prices, and producers, whose revenues and costs both fall, are no worse off. Because there is uncertainty about the extent to which the calculated impacts from reduced natural gas prices are a benefits transfer, DOE tentatively concluded that it should not give a heavy weight to this factor in its consideration of the economic justification of standards on heating products.

DOE investigated the possibility of estimating the impact of specific standard levels on electricity prices in its rulemaking for general service fluorescent lamps and incandescent reflector lamps. (See U.S. Department of Energy—Office of Energy Efficiency and Renewable Energy: Energy Conservation Standards for General Service Fluorescent Lamps and Incandescent Reflector Lamps; Proposed Rule, 74 FR 16920, 16978–979 (April 13, 2009).) It found that whereas natural gas markets exhibit a fairly simple chain of agents from producers to consumers, the electric power industry is a complex mix of fuel suppliers, producers, and distributors. While the distribution of electricity is regulated everywhere, its institutional structure varies, and upstream components are more complicated, because the cost of generation differs across the country. For these and other reasons, accurate modeling of the response of electricity prices to a decrease in residential-sector demand due to standards is problematic. Thus, DOE does not plan to estimate the value of potentially reduced electricity costs for all consumers associated with revised standards for heating products.

G. Consumer Subgroup Analysis

In analyzing the potential impact of new or amended standards on individual and commercial consumers, DOE evaluates the impact on identifiable subgroups of consumers that may be disproportionately affected by a national standard level. DOE used RECS data to analyze the potential effect of energy conservation standards on the considered consumer subgroups for selected heating products, as explained below. For gas-fired and electric storage water heaters, and gas wall fan and gas wall gravity DHE, DOE estimated consumer subgroup impacts for low-income households and senior-only households. In addition, for gas-fired and electric storage water heaters, DOE estimated consumer subgroup impacts for households in multi-family housing and households in manufactured homes as well.

DOE did not evaluate consumer subgroup impacts for gas-fired instantaneous water heaters and oil-fired storage water heaters. Gas-fired instantaneous water heaters were excluded from the consumer subgroup analysis due to insufficient data, and oil-fired storage water heaters were excluded due to low product shipments. For direct heating equipment, gas floor DHE and gas room DHE were excluded due to the low and decreasing levels of product shipments. For gas hearth DHE, DOE examined the senior-only subgroup, but did not evaluate the low-income subgroup because the saturation of this product is very small among low-income households due to the high product cost. DOE did not evaluate consumer subgroup impacts for pool heaters because the sample size of the subgroups is too small for meaningful analysis. More details on the consumer subgroup analysis and results can be found in chapter 11 of the NOPR TSD.

H. Manufacturer Impact Analysis

1. Overview

In determining whether an amended energy conservation standard for the three types of heating products subject to this rulemaking is economically justified, the Secretary is required to consider ‘‘the economic impact of the standard on the manufacturers and on the consumers of the products subject to such standard.’’ (42 U.S.C. 6295(o)(2)(B)(i)(I)) The statute also calls for an assessment of the impact of any lessening of competition as determined by the Attorney General that is likely to result from the adoption of a standard. (42 U.S.C. 6295(o)(2)(B)(i)(V)) DOE conducted the MIA to estimate the financial impact of amended energy conservation standards on manufacturers of residential water heaters, DHE, and pool heaters, and to assess the impacts of such standards on employment and manufacturing capacity.

The MIA has both quantitative and qualitative aspects. The quantitative part of the MIA relies on the Government Regulatory Impact Model (GRIM), an industry cash-flow model customized for the three heating products covered in this rulemaking. The GRIM inputs characterize each industry’s cost structure, shipments, and revenues. This includes information from many of the analyses described above, such as MPCs and MSPs from the engineering analysis and shipment forecasts from the NIA. The key GRIM output is the Industry Net Present Value (INPV), which estimates the value of each industry on the basis of cash flows, expenditures, and investment requirements as a function of TSLs. Different sets of assumptions (scenarios) will produce different results. The qualitative part of the MIA addresses factors such as product characteristics, characteristics of particular firms, and market trends. The qualitative discussion also includes an assessment of the impacts of standards on manufacturer subgroups. The complete MIA is discussed in chapter 12 of the NOPR TSD.

DOE conducted the MIA for the three types of heating products in three phases. Phase 1 (Industry Profile) characterized each industry using data on market shares, sales volumes and trends, pricing, employment, and financial structure. Phase 2 (Industry Cash Flow) focused on each industry as a whole. In this phase, DOE used each GRIM to prepare an industry cash-flow analysis. Using publicly-available information developed in Phase 1, DOE adapted each GRIM’s generic structure to perform an analysis of the impacts on residential water heater, directing heating equipment, and pool heater manufacturers due to amended energy conservation standards. In Phase 3 (Subgroup Impact Analysis), DOE conducted interviews with a representative cross-section of manufacturers that produce the majority of residential water heater, DHE, and pool heater sales. During these interviews, DOE discussed engineering, manufacturing, procurement, and financial topics specific to each company, and obtained each manufacturer’s view of the industry as a whole. The interviews also provided valuable information that DOE used to evaluate the impacts of amended energy conservation standard on manufacturer cash flows, manufacturing capacity, and employment levels. Each of these phases is discussed in further detail below.

a. Phase 1: Industry Profile

In Phase 1 of the MIA, DOE prepared a profile of each of the three heating product industries based on the market and technology assessment prepared for this rulemaking. Before initiating the detailed impact studies, DOE collected information on the present and past structure and market characteristics of each industry. This information included market share data, product shipments, manufacturer markups, and the cost structure for various manufacturers. The industry profile includes: (1) Further detail on the overall market and product characteristics; (2) estimated manufacturer market shares; (3) financial parameters such as net plant, property, and equipment, SG&A expenses, cost of goods sold, *etc.;* and (4) trends in the number of firms, market, and product characteristics for the three heating product industries.

The industry profile included a top-down cost analysis of residential water heater, DHE, and pool heater manufacturers that DOE used to derive preliminary financial inputs for the GRIMs (*e.g.,* revenues, depreciation, SG&A, and research and development (R&D) expenses). DOE also used public sources of information to further calibrate its initial characterization of each industry, including Security and Exchange Commission 10–K filings (available at *http://www.sec.gov),* Standard & Poor's stock reports (available at *http://www2.standardandpoors.com*), and corporate annual reports. DOE supplemented this public information with data released by privately held companies.

b. Phase 2: Industry Cash-Flow Analysis

Phase 2 focused on the financial impacts of potential amended energy conservation standards on industries as a whole. More-stringent energy conservation standards can affect manufacturer cash flow in three distinct ways: (1) Create a need for increased investment, (2) raise production costs per unit, and (3) alter revenue due to higher per-unit prices and possible changes in sales volumes. To quantify these impacts in Phase 2 of the MIA, DOE used the GRIMs to perform three cash-flow analyses: one for the residential water heater industry (separated into the impacts on gas-fired and electric storage, oil-fired storage, and gas-fired instantaneous water heaters), one for DHE (separated into the impacts on traditional DHE and gas hearth DHE), and one for gas-fired pool heaters. In performing these analyses, DOE used the financial values derived during Phase 1 and the shipment scenarios used in the NIA.

c. Phase 3: Subgroup Impact Analysis

Using average cost assumptions to develop an industry-cash-flow estimate does not adequately assess differential impacts of amended energy conservation standards among manufacturer subgroups. For example, small manufacturers, niche players, or manufacturers exhibiting a cost structure that largely differs from the industry average could be more negatively affected. DOE used the results of the industry characterization analysis in Phase 1 to group manufacturers that exhibit similar characteristics. The interviews provided valuable information on manufacturer subgroups. During the manufacturer interviews, DOE discussed financial topics specific to each manufacturer and obtained each manufacturer's view of the industry as a whole.

As stated above, DOE reports the MIA impacts by grouping the impacts of certain product classes together. DOE presents the industry impacts by the major product types (gas-fired and electric storage water heaters, oil-fired storage water heaters, gas-fired instantaneous water heaters, traditional DHE, gas hearth DHE, and gas-fired pool heaters). These product groupings represent separate markets that are served by the same manufacturers and are typically produced in the same factories. Once segmented into major product types by industry, DOE was only able to identify one subgroup—small manufacturers.

For its small business manufacturer subgroup analysis, DOE uses the small business size standards published by the Small Business Administration (SBA) to determine whether a company is 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,'' a residential water heater, DHE, or pool heater 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 upon this classification, DOE identified five residential water heater manufacturers, 12 DHE manufacturers, and one small gas-fired pool heater manufacturer that qualify as small businesses per the applicable SBA definition. The small business subgroup is discussed in chapter 12 of the TSD and in section VI.B of today's notice.

2. GRIM Analysis

DOE uses the GRIM to quantify the changes in cash flow that result in a higher or lower industry value. The GRIM analysis uses a standard, annual-cash-flow analysis that incorporates MPCs, MSPs, shipments, and industry financial information as inputs, and models changes in costs, distribution of shipments, product and capital conversion costs, and manufacturer markups that would result from amended energy conservation standards. The GRIM spreadsheet uses the inputs to arrive at a series of annual cash flows, beginning with the base year of the analysis, 2010, and continuing over the analysis period. DOE used the same base year (2010) as the NIA, which is the same year as the announcement of the final rule. DOE used the same analysis period in the MIA as in the NIA. For all rulemakings, DOE considers a 30-year analysis period after the anticipated compliance date of the final rule, which under EPCA means the date after which regulated parties must comply with the requirements of the amended standard. The compliance date of the rulemaking is estimated to be March of 2013 for DHE and pool heaters and March of 2015 for residential water heaters. The analysis period runs from the beginning of 2013 to 2043 for DHE and pool heaters and from the beginning of 2015 to 2045 for residential water heaters.

DOE uses the GRIM to calculate cash flows using standard accounting principles and to compare changes in INPV between the base case and various TSLs (the standards cases). The difference in INPV between the base case and the standards case represents the financial impact of the potential amended energy conservation standard on manufacturers. DOE collected this information from a number of sources, including publicly-available data and manufacturer interviews.

DOE created a separate GRIM for each of the three types of heating products. For today's notice, DOE is structuring separate TSLs for the three heating products. DOE also treats certain product classes within the three heating products separately. For example, DOE created specialized interview guides for different groups of product classes. These interview guides included one for storage water heaters (gas-fired storage, electric storage, and oil-fired storage water heaters), one for gas-fired instantaneous water heaters, one for traditional DHE (gas wall fan, gas wall gravity, gas floor, and gas room DHE), one for gas hearth DHE, and one for gas-fired pool heaters. DOE grouped product classes made by the same manufacturers and in the same production facilities together. This allowed DOE to better understand the impacts on manufacturers of these product classes.

For example, the TSLs DOE considered for residential water heater packages selected efficiency levels of gas-fired storage, electric storage, oil-fired storage, and gas-fired instantaneous water heaters. The TSLs DOE considered for DHE packages selected efficiency levels for gas wall fan, gas wall gravity, gas floor, gas room, and gas hearth units. Each of the TSLs DOE considered for pool heaters consist of a single efficiency level for gas-fired pool heaters. DOE describes the TSLs in section V.A of today's notice. Because the combinations of TSLs can make it more difficult to discuss the required efficiencies for each product class, DOE presents the MIA results in section V.B.2 of today's notice and chapter 12 of the NOPR TSD by groups of manufacturers that make the covered products. DOE presents the MIA results for gas-fired storage and electric storage water heaters together because manufacturers typically produce both types of water heaters in the same facilities. The MIA results for oil-fired storage and gas-fired instantaneous water heaters are presented separately. The MIA results for DHE are separated into traditional DHE (gas wall fan, gas wall gravity, gas floor, and gas room DHE) and gas hearth DHE. The MIA results for gas-fired pool heaters are also presented separately.

a. GRIM Key Inputs

i. Manufacturer Product Costs

In the MIA, DOE used the MPCs for the three types of heating products at each efficiency level calculated in the engineering analysis, as described in section IV.C and further detailed in chapter 5 of the NOPR TSD. Changes in MPCs can affect revenues and gross margins. For instance, manufacturing a higher-efficiency product is typically more expensive due to the use of more complex components and higher-cost raw materials. For gas-fired storage water heaters, DOE used a weighted average MPC using both standard burner and ultra-low-NO_X burner cost-efficiency curves from the engineering analysis to account for shipments of ultra-low-NO_X water heaters.

ii. Base-Case Shipments Forecast

The GRIM estimates manufacturer revenues based on total unit shipment forecasts and the distribution of these values by efficiency level. Changes in the efficiency mix at each standard level affect manufacturer finances. For this analysis, the GRIM uses the NIA shipments forecasts from 2008 and continuing until the end of the analysis period for each heating product (2045 for residential water heaters and 2043 for DHE and pool heaters). In the shipments analysis, DOE also estimated the distribution of efficiencies in the base case for all product classes. See section IV.F.1 for additional details.

iii. Product and Capital Conversion Costs

Amended energy conservation standards will cause manufacturers to incur one-time conversion costs to bring their production facilities and product designs into compliance. For the MIA, DOE classified these one-time conversion costs into two major groups: (1) Product conversion costs and (2) capital conversion costs. Product conversion costs are one-time investments in research, development, testing, marketing, and other costs focused on making product designs comply with the amended energy conservation standard. Capital conversion costs are one-time investments in property, plant, and equipment to adapt or change existing production facilities so that new product designs can be fabricated and assembled.

DOE assessed the product conversion costs manufacturers would be required to make at each TSL. For residential gas-fired storage water heaters, electric storage water heaters, and gas-fired pool heaters, DOE based most of its estimates of the product conversion costs on information obtained from manufacturer interviews. DOE estimated average industry product conversion costs by weighting the estimates from manufacturers by market share, then extrapolating the interviewed manufacturers' product conversion costs for each product class to account for the market share of companies that were not interviewed. DOE verified the accuracy of these product conversion costs by comparing them to its own estimate of the product development, testing, certification, and retraining effort required by each manufacturer at each TSL. DOE also compared the product conversion costs to the total cost of other recent product development efforts manufacturers have incurred (such as the cost to redesign burners to comply with ultra-low-NO_X requirements). For gas-fired and electric storage water heaters at TSL 5, DOE used the industry-wide product conversion costs for the standard-size volumes at TSL 4. DOE assumed the additional product conversion costs for the large gallon sizes at TSL 5 scaled with the total industry-wide product conversion costs. At TSL 5 for gas-fired and electric storage water heaters, DOE multiplied its estimate for the entire industry to exclusively offer heat pump products at TSL 6 and condensing products at TSL 7 by the percentage of total electric storage and gas-fired storage water heater models that exceed a 55 gallon rated volume (27 percent and 11 percent, respectively).

For oil-fired storage water heaters, gas-fired instantaneous water heaters, and all DHE product classes, DOE did not receive sufficient manufacturer data to serve as the basis for its industry-wide product conversion estimates. For these products, DOE calculated its estimates by reviewing product literature and publically-available information about the efficiency of the existing product lines. DOE used this information to estimate the number of product lines that manufacturers would need to modify or develop at each TSL. DOE also estimated a per-product-line development cost at each efficiency level and assumed these costs represented the product conversion costs for a manufacturer that has to upgrade product lines to meet that TSL. DOE also assumed that that the product development costs increase as the design changes become more complex and if manufacturers do not currently offer products that meet or exceed the required efficiency. DOE calculated the product conversion costs by multiplying its per-line product conversion cost estimate by the number of product lines that manufacturers would need to modify or develop at each TSL. For traditional DHE and gas-fired water heaters, DOE assumed that manufacturers would convert all existing product lines that did not meet the efficiencies required at that TSL. However, for gas hearth DHE DOE assumed that manufacturers would only convert up to 50-percent of their existing product lines that did not meet the required efficiencies. DOE's estimates of the product conversion costs for all of the heating products addressed in this rulemaking can be found in section V.B.2 of today's notice and in chapter 12 of the NOPR TSD.

DOE also evaluated the level of capital conversion costs manufacturers would incur to comply with potential amended energy conservation standards. During interviews, DOE asked manufacturers to estimate the required capital conversion costs to expand the production of higher-efficiency products or quantify the required tooling and plant changes if product lines meeting the required efficiency level do not exist. For residential gas-fired storage water heaters, electric storage water heaters, and gas-fired pool heaters, DOE based its capital conversion costs for most TSLs on these interviews. DOE verified the accuracy of these capital conversion costs by comparing them to a separate bottoms-up estimate of the number of sub-assembly and assembly lines for each manufacturer and the required tooling changes to each line at each TSL, considering the costs of recent line upgrades. As a final verification, DOE examined what level of capital investments would be required to maintain the historical value for net plant, property, and equipment as a ratio of total revenue. For gas-fired and electric storage water heaters at TSL 5, DOE used the industry-wide capital conversion costs for the standard-size volumes at TSL 4. At TSL 5 DOE also used a separate estimate to calculate the additional capital conversion costs that would be required to manufacture gas-fired condensing water heaters and electric heat pump water heaters for rated storage volumes above 55 gallons. For oil-fired storage water heaters, gas-fired instantaneous water heaters, and DHE, DOE used a bottoms-up approach to estimate the cost of additional production equipment and changes to existing production lines that the industry would require at each TSL. DOE used feedback from manufacturer interviews about the tooling requirements at each efficiency level and product catalogs to estimate the total capital conversion costs for each product category at each TSL.

DOE did not consider the provisions in the American Recovery and Reinvestment Act of 2009, Public Law 111–5, in its estimates of the capital conversion costs for all products. The industrial development bonds and advanced energy project tax credit programs in that Act have not been fully distributed, and there is insufficient information available to do a thorough analysis of their potential impacts. It is also unclear if manufacturers of residential water heaters, DHE, or pool heaters would qualify for these provisions. DOE is not aware of any manufacturers of products covered by this rulemaking being awarded funds from these programs (see *http://www.energy.gov/recovery/* for a list of awardees). Therefore, DOE did not include the bonds or tax credit in its analysis for this NOPR of potential impacts on the three heating product industries. DOE's estimates of the capital conversion costs for all three types of heating products can be found in section V.B.2 of today's notice and in chapter 12 of the NOPR TSD.

b. GRIM Scenarios

i. Residential Water Heater Standards-Case Shipments Forecasts

The GRIM used several residential water heater shipments developed in the NIA. The NIA incorporated different scenarios that account for fuel switching, penetration rates of gas-fired instantaneous water heaters, growth rates of ENERGY STAR products, and economic growth rates. To account for the likely impacts on the water heater industry of amended energy conservation standards, DOE used the main NIA shipment scenario. The main NIA water heater scenario accounted for fuel switching. In this scenario, DOE considered the potential for current users of electric storage water heaters to instead purchase a gas-fired storage water heater replacement if amended energy conservation standard for electric storage water heaters were set at levels that would effectively require the use of heat pumps. The main NIA scenario used the Reference case gas-fired instantaneous water heater market share scenario. Finally, the main NIA scenario used the Reference case economic growth scenario and the moderate rate of efficiency growth scenarios. In all standards-case shipment scenarios, DOE considered that shipments at efficiencies below the projected minimum standard levels would roll up to those efficiency levels in response to amended energy conservation standards. See section IV.F.1 of this NOPR and chapter 10 for more information on the residential water heater standards-case shipment scenarios.

ii. Direct Heating Equipment and Pool Heater Shipment Scenarios

For the DHE and pool heater shipments, DOE used the NIA shipments in the base case and the standards case. DOE also considered that shipments at efficiencies below the projected minimum standard levels in the base case would roll up to those efficiency levels in response to amended energy conservation standards. See section IV.F.1 of this NOPR and chapter 10 of the NOPR TSD for additional details about the shipment scenarios.

iii. Markup Scenarios

In the GRIM, DOE used the MSPs estimated in the engineering analysis for each product class and efficiency level. The MSPs include direct manufacturing production costs (*i.e.,* labor, material, and overhead estimated in DOE's MPCs), all non-production costs (*i.e.,* SG&A, R&D, shipping, and interest), along with profit.

DOE used several standards-case markup scenarios to represent the uncertainty about the potential impacts on prices and profitability following the implementation of amended energy conservation standards. For the three types of heating products, DOE analyzed two markup scenarios: (1) a preservation of return on invested capital scenario, and (2) a preservation of operating profit scenario.

Return on invested capital is defined as net operating profit after taxes divided by the total invested capital (fixed assets and working capital, or net plant, property, and equipment plus working capital). In the preservation of return on invested capital scenario, the manufacturer markups are set so that the return on invested capital the year after the compliance date of the amended energy conservation standards is the same as in the base case. This scenario models the situation in which manufacturers maintain a similar level of profitability from the investments required by amended energy conservation standards as they do from their current business operations. After standards, manufacturers have higher net operating profits but also greater working capital and investment requirements. Because manufacturers earn additional operating profit from the investments required by the amended energy conservation standards, this scenario represents the high bound to profitability following standards.

During interviews, multiple manufacturers stated that the higher production costs could severely harm profitability. Because of the highly competitive market, several manufacturers suggested that the additional costs required at higher efficiencies could not be fully passed through to customers. In the preservation of operating profit markup scenario, manufacturer markups are lowered so that only the total operating profit in absolute dollars is maintained as before the amended energy conservation standard. DOE implemented this scenario in GRIM by lowering the manufacturer markups at each TSL to yield approximately the same earnings before interest and taxes in the standards case in the year after the compliance date of the amended standards, as in the base case. This scenario represents the lower bound of industry profitability following amended energy conservation standards because higher production costs and the investments required to comply with the amended energy conservation standard do not yield additional operating profit.

3. Discussion of Comments

During the February 2009 public meeting, interested parties commented on the assumptions and results of the preliminary analysis. In oral and written comments, interested parties discussed the effects of the current economic downturn on manufacturers, the high costs required to educate installers and service contractors, and potential employment impacts due to amended energy conservation standards. DOE addresses these comments below. DOE also received comments on the cumulative burden of ultra-low-NO_X requirements, which are addressed in sections IV.C and V.B.2.f.

a. Responses to General Comments

AHRI stated that DOE must take into account the impacts of the current economic conditions on the manufacturing industry in the manufacturer impact analysis. (AHRI, Public Meeting Transcript, No. 34.4 at p. 19)

In the MIA, DOE models the impacts of amended energy conservation standards on manufacturers of residential water heaters, DHE, and pool heaters from the base year to the end of the analysis period (*i.e.,* 2010–2045 for residential water heaters and 2010–2043 for DHE and pool heaters). DOE notes the compliance dates for all three heating products (*i.e.,* 2015 for residential water heaters and 2013 for DHE and pool heaters). Using information that only reflects these three industries during the current economic downturn would not be representative of the three heating products over the entire analysis period. DOE used the most current information that is publicly available in many of its estimates and analyses, inputs that take the current economic downturn into consideration. For example, as described in section IV.C.4.b, DOE uses 5-year averages for metal material prices and up-to-date prices for other raw materials and purchased components in its engineering analysis cost models. For today's notice, DOE also updated many of its LCC and NIA assumptions to better reflect the most recent information (*e.g., AEO2009*) and in response to comments from interested parties (sections IV.E and IV.F). For the MIA, DOE uses financial parameters like standard R&D to model the cash-flow impacts on the water heater, DHE, and pool heater industries. To calculate the estimates of the financial parameters used in the GRIMs, DOE examined 6 years of SEC 10–K data. While DOE updated some of these GRIM estimates based on interviews with manufacturers, these changes were made to better reflect the parameters that are representative of each industry over the long-term and are not specifically attributable to current economic conditions.

b. Water Heater Comments

BWC and AHRI stated that the economic downturn has limited the funding available for R&D and the tooling necessary to develop and manufacture more-efficient products. (BWC, No. 46 at p. 3; AHRI, No. 33 at p. 1) Noritz America Corporation also stated that the economy has greatly affected manufacturers' bottom line and ability to support R&D. (Noritz, No. 36 at p. 3)

For today's notice, DOE includes the capital and product conversion costs that would be required to meet the entire industry demand at each TSL. While DOE agrees that the current economic downturn may affect the funding for R&D and capital expenditures in the near term, DOE notes that the compliance date for the residential water heater standard is 2015. In the GRIM, DOE allocates its estimates of the product conversion and capital conversion costs in between the announcement of the final rule adopting energy conservation standard (estimated to be March 2010) and the compliance date requiring compliance with the energy conservation standards for water heaters. DOE also assumes that more of the capital conversion and product conversion costs will occur closer to the compliance date than the announcement date. Because most of the product conversion and capital conversion costs are allocated several years in the future, it is expected that the economic conditions at that time will be different than they are currently.

BWC argued that as new technologies are developed, manufacturers must incur additional costs to educate installers and service contractors. (BWC, No. 46 at p. 3)

DOE agrees with BWC that a higher energy conservation standard could require manufacturers to incur costs to educate installers and service contractors, especially if the products have to change dramatically to accommodate amended energy conservation standards. During interviews, manufacturers indicated that significant resources are required to educate installers and service contractors when a new product is introduced. The resources required are even greater when the new product involves a new technology or a new mode of operation. For example, an energy conservation standard that eliminates atmospheric gas-fired storage water heaters would have such an impact on manufacturers. Product conversion costs are one-time investments which encompass research, development, testing, and marketing, focused on making product designs comply with the amended energy conservation standard. Hence, DOE includes an estimate of the cost to manufacturers to educate installers and service contractors in the product conversion costs at each TSL.

Bock asserted that the ENERGY STAR program will affect consumer purchasing patterns. Bock commented that ENERGY STAR, which ignored oil-fired storage water heaters, caused a loss of market share, a reduction in shipments, and a decrease in employment for oil-fired storage water heater manufacturers. (Bock, No. 53 at p. 3)

DOE agrees that a reduction in oil-fired storage water heater shipments could affect employment at oil-fired manufacturers' plants. However, DOE does not believe that the proposed energy conservation standard will cause a reduction in oil-fired storage water heater shipments. For example, today's proposed energy conservation standards increase the installed price of electric storage water heaters, gas storage water heaters, and instantaneous gas-fired water heaters by roughly $132, $101, and $588, respectively over the current baseline products. The installed cost of an oil-fired storage water heater increases by only $61. DOE does not believe that these minimum price increases for consumers would distort the market such that consumers would elect to replace oil-fired storage water heaters with another type of water heater. DOE addresses the direct employment impacts due to standards in section V.B.2.d.

4. Manufacturer Interviews

DOE interviewed manufacturers representing over 95 percent of residential storage water heater sales, about 50 percent of gas-fired instantaneous water heater sales, approximately 99 percent of traditional DHE sales (gas wall fan, gas wall gravity, gas floor, and gas room DHE), over 50 percent of gas hearth DHE sales, and about 75 percent of pool heater sales. These interviews were beyond those DOE conducted as part of the engineering analysis. DOE used these interviews to tailor each GRIM to incorporate unique financial characteristics for each industry. DOE contacted companies from its database of manufacturers, which provided a representative sample of each 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.

Before each telephone interview or site visit, DOE provided company representatives with an interview guide that included the topics for which DOE sought input. The MIA interview topics included: (1) Key issues to this rulemaking; (2) a company overview and organizational characteristics; (3) manufacturer production costs and selling prices; (4) manufacturer markups and profitability; (5) shipment projections and market shares; (6) product mix; (7) financial parameters; (8) conversion costs; (9) cumulative regulatory burden; (10) direct employment impact assessment; (11) exports, foreign competition, and outsourcing; (12) consolidation; and (13) impacts on small business. The MIA interview guide for storage water heaters contained three additional sections: (1) Ultra-low-NO_X water heaters; (2) unit shipping methods and associated costs; and (3) alternative energy efficiency equations. Appendix 12A of the NOPR TSD contains the five interview guides DOE used to conduct the MIA interviews.

In the manufacturer interviews, DOE asked manufacturers to describe their major concerns about this rulemaking. The following sections describe the most significant key issues identified by manufacturers. DOE also includes additional concerns in chapter 12 of the TSD. DOE's responses are provided where relevant in today's notice.

a. Storage Water Heater Key Issues

i. Fuel Switching

Gas-fired storage, electric storage, and oil-fired storage water heater manufacturers are concerned that this energy conservation standard rulemaking could cause fuel switching. While most storage water heater manufacturers also sell gas-fired instantaneous water heaters, storage manufacturers are concerned that a more aggressive standard on gas-fired and electric storage units could lower the first cost differential of gas-fired instantaneous water heaters and increase their market penetration. Increased penetration of gas-fired instantaneous water heaters would lower the shipments of storage water heaters, resulting in lower profitability and fewer shipments for manufacturers that focus on storage water heaters, especially if they lose market share to companies that exclusively manufacture instantaneous water heaters.

ii. Ultra-Low-NO_X Requirements

Manufacturers that make gas-fired storage water heaters are concerned about the large product development costs to meet the ultra-low-NO_X requirements in some regions of the Southwest. In particular, manufacturers are concerned that higher energy factors, lower NO_X emissions, and compliance with existing safety regulations are often at odds. Manufacturers also stated that the higher cost of the ultra-low-NO_X gas storage water heaters would hurt consumers in those regions and could cause them to switch to less expensive electric storage units.

iii. Profitability

Manufacturers stated that amended energy conservations standards could affect profitability. At any TSL, manufacturers will be forced to discontinue a certain percentage of their existing products and make potentially significant product and plant modifications. If manufacturers earn a lower markup for more-efficient products after the amended energy conservation standard, their profit margin would decrease. Energy conservation standards could also harm profitability by eliminating up-sell opportunities to more-efficient units that earn a greater absolute profit. Finally, while manufacturers generally agree with DOE's estimate of manufacturer production costs, many noted that their actual product offerings are more segmented into multiple models made at various production locations. Multiple product offerings could make it more difficult to reach the price points DOE calculates. If production costs were higher, markups would be lower than the manufacturer markup DOE assumes and profitability would decrease.

iv. Appropriateness of Heat Pump Water Heaters

Heat pump water heaters are effectively required for all rated storage volumes at TSL 6 and TSL 7 and for a portion of the market at TSL 5 for electric storage water heaters to meet the specified efficiency level. Most electric storage water heater manufacturers disagreed with DOE's decision to include heat pump water heaters in the electric storage water heater product class. In addition, all electric storage water heater manufacturers agreed that this technology is only appropriate for the ENERGY STAR level, not a minimum required efficiency. While many manufacturers intend to or currently are designing heat pump water heaters in response to the ENERGY STAR requirements, manufacturers believe that setting a minimum standard during the design phase is not appropriate and could cause many serious and negative consequences.

Manufacturers listed many reasons why this technology is not ready to be applied across the millions of electric storage water heaters needed to satisfy demand. A significant problem is that heat pump water heaters could not be installed in a large portion of existing homes (*e.g.,* 30 to 40 percent of homes), without incurring tremendous costs for affected consumers to modify their existing structures. The technology also has not been fully developed and has not yet been proven reliable for large-scale manufacturing. Some manufacturers are concerned that any problems that arise with applying the technology across millions of electric storage water heaters that could not be proven by the compliance date of the rule would cause significant harm to their industry due to the anti-backsliding provision in EPCA. Manufacturers stated that other problems could arise with the production of heat pump water heaters if the standard were set at TSL 6 or TSL 7. For example, there is almost no existing capacity to manufacture these water heaters, especially on the scale that an energy conservation standard would require. Requiring over 4 million annual shipments in 2015 could lead to acquisition problems because component suppliers are not prepared for such a jump in demand. In particular, acquiring sufficient compressors, thermal expansion valves, and other purchased parts to meet market demand could be a challenge.

Manufacturers also added that setting the energy conservation standard at a level effectively requiring the use of heat pump technology would cause many negative impacts in the industry, even if the technology were proven by the compliance date specified in the final rule. Because of the increased labor required, manufacturers would have to consider shifting a considerable portion of production overseas to obtain viable production costs, as was true for the residential air-conditioning industry. Domestic employment in the industry would be affected because only part of the production would likely remain in the United States after the compliance date of the amended energy conservation standard.

Manufacturers also stated that they would incur significant conversion costs if the standard level effectively mandates heat pump water heaters, for the reasons explained below. Every main assembly line and feeder line would need modifications to integrate the new assembly into existing production facilities. Finally, manufacturers would face a significant challenge to retrain their service technicians and installers for a completely new technology. Because the technology has not been fully developed, the skills needed to service and install heat pump water heaters are unknown. However, manufacturers indicated that a combination of plumbing and HVAC skills would be required that do not exist today.

v. Capital Conversion Costs for Oil-Fired Storage Water Heaters

Oil-fired storage water heater manufacturers indicated that capital conversion costs for oil-fired storage water heaters at higher efficiency levels, while perhaps not appearing prohibitively large on a nominal basis, are extremely significant relative to the volume of oil-fired water heater shipments. At any level above TSL 1, at least one manufacturer with substantial market share indicated that there is a real risk that these capital and product conversion costs could cause it to exit the market.

b. Gas-Fired Instantaneous Water Heater Key Issues

i. Potential Market Distortion

Manufacturers stated that amended energy conservation standard could greatly affect the market penetration of gas-fired instantaneous water heaters. If the prices were greatly increased relative to storage water heaters, market penetration could be slowed. In addition, a drastic increase in the required efficiency (at TSL 7) could disrupt current arrangements with overseas suppliers or parent companies and limit product availability in the United States.

ii. Ultra-Low-NO_X Requirements

Manufacturers of gas-fired instantaneous water heaters expressed great concern about the conflicting requirements of higher energy factor requirements and pending ultra-low-NO_X requirements. At most efficiency levels, manufacturers commented that there is a tradeoff in burner design between higher efficiency and lower NO_X emissions. Manufacturers indicated that they have not found a solution and are very concerned about concurrently meeting the ultra-low-NO_X requirements and amended energy conservation standards.

c. Direct Heating Equipment Key Issues (Gas Wall Fan, Gas Wall Gravity, Gas Floor, and Gas Room Direct Heating Equipment)

i. Consumer Impacts

Manufacturers remarked that energy conservation standards could hurt consumers, arguing that many of existing installations cannot be replaced with more-efficient units because of space considerations. Customers that choose these units would either have to pay for structural modifications or switch to a different heat source. Some manufacturers also noted that improvements in efficiency for the most common type of traditional DHE (gas wall gravity DHE) have long paybacks at any TSL.

All manufacturers stated that gas wall gravity and gas room DHE provide a unique utility by operating in the event of a power failure. Manufacturers stated that consumers would be hurt if these products required line power, because it would leave many without a backup source of heat.

ii. Significant Capital and Product Development Costs

Manufacturers stated that any product conversion or capital conversion cost would be difficult to justify because of the very low shipment volumes of each product line. Manufacturers remarked that any required investments could force them to reduce their product offerings at best and permanently exit the market at worst. Due to the large number of product offerings that would need to be recertified and/or redesigned, some manufacturers argued that 3 years would not be enough lead time. Finally, because shipment volumes are so low, any investment would significantly add to the final cost of the product, assuming that manufacturers could pass part of the increased cost on to consumers.

Manufacturers are also concerned that higher production costs could drive more consumers to purchase a central system rather than replace their failed direct heating system. If shipments declined at all, manufacturers stated they would be less able to justify the required investment to upgrade products and product lines, which would hurt their industry further. All manufacturers said that potential energy conservation standards are a real threat to their business and could cause them to exit the market completely.

d. Direct Heating Equipment Key Issues (Gas Hearth Direct Heating Equipment)

i. Loss of Aesthetic Appeal for Decorative Products

According to manufacturers, all gas hearth products have an aesthetic function in addition to a heating function. In fact, manufacturers stated that the primary function of most gas hearth products covered by this rulemaking is the ambiance and aesthetic appeal provided by the flame. Gas hearth DHE are used mostly to zone heat when occupants are in close proximity or to supplement a central heating system, but are used as a primary heating source only in very rare cases.

Because gas hearth DHE are mostly decorative items in residences, manufacturers believe that energy conservation standards could have a different impact on their industry than the water heater industry, for example. Gas hearth manufacturers stated that the utility of the other strictly heating products covered by today's rule has little to do with the appearance of the products and would not be impacted at any standard level. For example, the consumer utility from water heaters would not be impacted by amended energy conservation standards as long as hot water is still delivered. However, the relevant manufacturers were greatly concerned that potential energy conversation standards for gas hearth DHE could harm their industry and consumers in qualitative ways, in addition to the direct impacts on industry value. Their customers' needs are related to the size, shape, and appearance of the flame, and for these customers, efficiency is not usually a concern, given such products' low usage patterns. Manufacturers stated that they earn premiums for aesthetic features such as better-looking flames and more attractive masonry, rather than higher efficiency. Multiple manufacturers stated that the yellow flames that consumers look for in a log set depend on a rich gas-to-air mixture, which inherently limits the achievable energy efficiency. Hence, at higher efficiency levels, it becomes more difficult to improve efficiency and maintain a desirable flame color, an impact that is hard to measure and which could have a significant detrimental effect on the industry.

ii. Product Switching and Profitability

Because the aesthetic appeal of the unit and the flame are critical features, manufacturers believed that overly-stringent energy conservation standards could cause customers to switch to non-covered hearth products, such as wood-burning stoves or strictly decorative units, if the energy conservation standards greatly raised prices. Finally, manufacturers stated that a significant portion of gas hearth products are purchased by builders. Because the appearance of the units and the flame are more critical features than efficiency, manufacturers believed that higher costs could cause more builders to purchase strictly decorative products that are not covered by this rulemaking.

Besides higher prices potentially causing a switching to non-covered products, manufacturers were also concerned that higher standards had the potential to lower overall demand for gas hearth products. At higher costs, manufacturers believe that customers would no longer purchase inserts for existing homes or that builders would make gas hearth products in new homes an option rather than a standard feature. Manufacturers also believe that a shrinking market would reduce profits.

e. Pool Heater Key Issues

i. Impacts on Consumers

Manufacturers stated that an amended energy conservation standards set above an efficiency level achievable using atmospheric technology (TSL 3 through TSL 6) could hurt consumers. According to manufacturers, customers would not recoup the initial higher costs with lower utility bills at these TSLs. Because most residential pool heaters are a luxury item with low usage patterns, most customers do not purchase units at TSL 4 and above. Thus, manufacturers stated that more-efficient residential pool heaters are only appropriate in commercial settings (*e.g.,* hotels, gyms) because the higher usage allows such customers to recoup the higher initial costs.

ii. Future Shipment Trends

Manufacturers commented that pool heater shipments follow new housing starts. Because the new housing market is down, manufacturers have lowered their projections for future pool heater sales as well. Manufacturers also do not expect future shipments to return to historical levels, as recent new housing starts have increasingly been on smaller lots that do not have the room to accommodate swimming pools.

Manufacturers are concerned that amended energy conservation standards could further decrease future sales. Because pool heaters are not a necessity, the higher initial cost could dissuade some consumers from replacing a failed unit or adding a heater to a new pool or spa. Manufacturers are also concerned that a higher price point for gas-fired pool heaters could hurt future shipments by making alternatives like solar or heat pump pool heaters comparatively cheaper. Manufacturers stated that this trend is already a concern because a few States and utilities have offered subsidies for solar water heaters.

iii. Future NO_X Emission Requirements

According to manufacturers, residential gas-fired pool heaters are currently exempt from ultra-low NO_X requirements in the Southwest air quality management districts. However, most manufacturers voiced a concern over potential future requirements. If air quality management districts set more restrictive NO_X requirements in the future, some manufacturers may be required to incur a costly redesign of their burner systems.

I. Employment Impact Analysis

Employment impacts consist of direct and indirect impacts. Direct employment impacts are any changes in the number of employees of manufacturers of the appliance products that are the subject of this rulemaking, their suppliers, and related service firms. Indirect employment impacts are changes in employment in the larger economy that occur due to the shift in expenditures and capital investment caused by the purchase and operation of more-efficient appliances. The MIA addresses the direct employment impacts that concern manufacturers of the three heating products.

Indirect employment impacts from standards consist of the net jobs created or eliminated in the national economy, other than in the manufacturing sector being regulated, due to: (1) Reduced spending by end users on energy (electricity, gas—including liquefied petroleum gas—and oil); (2) reduced spending on new energy supply by the utility industry; (3) increased spending on new products to which the new standards apply; and (4) the effects of those three factors throughout the economy. DOE expects the net monetary savings from standards to be redirected to other forms of economic activity. DOE also expects these shifts in spending and economic activity to affect the demand for labor in the short term, as explained below.

One method for assessing the possible effects on the demand for labor of such shifts in economic activity is to compare sectoral employment statistics developed by the Labor Department's Bureau of Labor Statistics (BLS). (Data on industry employment, hours, labor compensation, value of production, and the implicit price deflator for output for these industries are available upon request by calling the Division of Industry Productivity Studies (202–691–5618) or by sending a request by e-mail to *dipsweb@bls.gov.* See *http://www.bls.gov/news.release/prin1.nr0.htm.*) The BLS regularly publishes its estimates of the number of jobs per million dollars of economic activity in different sectors of the economy, as well as the jobs created elsewhere in the economy by this same economic activity. Data from BLS indicate that expenditures in the utility sector generally create fewer jobs (both directly and indirectly) than expenditures in other sectors of the economy. There are many reasons for these differences, including wage differences and the fact that the utility sector is more capital intensive and less labor intensive than other sectors. See Bureau of Economic Analysis, Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II), U.S. Department of Commerce, 1992.

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 manufacturing sectors).

In developing the preliminary analysis and today's NOPR, DOE estimated indirect national employment impacts using an input/output model of the U.S. economy called Impact of Sector Energy Technologies (ImSET). ImSET is a spreadsheet model of the U.S. economy that focuses on 188 sectors most relevant to industrial, commercial, and residential building energy use. (See J. M. Roop, M. J. Scott, and R. W. Schultz, *ImSET: Impact of Sector Energy Technologies,* PNNL–15273, Pacific Northwest National Laboratory, 2005). ImSET is a special-purpose version of the ''U.S. Benchmark National Input-Output'' (I–O) model designed to estimate the national employment and income effects of energy-saving technologies. The ImSET software includes a computer-based I–O model with structural coefficients to characterize economic flows among the 188 sectors. ImSET's national economic

I–O structure is based on a 1997 U.S. benchmark table (See Lawson, Ann M., *et al.,* ''Benchmark Input-Output Accounts of the U.S. Economy, 1997,'' Survey of Current Business, Dec. 2002, pp. 19–117.) Chapter 13 of the NOPR TSD presents further details on the employment impact analysis.

J. Utility Impact Analysis

The utility impact analysis included an analysis of the potential effects of amended energy conservation standards for the three types of heating products on the electric and gas utility industries. For this analysis, DOE used NEMS–BT to generate forecasts of electricity and natural gas consumption, electricity generation by plant type, and electric generating capacity by plant type. DOE conducts the utility impact analysis as a scenario that departs from the latest *AEO* Reference case. In other words, the energy savings impacts from amended energy conservation standards are modeled using NEMS–BT to generate forecasts that deviate from the *AEO* Reference case. Chapter 13 of the NOPR TSD presents details on the utility impact analysis.

NEEA and NPCC urged DOE to consider the impact of gas-fired instantaneous water heaters on local gas distribution companies' ability to meet hot water demand during peak periods, and the possibility that they may have to invest in shoring up system peak capacity, adding significant upward pressure on rates. (NEEA and NPCC, No. 42 at p. 9) DOE acknowledges that growing use of gas-fired instantaneous water heaters could contribute to peak demand problems, and that higher-efficiency gas-fired instantaneous water heaters could ameliorate the problem. However, DOE currently does not have adequate data to reliably quantify the potential impacts.

K. Environmental Analysis

DOE has prepared a draft environmental assessment (EA) pursuant to the National Environmental Policy Act and the requirements of 42 U.S.C. 6295(o)(2)(B)(i)(VI) and 6316(a) to determine the environmental impacts of the proposed standards. DOE estimated the impacts on power sector emissions of CO_2, NO_X, and Hg using the NEMS–BT model. Because the on-site operation of non-electric heating products requires use of fossil fuels and results in emissions of CO_2, NO_X and sulfur dioxide (SO_2), DOE also accounted for the reduction in these emissions due to standards at the sites where these appliances are used.

1. Impacts of Standards on Emissions

In the EA, NEMS–BT is run similarly to the AEO NEMS, except that heating product energy use is reduced by the amount of energy saved (by fuel type) due to each TSL. The inputs of national energy savings come from the NIA spreadsheet model; the output is the forecasted physical emissions at each TSL. The net benefit of the standard is the difference between emissions estimated by NEMS–BT at each TSL and the AEO Reference Case.

NEMS–BT tracks CO_2 emissions using a detailed module that provides results with broad coverage of all sectors and inclusion of interactive effects. For the preliminary TSD, DOE used *AEO2008.* For today's NOPR, DOE used the *AEO2009* NEMS (stimulus version). For the final rule, DOE intends to revise the emissions analysis using the most current AEO.

DOE has preliminarily determined that SO_2 emissions from affected Electric Generating Units (EGUs) are subject to nationwide and regional emissions cap and trading programs that create uncertainty about the standards' impact on SO_2 emissions. Title IV of the Clean Air Act sets an annual emissions cap on SO_2 for all affected EGUs. SO_2 emissions from 28 eastern States and the District of Columbia (D.C.) are also limited under the Clean Air Interstate Rule (CAIR, published in the **Federal Register** on May 12, 2005. 70 FR 25162 (May 12, 2005), which creates an allowance-based trading program that will gradually replace the Title IV program in those States and DC. (The recent legal history surrounding CAIR is discussed below.) The attainment of the emissions caps is flexible among EGUs and is enforced through the use of emissions allowances and tradable permits. Energy conservation standards could lead EGUs to trade allowances and increase SO_2 emissions that offset some or all SO_2 emissions reductions attributable to the standard. DOE is not certain that there will be reduced overall SO_2 emissions from the standards. The NEMS–BT modeling system that DOE used to forecast emissions reductions currently indicates that no physical reductions in power sector emissions would occur for SO_2. The above considerations prevent DOE from estimating SO_2 reductions from standards at this time.

Even though DOE is not certain that there will be reduced overall emissions from the standard, there may be an economic benefit from reduced demand for SO_2 emission allowances. Electricity savings decrease the generation of SO_2 emissions from power production, which can lessen the need to purchase SO_2 emissions allowance credits, and thereby decrease the costs of complying with regulatory caps on emissions.

Much like SO_2, NO_X emissions from 28 eastern States and the District of Columbia (DC) are limited under the CAIR. Although CAIR has been remanded to EPA by the D.C. Circuit, it will remain in effect until it is replaced by a rule consistent with the Court's July 11, 2008, opinion in *North Carolina* v. *EPA.* 531 F.3d 896 (D.C. Cir. 2008); see also *North Carolina* v. *EPA,* 550 F.3d 1176 (D.C. Cir. 2008). Because all States covered by CAIR opted to reduce NO_X emissions through participation in cap-and-trade programs for electric generating units, emissions from these sources are capped across the CAIR region.

In the 28 eastern States and DC where CAIR is in effect, DOE's forecasts indicate that no NO_X emissions reductions will occur because of the permanent cap. Energy conservation standards have the potential to produce environmentally-related economic impact in the form of lower prices for emissions allowance credits, if they were large enough. However, DOE has preliminarily concluded that the proposed standard would not have such an effect because the estimated reduction in NO_X emissions or the corresponding allowance credits in States covered by the CAIR cap would be too small to affect allowance prices for NO_X under the CAIR.

The proposed standard would reduce NO_X emissions in those 22 States not affected by the CAIR. As a result, DOE used the NEMS–BT to forecast emission reductions from the standards that are considered in today's NOPR.

Similar to emissions of SO_2 and NO_X, future emissions of Hg would have been subject to emissions caps. The Clean Air Mercury Rule (CAMR) would have permanently capped emissions of mercury for new and existing coal-fired plants in all States beginning in 2010 (70 FR 28606). However, the CAMR was vacated by the D.C. Circuit in its decision in *New Jersey* v. *Environmental Protection Agency.* 517 F 3d 574 (D.C. Cir. 2008) Thus, DOE was able to use the NEMS–BT model to estimate the changes in Hg emissions resulting from the proposed rule.

EEI stated that DOE's analysis of emissions from electric power generation should account for the rise in renewable portfolio standards and the possibility of an upcoming CO_2 cap and trade program, both of which would reduce the amount of emissions produced per kWh electricity generated. (EEI, No. 40 at p. 6) DOE's projections of CO_2 emissions from electric power generation are based on the *AEO2009* version of NEMS. The emissions projections reflect market factors and policies that affect utility choice of power plants for electricity generation, including existing renewable portfolio standards. Because of the speculative nature of forecasting future regulations, DOE does not include the impact of possible future regulations in its forecasts.

EEI stated that if DOE examines changes in power plant emissions, then it should also examine changes in the emissions associated with oil extraction (domestic and overseas), crude oil transportation (sea and land-based), natural gas flaring, oil refining, refined oil delivery, natural gas production, natural gas delivery, natural gas delivery system methane leaks, propane production and delivery, and emissions associated with the extraction and importation of liquefied natural gas. (EEI, No. 40 at p. 6)

Emissions occur at each stage of the extraction, conversion, and delivery of the energy supply chain. Nonetheless, emissions are dominated by power plant emissions in the case of electric appliances and in-house emissions in the case of natural gas and oil-fired appliances, so DOE focuses on those points.

The operation of non-electric heating products 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. NEMS–BT provides no means for estimating such emissions. DOE calculated the effect of the proposed standards on the above site emissions based on emissions factors derived from the literature.

2. Valuation of CO_2 Emissions Reductions

DOE received comments on the desirability of valuing the CO_2 emissions reductions that result from standards. NRDC stated that DOE must account for the value of avoided carbon emissions. (NRDC, No. 48 at p. 4) NEEA and NPCC stated that it would be inappropriate to assign a value of zero to avoided carbon emissions. (NEEA and NPCC, No. 42 at p. 10) Earthjustice stated that DOE must consider well-established literature on the value of CO_2 emissions to consider reduced emissions in States that will remain outside CO_2 reduction regimes. (Earthjustice, No. 47 at p. 4)

For today's NOPR, DOE is relying on a new set of values recently developed by an interagency process that conducted a thorough review of existing estimates of the social cost of carbon (SCC). The SCC is intended to be a monetary measure of the incremental damage resulting from greenhouse gas (GHG) emissions, including, but not limited to, net agricultural productivity loss, human health effects, property damages from sea level rise, and changes in ecosystem services. Any effort to quantify and to monetize the harms associated with climate change will raise serious questions of science, economics, and ethics. But with full regard for the limits of both quantification and monetization, the SCC can be used to provide estimates of the social benefits of reductions in GHG emissions.

For at least three reasons, any single estimate of the SCC will be contestable. First, scientific and economic knowledge about the impacts of climate change continues to grow. With new and better information about relevant questions, including the cost, burdens, and possibility of adaptation, current estimates will inevitably change over time. Second, some of the likely and potential damages from climate change—for example, the value society places on adverse impacts on endangered species—are not included in all of the existing economic analyses. These omissions may turn out to be significant in the sense that they may mean that the best current estimates are too low. Third, controversial ethical judgments, including those involving the treatment of future generations, play a role in judgments about the SCC (see in particular the discussion of the discount rate, below).

To date, regulations have used a range of values for the SCC. For example, a regulation proposed by the U.S. Department of Transportation (DOT) in 2008 assumed a value of $7 per ton CO_2 (2006$) for 2011 emission reductions (with a range of $0–14 for sensitivity analysis). Regulation finalized by DOE used a range of $0–$20 (2007$). Both of these ranges were designed to reflect the value of damages to the United States resulting from carbon emissions, or the ''domestic'' SCC. In the final Model Year 2011 Corporate Average Fuel Economy rule, DOT used both a domestic SCC value of $2/t CO_2 and a global SCC value of $33/t CO_2 (with sensitivity analysis at $80/t$CO_2$), increasing at 2.4 percent per year thereafter.

In recent months, a variety of agencies have worked to develop an objective methodology for selecting a range of interim SCC estimates to use in regulatory analyses until improved SCC estimates are developed. The following summary reflects the initial results of these efforts and proposes ranges and values for interim social costs of carbon used in this rule. It should be emphasized that the analysis described below is preliminary. These complex issues are of course undergoing a process of continuing review. Relevant agencies will be evaluating and seeking comment on all of the scientific, economic, and ethical issues before establishing final estimates for use in future rulemakings.

The interim judgments resulting from the recent interagency review process can be summarized as follows: (a) DOE and other Federal agencies should consider the global benefits associated with the reductions of CO_2 emissions resulting from efficiency standards and other similar rulemakings, rather continuing the previous focus on domestic benefits; (b) these global benefits should be based on SCC estimates (in 2007$) of $55, $33, $19, $10, and $5 per ton of CO_2 equivalent emitted (or avoided) in 2007 (in calculating the benefits reported in this NOPR, DOE has escalated the 2007$ values to 2008$ for consistency with other dollar values presented in this notice, resulting in SCC estimates (in 2008$) of approximately $5, $10, $20, $34, and $56); (c) the SCC value of emissions that occur (or are avoided) in future years should be escalated using an annual growth rate of 3 percent from the current values); and (d) domestic benefits are estimated to be approximately 6 percent of the global values. These interim judgments are based on the following considerations.

1. *Global and domestic estimates of SCC.* Because of the distinctive nature of the climate change problem, estimates of both global and domestic SCC values should be considered, but the global measure should be ''primary.'' This approach represents a departure from past practices, which relied, for the most part, on measures of only domestic impacts. As a matter of law, both global and domestic values are permissible; the relevant statutory provisions are ambiguous and allow the agency to choose either measure. (It is true that Federal statutes are presumed not to have extraterritorial effect, in part to ensure that the laws of the United States respect the interests of foreign sovereigns. But use of a global measure for the SCC does not give extraterritorial effect to Federal law and hence does not intrude on such interests.)

It is true that under OMB guidance, analysis from the domestic perspective is required, while analysis from the international perspective is optional. The domestic decisions of one nation are not typically based on a judgment about the effects of those decisions on other nations. But the climate change problem is highly unusual in the sense that it involves (a) a global public good in which (b) the emissions of one nation may inflict significant damages on other nations and (c) the United States is actively engaged in promoting an international agreement to reduce worldwide emissions.

In these circumstances, the global measure is preferred. Use of a global measure reflects the reality of the problem and is expected to contribute to the continuing efforts of the United States to ensure that emission reductions occur in many nations.

Domestic SCC values are also presented. The development of a domestic SCC is greatly complicated by the relatively few region- or country-specific estimates of the SCC in the literature. One potential estimate comes from the DICE (Dynamic Integrated Climate Economy, William Nordhaus) model. In an unpublished paper, Nordhaus (2007) produced disaggregated SCC estimates using a regional version of the DICE model. He reported a U.S. estimate of $1/t$CO_2$ (2007 value, 2007$), which is roughly 11 percent of the global value.

An alternative source of estimates comes from a recent EPA modeling effort using the FUND (Climate Framework for Uncertainty, Negotiation and Distribution, Center for Integrated Study of the Human Dimensions of Global Change) model. The resulting estimates suggest that the ratio of domestic to global benefits varies with key parameter assumptions. With a 3 percent discount rate, for example, the US benefit is about 6 percent of the global benefit for the ''central'' (mean) FUND results, while, for the corresponding ''high'' estimates associated with a higher climate sensitivity and lower global economic growth, the US benefit is less than 4 percent of the global benefit. With a 2 percent discount rate, the U.S. share is about 2 to 5 percent of the global estimate.

Based on this available evidence, a domestic SCC value equal to 6 percent of the global damages is used in this rulemaking. This figure is in the middle of the range of available estimates from the literature. It is recognized that the 6 percent figure is approximate and highly speculative and alternative approaches will be explored before establishing final values for future rulemakings.

2. *Filtering existing analyses.* There are numerous SCC estimates in the existing literature, and it is legitimate to make use of those estimates to produce a figure for current use. A reasonable starting point is provided by the meta-analysis in Richard Tol, ''The Social Cost of Carbon: Trends, Outliers, and Catastrophes, Economics: The Open-Access, Open-Assessment E–Journal,'' Vol. 2, 2008–25. *http://www.economics-ejournal.org/economics/journalarticles/2008-25* (2008). With that starting point, it is proposed to ''filter'' existing SCC estimates by using those that (1) are derived from peer-reviewed studies; (2) do not weight the monetized damages to one country more than those in other countries; (3) use a ''business as usual'' climate scenario; and (4) are based on the most recent published version of each of the three major integrated assessment models (IAMs): FUND, DICE and PAGE (Policy Analysis of the Greenhouse Effect).

Proposal (1) is based on the view that those studies that have been subject to peer review are more likely to be reliable than those that have not been. Proposal (2) is based on a principle of neutrality and simplicity; it does not treat the citizens of one nation differently on the basis of speculative or controversial considerations. Proposal (3) stems from the judgment that as a general rule, the proper way to assess a policy decision is by comparing the implementation of the policy against a counterfactual state where the policy is not implemented. A departure from this approach would be to consider a more dynamic setting in which other countries might implement policies to reduce GHG emissions at an unknown future date, and the United States could choose to implement such a policy now or in the future.

Proposal (4) is based on three complementary judgments. First, the FUND, PAGE, and DICE models now stand as the most comprehensive and reliable efforts to measure the damages from climate change. Second, the latest versions of the three IAMs are likely to reflect the most recent evidence and learning, and hence they are presumed to be superior to those that preceded them. It is acknowledged that earlier versions may contain information that is missing from the latest versions. Third, any effort to choose among them, or to reject one in favor of the others, would be difficult to defend at this time. In the absence of a clear reason to choose among them, it is reasonable to base the SCC on all of them.

The agency is keenly aware that the current IAMs fail to include all relevant information about the likely impacts from greenhouse gas emissions. For example, ecosystem impacts, including species loss, do not appear to be included in at least two of the models. Some human health impacts, including increases in food-borne illnesses and in the quantity and toxicity of airborne allergens, also appear to be excluded. In addition, there has been considerable recent discussion of the risk of catastrophe and of how best to account for worst-case scenarios. It is not clear whether the three IAMs take adequate account of these potential effects.

3. *Use a model-weighted average of the estimates at each discount rate.* At this time, there appears to be no scientifically valid reason to prefer any of the three major IAMs (FUND, PAGE, and DICE). Consequently, the estimates are based on an equal weighting of estimates from each of the models. Among estimates that remain after applying the filter, the average of all estimates within a model is derived. The estimated SCC is then calculated as the average of the three model-specific averages. This approach ensures that the interim estimate is not biased towards specific models or more prolific authors.

4. *Apply a 3 percent annual growth rate to the chosen SCC values.* SCC is assumed to increase over time, because future emissions are expected to produce larger incremental damages as physical and economic systems become more stressed as the magnitude of climate change increases. Indeed, an implied growth rate in the SCC is produced by most studies that estimate economic damages caused by increased GHG emissions in future years. But neither the rate itself nor the information necessary to derive its implied value is commonly reported. In light of the limited amount of debate thus far about the appropriate growth rate of the SCC, applying a rate of 3 percent per year seems appropriate at this stage. This value is consistent with the range recommended by IPCC (2007) and close to the latest published estimate (Hope, 2008).

For climate change, one of the most complex issues involves the appropriate discount rate. OMB's current guidance offers a detailed discussion of the relevant issues and calls for discount rates of 3 percent and 7 percent. It also permits a sensitivity analysis with low rates for intergenerational problems. (''If your rule will have important intergenerational benefits or costs you might consider a further sensitivity analysis using a lower but positive discount rate in addition to calculating net benefits using discount rates of 3 and 7 percent.'') The SCC is being developed within the general context of the current guidance.

The choice of a discount rate, especially over long periods of time, raises highly contested and exceedingly difficult questions of science, economics, philosophy, and law. See, *e.g.,* William Nordhaus, ''The Challenge of Global Warming (2008); Nicholas Stern, The Economics of Climate Change'' (2007); ''Discounting and Intergenerational Equity'' (Paul Portney and John Weyant, eds., 1999). Under imaginable assumptions, decisions based on cost-benefit analysis with high discount rates might harm future generations—at least if investments are not made for the benefit of those generations. See Robert Lind, ''Analysis for Intergenerational Discounting,'' id. at 173, 176–177. At the same time, use of low discount rates for particular projects might itself harm future generations, by ensuring that resources are not used in a way that would greatly benefit them. In the context of climate change, questions of intergenerational equity are especially important.

Reasonable arguments support the use of a 3 percent discount rate. First, that rate is among the two figures suggested by OMB guidance, and hence it fits with existing National policy. Second, it is standard to base the discount rate on the compensation that people receive for delaying consumption, and the 3 percent rate is close to the risk-free rate of return, proxied by the return on long term inflation-adjusted U.S. Treasury Bonds. (In the context of climate change, it is possible to object to this standard method for deriving the discount rate.) Although these rates are currently closer to 2.5 percent, the use of 3 percent provides an adjustment for the liquidity premium that is reflected in these bonds' returns.

At the same time, other arguments support use of a 5 percent discount rate. First, that rate can also be justified by reference to the level of compensation for delaying consumption, because it fits with market behavior with respect to individuals' willingness to trade off consumption across periods as measured by the estimated post-tax average real returns to private investment (*e.g.,* the S&P 500). In the climate setting, the 5 percent discount rate may be preferable to the riskless rate because it is based on risky investments and the return to projects to mitigate climate change is also risky. In contrast, the 3 percent riskless rate may be a more appropriate discount rate for projects where the return is known with a high degree of confidence (*e.g.,* highway guardrails).

Second, 5 percent, and not 3 percent, is roughly consistent with estimates implied by reasonable inputs to the theoretically derived Ramsey equation, which specifies the optimal time path for consumption. That equation specifies the optimal discount rate as the sum of two components. The first reflects the fact that consumption in the future is likely to be higher than consumption today (even accounting for climate impacts), so diminishing marginal utility implies that the same monetary damage will cause a smaller reduction of utility in the future. Standard estimates of this term from the economics literature are in the range of 3 to 5 percent. The second component reflects the possibility that a lower weight should be placed on utility in the future, to account for social impatience or extinction risk, which is specified by a pure rate of time preference (PRTP). A conventional estimate of the PRTP is 2 percent. (Some observers believe that a principle of intergenerational equity suggests that the PRTP should be close to zero.) It follows that discount rate of 5 percent is within the range of values which are able to be derived from the Ramsey equation, albeit at the low end of the range of estimates usually associated with Ramsey discounting.

It is recognized that the arguments above—for use of market behavior and the Ramsey equation—face objections in the context of climate change, and of course there are alternative approaches. In light of climate change, it is possible that consumption in the future will not be higher than consumption today, and if so, the Ramsey equation will suggest a lower figure. Some people have suggested that a very low discount rate, below 3 percent, is justified in light of the ethical considerations calling for a principle of intergenerational neutrality. See Nicholas Stern, ''The Economics of Climate Change'' (2007); for contrary views, see William Nordhaus, A Question of Balance (2008); Martin Weitzman, ''*Review* of the *Stern Review* on the Economics of Climate Change.'' *Journal of Economic Literature,* 45(3): 703–724 (2007). Additionally, some analyses attempt to deal with uncertainty with respect to interest rates over time; a possible approach enabling the consideration of such uncertainties is discussed below. Richard Newell and William Pizer, ''Discounting the Distant Future: How Much Do Uncertain Rates Increase Valuations?'' J. Environ. Econ. Manage. 46 (2003) 52–71.

The application of the methodology outlined above yields estimates of the SCC that are reported in Table IV.31. These estimates are reported separately using 3 percent and 5 percent discount rates. The cells are empty in rows 10 and 11 because these studies did not report estimates of the SCC at a 3 percent discount rate. The model-weighted means are reported in the final or summary row; they are $33 per tCO_2 at a 3% discount rate and $5 per tCO_2 with a 5% discount rate.

TABLE IV.31—GLOBAL SOCIAL COST OF CARBON ESTIMATES ($/$tCO_2$ IN 2007 IN 2007$), BASED ON 3% AND 5% DISCOUNT RATES *

	Model	Study	Climate scenario	3%	5%
1	FUND	Anthoff *et al.* 2009	FUND default	6	−1
2	FUND	Anthoff *et al.* 2009	SRES A1b	1	−1
3	FUND	Anthoff *et al.* 2009	SRES A2	9	−1
4	FUND	Link and Tol 2004	No THC	12	3
5	FUND	Link and Tol 2004	THC continues	12	2
6	FUND	Guo *et al.* 2006	Constant PRTP	5	−1
7	FUND	Guo *et al.* 2006	Gollier discount 1	14	0
8	FUND	Guo *et al.* 2006	Gollier discount 2	7	−1
			FUND Mean	8.25	0
9	PAGE	Wahba & Hope 2006	A2–scen	57	7
10	PAGE	Hope 2006			7
11	DICE	Nordhaus 2008			8

TABLE IV.31—GLOBAL SOCIAL COST OF CARBON ESTIMATES ($/TCO$_2$ IN 2007 IN 2007$), BASED ON 3% AND 5% DISCOUNT RATES *—Continued

	Model	Study	Climate scenario	3%	5%
Summary			Model-weighted Mean	33	5

* The sample includes all peer reviewed, non-equity-weighted estimates included in Tol (2008), Nordhaus (2008), Hope (2008), and Anthoff *et al.* (2009), that are based on the most recent published version of FUND, PAGE, or DICE and use business-as-usual climate scenarios. All values are based on the best available information from the underlying studies about the base year and year dollars, rather than the Tol (2008) assumption that all estimates included in his review are 1995 values in 1995$. All values were updated to 2007 using a 3 percent annual growth rate in the SCC, and adjusted for inflation using GDP deflator.

DOE used the model-weighted mean values of $33 and $5 per ton (2007$), as these represent the estimates associated with the 3 percent and 5 percent discount rates, respectively. The 3 percent and 5 percent estimates have independent appeal and at this time a clear preference for one over the other is not warranted. These values were then escalated to 2008$ and rounded to $34 and $5. Thus, DOE has also included—and centered its current attention on—the average of the estimates associated with these discount rates, which is approximately $20 (in 2008$). (Based on the $20 global value, the domestic value would be approximately $1 per ton of CO_2 equivalent.)

It is true that there is uncertainty about interest rates over long time horizons. Recognizing that point, Newell and Pizer have made a careful effort to adjust for that uncertainty. See Newell and Pizer, supra. This is a relatively recent contribution to the literature.

There are several concerns with using this approach in this context. First, it would be a departure from current OMB guidance. Second, an approach that would average what emerges from discount rates of 3 percent and 5 percent reflects uncertainty about the discount rate, but based on a different model of uncertainty. The Newell-Pizer approach models discount rate uncertainty as something that evolves over time; in contrast, one alternative approach would assume that there is a single discount rate with equal probability of 3 percent and 5 percent.

Table IV.32 reports on the application of the Newell-Pizer adjustments. The precise numbers depend on the assumptions about the data generating process that governs interest rates. Columns (1a) and (1b) assume that ''random walk'' model best describes the data and uses 3 percent and 5 percent discount rates, respectively. Columns (2a) and (2b) repeat this, except that it assumes a ''mean-reverting'' process. As Newell and Pizer report, there is stronger empirical support for the random walk model.

TABLE IV.32—GLOBAL SOCIAL COST OF CARBON ESTIMATES ($/TCO$_2$ IN 2007 IN 2007$),* USING NEWELL & PIZER ADJUSTMENT FOR FUTURE DISCOUNT RATE UNCERTAINTY**

	Model	Study	Climate scenario	Random-walk model		Mean-reverting model	
				3%	5%	3%	5%
				(1a)	(1b)	(2a)	(2b)
1	FUND	Anthoff *et al.* 2009	FUND default	10	0	7	−1
2	FUND	Anthoff *et al.* 2009	SRES A1b	2	0	1	−1
3	FUND	Anthoff *et al.* 2009	SRES A2	15	0	10	−1
4	FUND	Link and Tol 2004	No THC	20	6	13	4
5	FUND	Link and Tol 2004	THC continues	20	4	13	2
6	FUND	Guo *et al.* 2006	Constant PRTP	9	0	6	−1
7	FUND	Guo *et al.* 2006	Gollier discount 1	14	0	14	0
8	FUND	Guo *et al.* 2006	Gollier discount 2	7	−1	7	−1
			FUND Mean	12	1	9	0
9	PAGE	Wahba & Hope 2006	A2-scen	97	13	63	8
10	PAGE	Hope 2006			13		8
11	DICE	Nordhaus 2008			15		9
Summary			Model-weighted Mean	55	10	36	6

* The sample includes all peer reviewed, non-equity-weighted estimates included in Tol (2008), Nordhaus (2008), Hope (2008), and Anthoff *et al.* (2009), that are based on the most recent published version of FUND, PAGE, or DICE and use business-as-usual climate scenarios. All values are based on the best available information from the underlying studies about the base year and year dollars, rather than the Tol (2008) assumption that all estimates included in his review are 1995 values in 1995$. All values were updated to 2007 using a 3 percent annual growth rate in the SCC, and adjusted for inflation using GDP deflator.

** Assumes a starting discount rate of 3 percent. Newell and Pizer (2003) based adjustment factors are not applied to estimates from Guo *et al.* (2006) that use a different approach to account for discount rate uncertainty (rows 7–8).

The resulting estimates of the social cost of carbon are necessarily greater. When the adjustments from the random walk model are applied, the estimates of the social cost of carbon are $10 and $55 (2007$), with the 5 percent and 3 percent discount rates, respectively. The application of the mean-reverting adjustment yields estimates of $6 and $36 (2007$). Since the random walk model has greater support from the data, DOE also used the SCC values of $10 and $55 (2007$). When escalated to 2008$, these values were approximately $10 and $56.

In summary, in considering the potential global benefits resulting from reduced CO_2 emissions, DOE used values based on a social cost of carbon of approximately $5, $10, $20, $34 and

$56 per metric ton avoided in 2007 (values expressed in 2008$). DOE also calculated the domestic benefits based on a value of approximately $1 per metric ton avoided in 2007. To monetize the CO_2 emissions reductions expected to result from amended standards for heating products in 2013–2045, DOE escalated the above values for 2007 using a three-percent escalation rate. As indicated in the discussion above, estimates of SCC are assumed to increase over time since future emissions are expected to produce larger incremental damages as physical and economic systems become more stressed as the magnitude of climate change increases. Although most studies that estimate economic damages caused by increased GHG emissions in future years produce an implied growth rate in the SCC, neither the rate itself nor the information necessary to derive its implied value is commonly reported. However, applying a rate of 3 percent per year is consistent with the range recommended by IPCC (2007).

DOE recognizes that scientific and economic knowledge about the contribution of CO_2 and other GHG to changes in the future global climate and the potential resulting damages to the world economy continues to evolve rapidly. Thus, any value placed in this rulemaking on CO_2 emissions reduction 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 greenhouse gas 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 ongoing interagency review process.

3. Valuation of Other Emissions Reductions

DOE also investigated the potential monetary benefit of reduced NO_X and Hg emissions from the TSLs it considered. As previously stated, DOE's analysis assumed the presence of nationwide emission caps on SO_2 and caps on NO_X emissions in the 28 States covered by the CAIR. In the presence of these caps, the NEMS–BT modeling system that DOE used to forecast emissions reduction indicated that no physical reductions in power sector emissions would occur for SO_2, but that the standards could put slight downward pressure on the prices of emissions allowances in cap-and-trade markets. Estimating this effect is very difficult because such factors as credit banking can change the trajectory of prices. From its modeling to date, DOE is unable to estimate a benefit from SO_2 emissions reductions at this time. See the environmental assessment in the NOPR TSD for further details.

As noted above, new or amended energy conservation standards would reduce NO_X emissions in those 22 States that are not affected by the CAIR, in addition to the reduction in site NO_X emissions nationwide. DOE estimated the monetized value of NO_X emissions reductions resulting from each of the TSLs considered for today's NOPR based on environmental damage estimates from the literature. Available estimates suggest a very wide range of monetary values, ranging from $370 per ton to $3,800 per ton of NO_X from stationary sources, measured in 2001$ (equivalent to a range of $442 to $4,540 per ton in 2008$). Refer to the OMB, 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,'' Washington, DC, for additional information.

For Hg emissions reductions, DOE estimated the monetized values resulting from the TSLs considered for today's NOPR based on environmental damage estimates from the literature. The impact of mercury emissions from power plants on humans is considered highly uncertain. However, DOE identified two estimates of the environmental damage of mercury based on estimates of the adverse impact of childhood exposure to methyl mercury on intelligence quotient (IQ) for American children, and subsequent loss of lifetime economic productivity resulting from these IQ losses. The high-end estimate is based on an estimate of the current aggregate cost of the loss of IQ in American children that results from exposure to mercury of U.S. power plant origin ($1.3 billion per year in 2000$), which works out to $33.3 million per ton emitted per year (2008$). Refer to L. Trasande *et al.,* ''Applying Cost Analyses to Drive Policy that Protects Children,'' 1076 Ann. N.Y. Acad. Sci. 911 (2006) for additional information. DOE's low-end estimate is $0.66 million per ton emitted (in 2004$) or $0.745 million per ton in 2008$. DOE derived this estimate from an evaluation of mercury control that used different methods and assumptions from the first study but was also based on the present value of the lifetime earnings of children exposed. See Ted Gayer and Robert Hahn, ''Designing Environmental Policy: Lessons from the Regulation of Mercury Emissions,'' Regulatory Analysis 05–01, AEI-Brookings Joint Center for Regulatory Studies, Washington, DC (2004). A version of this paper was published in the *Journal of Regulatory Economics* in 2006.

EEI stated that the costs of remediating emissions of CO_2, SO_2, NO_X, and Hg are included in the rates customers pay, so monetizing their values would be double counting. (EEI, No. 40 at p. 6) DOE understands the comment as referring to actions power plant operators take to meet environmental regulations, the costs of which are reflected in electricity rates. With regulations currently in place, revised standards for heating products would result in a reduction in CO_2, NO_X, and Hg emissions by avoiding electricity generation. Because these emissions impose societal costs, their reduction has an economic value that can be estimated.

Earthjustice stated that DOE must calculate and monetize the value of the reductions in emissions of particulate matter (PM) that will result from standards; even if DOE cannot consider secondary PM emissions, it must consider primary emissions. (Earthjustice, No. 47 at p. 5) DOE agrees that PM impacts are of concern due to human exposures that can impact health. But impacts of PM emissions reduction are much more difficult to estimate than other emissions reductions due to the complex interactions between PM, other power plant emissions, meteorology and atmospheric chemistry that impact human exposure to particulates. Human exposure to PM usually occurs at a significant distance from the power plants that are emitting particulates and particulate precursors. When power plant emissions travel this distance they undergo highly complex atmospheric chemical reactions. While the Environmental Protection Agency (EPA) does keep inventories of direct PM emissions of power plants, in its source attribution reviews the EPA does not separate direct PM emissions from power plants from the particulates indirectly produced through complex atmospheric chemical reactions. This is in part because SO_2 emissions react with direct PM emissions particles to produce combined sulfate particulates. Thus it is not useful to examine how the standard impacts direct PM emissions independent of indirect PM production and atmospheric dynamics. DOE is not currently able to run a model that can make these estimates reliably at the national level.

Earthjustice stated that DOE must consider coming climate change legislation and a national cap on carbon emissions and must account for the effect of the standards in reducing allowance prices. (Earthjustice, No. 47 at p. 4) Because no climate change legislation has been enacted to date, the timing and shape of any national cap on carbon emissions is uncertain at this point. Therefore, DOE did not account for such a cap in its NOPR analysis.

V. Analytical Results

A. Trial Standard Levels

DOE analyzed the benefits and burdens of a number of TSLs for each of the three types of heating products separately. For a given product consisting of several product classes, DOE developed some of the TSLs so that each TSL is comprised of energy efficiency levels from each product class that exhibit similar characteristics. For example, in the case of water heaters, one of the TSLs consists of the max-tech efficiency levels from each product class being considered for this rulemaking. DOE attempted to limit the number of TSLs considered for the NOPR by eliminating efficiency levels that do not exhibit significantly different economic and/or engineering characteristics from the efficiency levels already selected as a TSL. A description of each TSL DOE analyzed for each of the three types of heating products is provided below. While DOE only presents the results for those efficiency levels in TSL combinations in today's NOPR, DOE presents the results for all efficiency levels analyzed in the NOPR TSD. DOE requests comments on the results for all of the efficiency levels since DOE could consider any combination of efficiency levels for the final rule as a result of comments from interested parties.

1. Water Heaters

Table V.1 shows the seven TSLs DOE analyzed for water heaters. Since amended water heater standards would apply to the full range of storage volumes, DOE is presenting the TSLs for water heaters in terms of the energy efficiency equations, rather than only showing the required efficiency level at the representative capacities. As discussed in section IV.C.7, DOE is using the alternative energy-efficiency equations developed in the engineering analysis for the NOPR. DOE is grouping the energy efficiency equations for each of the four water heater product classes to show the benefits and burdens of amended energy conservation standards.

For TSL 1, 2, 3, and 4, DOE is using the rated storage volume divisions and the energy efficiency equations as shown in section IV.C.7, which specify a two-slope approach. TSL 1 consists of the efficiency levels for each product class that are approximately equal to the current shipment-weighted average efficiency. TSL 2 and TSL 3 consist of efficiency levels with slightly higher efficiencies compared to TSL 1 for most of the product classes. TSL 4 represents the maximum electric resistance water heater efficiency across the entire range of storage volumes that DOE analyzed for electric storage water heaters, and the maximum atmospherically vented efficiency across the entire range of storage volumes that DOE analyzed for gas-fired storage water heaters.

For TSL 5, DOE further modified the two-slope approach developed in the engineering analysis. For this TSL, DOE considers a pairing of efficiency levels that would promote the penetration of advanced technologies into the electric and gas-fired storage water heater markets and potentially save additional energy by using a two-slope approach with different requirements for each subsection. Consequently, DOE pairs an efficiency level requiring heat pump technology for large-volume electric storage water heaters with an efficiency level achievable using electric resistance technology for small-volume electric storage water heaters. In addition, DOE pairs an efficiency level requiring condensing technology for large-volume gas storage water heaters with an efficiency level that can be achieved in atmospherically vented gas-fired storage water heaters with increased insulation thickness for small storage volumes.

In addition to pairing different technologies for small and large volume products for TSL 5, DOE also modified the division point between small-volume and large-volume gas-fired and electric storage water heaters. DOE used an analysis of market data to determine the initial division points (see section IV.C.7 for details), which were 60 gallons for gas-fired storage water heaters and 80 gallons for electric storage water heaters. These division points are used to modify the two-slope equations for TSLs 1, 2, 3, and 4 (as well as TSLs 6 and 7, described below). Because DOE pairs two different technologies for consideration as an amended standard in TSL 5, DOE is concerned that manufacturers may attempt to circumvent the increased standards for large-volume water heaters by producing water heaters at volumes just below the division points. As a result, DOE has chosen to modify the division points for TSL 5 to 55 gallons for gas-fired and electric storage water heaters to attempt to mitigate the potential loophole. TSL 5 includes efficiency levels that effectively require heat pump technology for electric storage water heater with rated storage volumes above 55 gallons, and efficiency levels that effectively require condensing technology for gas-fired storage water heaters with rated storage volumes above 55 gallons. Using DOE's shipments model and market assessment, DOE estimated approximately 4 percent of gas-fired storage water heater shipments and 11 percent of models would be subject to the large-volume water heater requirements using the TSL 5 division. Similarly, DOE estimated approximately 9 percent of electric storage water heater shipments and 27 percent of models would be subject to the large volume water heater requirements using the TSL 5 division.

DOE specifically seeks comment on the different approach taken in TSL 5, including the rated storage volume division of 55 gallons between small and large storage volumes for gas-fired and electric storage water heaters at TSL 5. In particular, DOE is interested in comments from interested parties regarding whether DOE should consider an alternative division in the final rule, including (but not limited to), 66 gallons or 75 gallons. In addition, DOE seeks comments regarding whether different divisions should be specified for gas-fired and electric storage water heaters such that a similar percentage of the market is impacted in terms of shipments and/or models.

TSL 6 uses the same divisions as TSL 1, 2, 3, and 4 for gas-fired water heaters. TSL 6 is identical to TSL 4 except DOE is considering a heat pump water heater level for electric storage water heaters across the entire range of storage volumes, which is compatible with ENERGY STAR criteria for electric storage water heaters at the representative rated storage volume. DOE did use a division point for the max-tech energy efficiency equations as described in the engineering analysis. TSL 7 consists of the max-tech efficiency levels for each of the water heater product classes at the time the analysis was developed. TSL 6 and 7 both require efficiency levels that can be met using heat pump technology for electric storage water heaters. TSL 7, however, requires a higher efficiency level than TSL 6, which corresponds to the max-tech efficiency level for the representative rated storage capacity (i.e., 2.2 EF at 50 gallons). TSL 7 also requires efficiency levels that can be met using condensing technology for gas-fired storage and instantaneous water heaters.

Table V.1 demonstrates the energy efficiency equations and associated two slope divisions for TSLs 1 through 7.

TABLE V.1—TRIAL STANDARD LEVELS FOR RESIDENTIAL WATER HEATERS (ENERGY FACTOR)

Trial standard level	Energy efficiency equation	
TSL 1	For GSWHs with a Rated Storage Volume at or below 60 gallons: EF = 0.675 − (0.0015 × Rated Storage Volume in gallons).	For GSWHs with a Rated Storage Volume above 60 gallons: EF = 0.699 − (0.0019 × Rated Storage Volume in gallons).
	For ESWHs with a Rated Storage Volume at or below 80 gallons: EF = 0.967 − (0.00095 × Rated Storage Volume in gallons).	For ESWHs with a Rated Storage Volume above 80 gallons: EF = 1.013 − (0.00153 × Rated Storage Volume in gallons).
	For OSWHs (over the Entire Rated Storage Volume range): EF = 0.64 − (0.0019 × Rated Storage Volume in gallons).	
	For GIWHs (over the Entire Rated Storage Volume range): EF = 0.82 − (0.0019 × Rated Storage Volume in gallons).	
TSL 2	For GSWHs with a Rated Storage Volume at or below 60 gallons: EF = 0.675 − (0.0012 × Rated Storage Volume in gallons).	For GSWHs with a Rated Storage Volume above 60 gallons: EF = 0.717 − (0.0019 × Rated Storage Volume in gallons).
	For ESWHs with a Rated Storage Volume at or below 80 gallons: EF = 0.966 − (0.0008 × Rated Storage Volume in gallons).	For ESWHs with a Rated Storage Volume above 80 gallons: EF = 1.026 − (0.00155 × Rated Storage Volume in gallons).
	For OSWHs (over the Entire Rated Storage Volume range): EF = 0.66 − (0.0019 × Rated Storage Volume in gallons).	
	For GIWHs (over the Entire Rated Storage Volume range): EF = 0.82 − (0.0019 × Rated Storage Volume in gallons).	
TSL 3	For GSWHs with a Rated Storage Volume at or below 60 gallons: EF = 0.675 − (0.0012 × Rated Storage Volume in gallons).	For GSWHs with a Rated Storage Volume above 60 gallons: EF = 0.717 − (0.0019 × Rated Storage Volume in gallons).
	For ESWHs with a Rated Storage Volume at or below 80 gallons: EF = 0.965 − (0.0006 × Rated Storage Volume in gallons).	For ESWHs with a Rated Storage Volume above 80 gallons: EF = 1.051 − (0.00168 × Rated Storage Volume in gallons).
	For OSWHs (over the Entire Rated Storage Volume range): EF = 0.66 − (0.0019 × Rated Storage Volume in gallons).	
	For GIWHs (over the Entire Rated Storage Volume range): EF = 0.82 − (0.0019 × Rated Storage Volume in gallons).	
TSL 4	For GSWHs with a Rated Storage Volume at or below 60 gallons: EF = 0.675 − (0.0012 × Rated Storage Volume in gallons).	For GSWHs with a Rated Storage Volume above 60 gallons: EF = 0.717 − (0.0019 × Rated Storage Volume in gallons).
	For ESWHs with a Rated Storage Volume at or below 60 gallons: EF = 0.960 − (0.0003 × Rated Storage Volume in gallons).	For ESWHs with a Rated Storage Volume above 60 gallons: EF = 1.088 − (0.0019 × Rated Storage Volume in gallons).
	For OSWHs (over the Entire Rated Storage Volume range): EF = 0.68 − (0.0019 × Rated Storage Volume in gallons).	
	For GIWHs (over the Entire Rated Storage Volume range): EF = 0.82 − (0.0019 × Rated Storage Volume in gallons).	

TABLE V.1—TRIAL STANDARD LEVELS FOR RESIDENTIAL WATER HEATERS (ENERGY FACTOR)—Continued

Trial standard level		
TSL 5	For GSWHs with a Rated Storage Volume at or below 55 gallons: EF = 0.675 − (0.0012 × Rated Storage Volume in gallons).	For GSWHs with a Rated Storage Volume above 55 gallons: EF = 0.831 − (0.00078 × Rated Storage Volume in gallons).
	For ESWHs with a Rated Storage Volume at or below 55 gallons: EF = 0.960 − (0.0003 × Rated Storage Volume in gallons).	For ESWHs with a Rated Storage Volume above 55 gallons: EF = 2.057 − (0.00113 × Rated Storage Volume in gallons).
	For OSWHs (over the Entire Rated Storage Volume range): EF = 0.68 − (0.0019 × Rated Storage Volume in gallons).	
	For GIWHs (over the Entire Rated Storage Volume range): EF = 0.82 − (0.0019 × Rated Storage Volume in gallons).	
TSL 6	For GSWHs with a Rated Storage Volume at or below 60 gallons: EF = 0.675 − (0.0012 × Rated Storage Volume in gallons).	For GSWHs with a Rated Storage Volume above 60 gallons: EF = 0.717 − (0.0019 × Rated Storage Volume in gallons).
	For ESWHs (over the Entire Rated Storage Volume range): EF = 2.057 − (0.00113 × Rated Storage Volume in gallons).	
	For OSWHs (over the Entire Rated Storage Volume range): EF = 0.68 − (0.0019 × Rated Storage Volume in gallons).	
	For GIWHs (over the Entire Rated Storage Volume range): EF = 0.82 − (0.0019 × Rated Storage Volume in gallons).	
TSL 7	For GSWHs (over the Entire Rated Storage Volume range): EF = 0.831 − (0.00078 × Rated Storage Volume in gallons).	
	For ESWHs (over the Entire Rated Storage Volume range): EF = 2.057 − (0.00113 × Rated Storage Volume in gallons).	
	For OSWHs (over the Entire Rated Storage Volume range): EF = 0.74 − (0.0019 × Rated Storage Volume in gallons).	
	For GIWHs (over the Entire Rated Storage Volume range): EF = 0.95 − (0.0019 × Rated Storage Volume in gallons).	

2. Direct Heating Equipment

Table V.2 demonstrates the six TSLs DOE analyzed for DHE. TSL 1 consists of the efficiency levels that are close to the current shipment-weighted average efficiency. TSL 2, TSL 3 and TSL 4 consist of efficiency levels that have gradually higher efficiency than TSL 1. TSL 5 consists of the efficiency levels that include electronic ignition and fan assist (where applicable), and TSL 6 consists of the max-tech efficiency levels.

TABLE V.2—TRIAL STANDARD LEVELS FOR DIRECT HEATING EQUIPMENT (AFUE)

Product class	TSL 1 (percent)	TSL 2 (percent)	TSL 3 (percent)	TSL 4 (percent)	TSL 5 (percent)	TSL 6 (percent)
Gas Wall Fan (over 42,000 Btu/h)	75	76	77	80	75	80
Gas Wall Gravity (over 27,000 and up to 46,000 Btu/h)	66	68	71	71	72	72
Gas Floor (over 37,000 Btu/h)	58	58	58	58	58	58
Gas Room (over 27,000 and up to 46,000 Btu/h)	66	67	68	68	83	83
Gas Hearth (over 27,000 and up to 46,000 Btu/h)	67	67	67	72	72	93

3. Gas-Fired Pool Heaters

Table V.3 shows the six TSLs DOE analyzed for pool heaters. TSL 1 consists of the efficiency level that is close to the current shipment-weighted average efficiency. TSL2 and TSL 3 consist of the efficiency levels that have gradually higher efficiency than TSL 1. TSL 4 is the highest efficiency level with positive NPV. TSL 5 is the highest analyzed non-condensing efficiency level, and TSL 6 consists of the max-tech efficiency level.

TABLE V.3—TRIAL STANDARD LEVELS FOR POOL HEATERS

[Thermal efficiency]

Product class	TSL 1 (percent)	TSL 2 (percent)	TSL 3 (percent)	TSL 4 (percent)	TSL 5 (percent)	TSL 6 (percent)
Gas	81	82	83	84	86	95

B. Economic Justification and Energy Savings

1. Economic Impacts on Consumers

a. Life-Cycle Cost and Payback Period

Consumers affected by new or amended standards usually experience higher purchase prices and lower operating costs. Generally, these impacts are best captured by changes in life-cycle costs and payback period. Therefore, DOE calculated the LCC and PBP for the potential standard levels considered in this rulemaking. DOE's LCC and PBP analyses provided key outputs for each TSL, which are reported by product in Table V.4 through Table V.13, below. In each table, the first two outputs are the average total LCC and the average LCC savings. The next three outputs show the percentage of households where the purchase of a product complying with each TSL would create a net life-cycle cost, no impact, or a net life-cycle savings for the purchaser. The last outputs are the median PBP and the average PBP for the consumer purchasing a design that complies with the TSL. The results for each TSL are relative to the efficiency distribution in the base case (no amended standards).

DOE based its LCC and PBP analyses for heating products on energy consumption under conditions of actual use, whereas it based the rebuttable presumption PBP test on consumption under conditions prescribed by the DOE test procedure, as required by EPCA. (42 U.S.C. 6295(o)(2)(B)(iii))

TABLE V.4—GAS-FIRED STORAGE WATER HEATERS: LCC AND PBP RESULTS

TSL	Energy factor	LCC					Payback period	
		Average LCC 2008$	Average LCC savings 2008$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1	0.62	3,369	69	9	22	69	1.4	4.6
2, 3, 4	0.63	3,369	68	15	17	68	2.7	11.6
5	*0.63	3,355	78	16	16	68	3.0	12.1
6	0.67	3,618	−150	67	6	27	20.9	24.6
7	0.80	3,522	−55	62	1	36	14.1	14.2

*For TSL 5, the EF and the results represent shipments-weighted averages f the EFs and results that apply to small- and large-volume water heaters, respectively. For the other TSLs the EF and the results refer to the representative rated volume (40 gal).

TABLE V.5—ELECTRIC STORAGE WATER HEATERS: LCC AND PBP RESULTS

TSL	Energy factor	LCC					Payback period	
		Average LCC 2008$	Average LCC savings 2008$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1	0.92	3,372	16	10	32	59	2.8	7.8
2	0.93	3,361	23	11	29	60	3.0	8.0
3	0.94	3,351	32	20	14	66	4.5	8.6
4	0.95	3,342	39	25	10	65	5.8	8.8
5	*1.04	3,306	96	25	10	65	5.9	9.1
6	2.00	3,145	224	45	5	50	8.3	25.9
7	2.20	3,095	273	45	1	54	8.2	21.5

*For TSL 5, the EF and the results represent shipments-weighted averages of the EFs and results that apply to small- and large-volume water heaters, respectively. For the other TSLs the EF and the results refer to the representative rated volume (50 gal).

TABLE V.6 OIL-FIRED STORAGE WATER HEATERS: LCC AND PBP RESULTS

TSL	Energy factor	LCC					Payback period	
		Average LCC 2008$	Average LCC savings 2008$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1	0.58	8,616	171	0	69	31	0.7	0.8
2	0.60	8,377	288	0	52	48	0.4	0.3
3, 4, 5, 6	0.62	8,190	395	0	45	55	0.5	0.7
7	0.68	7,863	655	0	7	93	1.4	1.7

TABLE V.7—GAS-FIRED INSTANTANEOUS WATER HEATERS: LCC AND PBP RESULTS

TSL	Energy factor	LCC					Payback period	
		Average LCC 2008$	Average LCC savings 2008$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1, 2, 3, 4, 5	0.82	5,409	0	11	85	4	23.5	30.4
6	0.92	5,665	−181	70	15	15	34.1	50.2
7	0.95	5,798	−307	83	6	12	39.5	58.7

TABLE V.8—GAS WALL FAN DHE: LCC AND PBP RESULTS

TSL	AFUE %	LCC					Payback period	
		Average LCC 2008$	Average LCC savings 2008$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1, 5	75	6,879	73	3	59	38	3.1	3.1
2	76	6,842	90	5	55	41	3.9	6.7
3	77	6,825	104	30	14	56	6.0	15.0
4, 6	80	6,793	135	44	5	52	9.8	22.6

TABLE V.9—GAS WALL GRAVITY DHE: LCC AND PBP RESULTS

TSL	AFUE %	LCC					Payback period	
		Average LCC 2008$	Average LCC savings 2008$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1	66	6,533	25	12	70	18	8.1	14.8
2	68	6,458	83	19	40	41	6.5	10.9
3, 4	71	6,349	192	39	0	61	8.3	14.1
5, 6	72	6,473	68	59	0	41	13.0	26.5

TABLE V.10—GAS FLOOR DHE: LCC AND PBP RESULTS

TSL	AFUE %	LCC					Payback period	
		Average LCC 2008$	Average LCC savings 2008$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1, 2, 3, 4, 5, 6	58	7,404	13	25	57	18	14.7	20.4

TABLE V.11—GAS ROOM DHE: LCC AND PBP RESULTS

TSL	AFUE %	LCC					Payback period	
		Average LCC 2008$	Average LCC savings 2008$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1	66	7,702	42	19	50	31	8.1	13.4
2	67	7,630	96	19	25	56	4.9	9.4
3, 4	68	7,567	143	20	25	55	5.3	10.2
5, 6	83	6,892	646	26	25	49	7.0	15.2

TABLE V.12—GAS HEARTH DHE: LCC AND PBP RESULTS

TSL	AFUE %	LCC					Payback period	
		Average LCC 2008$	Average LCC savings 2008$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1, 2, 3	67	5,195	96	9	51	40	0.0	7.9
4, 5	72	5,388	−70	69	13	17	25.9	77.6
6	93	5,571	−253	81	0	19	37.5	78.2

TABLE V.13—GAS-FIRED POOL HEATERS: LCC AND PBP RESULTS

TSL	Thermal efficiency %	LCC					Payback period	
		Average LCC 2008$	Average LCC savings 2008$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1	81	6,383	24	6	64	30	2.5	3.5
2	82	6,395	18	31	46	22	7.4	10.1
3	83	6,395	39	52	24	24	10.6	18.7
4	84	6,461	−13	*59	22	20	13.0	19.5
5	86	7,034	−555	90	6	5	28.6	42.4
6	95	7,809	−1,323	96	1	3	28.1	37.2

*For TSL 4, DOE determined that 14 percent of the consumers will experience a net cost smaller than 2 percent of their total LCC (see chapter 8 of the TSD).

b. Analysis of Consumer Subgroups

For gas-fired and electric storage water heaters, and gas wall fan and gas wall gravity DHE, DOE estimated consumer subgroup impacts for low-income households and senior-only households. In addition, for gas-fired and electric storage water heaters, DOE estimated consumer subgroup impacts for households in multi-family housing and households in manufactured homes as well. (As a reminder and as explained in section IV.6, not all products in this rulemaking were included in DOE's consumer subgroup analysis.)

For gas-fired storage water heaters, the impacts of the proposed standard (0.63 EF) are roughly the same for the senior-only sample and the low-income sample as they are for the full household sample for this product class. For the multi-family sample and the manufactured home sample, the average LCC savings are somewhat lower than they are for the full household sample, and the fraction of households experiencing a cost (negative savings) is higher. In both cases, however, the average LCC savings is positive, and more than half of the households in the identified subgroups would experience an LCC benefit.

For electric storage water heaters, the impacts of the proposed TSL 4 standard (0.95 EF) are roughly the same for the senior-only sample as they are for the full household sample for this product class. The impacts are slightly more negative for the low-income sample, and they are moderately more negative for the multi-family sample and the manufactured home sample. The average LCC savings are −$2 for the latter two subgroups, but in both cases, more than half of the households in the identified subgroups would experience an LCC benefit.

In the case of a standard for electric storage water heaters at TSL 5, which would require 2.0 EF only for large-volume water heaters, the negative subgroup impacts seen in the case of TSL 6 are substantially less because only a small fraction of the households in the subgroups has large-volume water heaters for which the standard would effectively require a heat pump water heater.

In the case of a standard for electric storage water heaters at TSL 6, the average LCC savings are lower for all of the subgroups than for the full household sample for this product class. The multi-family subgroup would experience an average negative LCC savings of $359 (*i.e.,* the average LCC would increase), and three-fourths of the households in the subgroup would experience a net cost. For the other subgroups, the fraction of households that would experience a net cost is close to or just above 50 percent, which is slightly higher than for the full household sample. The impact on the multi-family subgroup is primarily due to the lower hot water use among these households.

For gas wall fan and gas wall gravity DHE, DOE estimated that the impacts of the proposed standards are roughly the same for the senior-only sample and the low-income sample as they are for the full household sample for these product classes.

Chapter 11 of the NOPR TSD presents the detailed results of the consumer subgroup analysis.

TABLE V.14—COMPARISON OF SUBGROUP IMPACTS FOR ELECTRIC STORAGE WATER HEATERS

Subgroup	Average LCC savings (2008$)	Households with net cost (%)	Median payback period (years)
0.95 EF			
Senior-only	38	24	5.3
Low-income	17	29	6.3

TABLE V.14—COMPARISON OF SUBGROUP IMPACTS FOR ELECTRIC STORAGE WATER HEATERS—Continued

Subgroup	Average LCC savings (2008$)	Households with net cost (%)	Median payback period (years)
Multi-family	−2	35	6.8
Mobile Home	−2	34	7.0
All Households	39	25	5.8
2.0 EF			
Senior-only	30	52	9.8
Low-income	143	49	9.3
Multi-family	−359	76	23.8
Mobile Home	81	51	9.6
All Households	224	45	8.3

c. Rebuttable Presumption Payback

As discussed above, EPCA provides 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 (42 U.S.C. 6295(o)(2)(B)(iii)) 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 discussed above. 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).

In the present case, DOE calculated a rebuttable presumption payback period for each TSL. Rather than using distributions for input values, DOE used discrete values and, as required by EPCA, based the calculation on the assumptions in the DOE test procedures for the three types of heating products. As a result, DOE calculated a single rebuttable presumption payback value, and not a distribution of payback periods, for each standard level. Table V.15 through Table V.17 show the rebuttable presumption payback periods that are less than 3 years. For gas-fired and electric storage water heaters and gas wall gravity DHE and gas room DHE, there were no payback periods under 3 years.

While DOE examined the rebuttable-presumption criterion, it considered whether the standard levels considered for today's rule are economically justified through a more detailed analysis of the economic impacts of these levels pursuant to 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).

TABLE V.15—WATER HEATERS: REBUTTABLE PAYBACK PERIODS

Product class	Energy factor	PBP (years)
Oil-Fired Storage	0.54	1.0
	0.56	0.7
	0.58	0.9
	0.60	0.5
	0.62	0.7
	0.66	1.4
	0.68	1.3
Gas-Fired Instantaneous	0.69	0.9

TABLE V.16—DIRECT HEATING EQUIPMENT: REBUTTABLE PAYBACK PERIODS

Product class	AFUE %	PBP (years)
Gas Wall Fan DHE	75	2.9
	76	2.9
Gas Hearth DHE	67	2.0

TABLE V.17—POOL HEATERS: REBUTTABLE PAYBACK PERIODS

Thermal efficiency %	PBP *years*
79	1.1
81	1.9

2. Economic Impacts on Manufacturers

DOE performed an MIA to estimate the impact of amended energy conservation standards on manufacturers of residential water heaters, DHE, and pool heaters. Chapter 12 of the NOPR TSD explains this analysis in further detail. The tables below depict the financial impacts on manufacturers (represented by changes in INPV) and the conversion costs DOE estimates manufacturers would incur at each TSL. DOE shows the results by grouping product classes made by the same manufacturer and uses the scenarios that show the likely changes in industry value following amended energy conservation standards. In the following discussion, the INPV results refer the difference in industry value between the base case and the standards case that result from the sum of discounted cash flows from the base year (2010) through the end of the analysis period. The results also discuss the difference in cash flow between the base case and the standards case in the year before the compliance date of amended energy conservation standards. This figure gives a representation of how large the required conversion costs are relative to the cash flow generated by the industry in the absence of amended energy conservation standards. In the engineering analysis, DOE presents its findings of the common technology options that achieve the efficiencies for each of the representative product classes. To refer to the description of technology options and the required efficiencies at each TSL, see section IV.C of today's notice.

a. Water Heater Cash-Flow Analysis Results

DOE modeled two different markup scenarios to estimate the potential impacts of amended energy conservation standards on residential water heater manufacturers. To assess the lower end of the range of potential impacts on water heater manufacturers, DOE modeled the preservation of return on invested capital scenario. Besides the impact of the main NIA shipment scenario and the required capital and product conversion costs on INPV, this case models that manufacturers would maintain the base-case return on invested capital in the standards case. This scenario represents the lower end of the range of potential impacts on manufacturers because manufacturers generate a historical rate of additional operating profit on the physical and financial investments required by energy conservation standards.

To assess the higher end of the range of potential impacts on the residential water heater industry, DOE modeled the preservation of operating profit markup scenario in which higher energy conservation standards result in lower manufacturer markups. This scenario models manufacturers' concerns about the higher costs of more efficient technology harming profitability. The scenario represents the upper end of the range of potential impacts on manufacturers only because no additional operating profit is earned on the investments required the meet the amended energy conservation standards. The results of these scenarios for the residential water heater industry are presented in Table V.18 through Table V.23.

i. Cash-Flow Analysis Results for Gas-Fired and Electric Storage Water Heaters

TABLE V.18—MANUFACTURER IMPACT ANALYSIS FOR GAS-FIRED AND ELECTRIC STORAGE WATER HEATERS—PRESERVATION OF RETURN ON INVESTED CAPITAL MARKUP SCENARIO

	Units	Base case	Trial standard level						
			1	2	3	4	5	6	7
INPV	(2008$ millions)	842.7	838.9	837.7	837.8	839.2	821.8	840.7	905.7
Change in INPV	(2008$ millions)		(3.8)	(5.1)	(4.9)	(3.5)	(20.9)	(2.0)	62.9
	(%)		−0.45%	−0.60%	−0.59%	−0.41%	−2.48%	−0.24%	7.47%
Product Conversion Costs.	(2008$ millions)		11.0	13.2	13.2	13.2	28.9	55.7	72.6
Capital Conversion Costs.	(2008$ millions)		0.0	3.9	3.9	37.1	58.0	69.3	189.2
Total Investment Required.	(2008$ millions)		11.0	17.0	17.0	50.3	86.9	125.0	261.8

TABLE V.19—MANUFACTURER IMPACT ANALYSIS FOR GAS-FIRED AND ELECTRIC STORAGE WATER HEATERS—PRESERVATION OF OPERATING PROFIT MARKUP SCENARIO

	Units	Base case	Trial standard level						
			1	2	3	4	5	6	7
INPV	(2008$ millions)	842.7	830.4	812.0	807.4	$763.9	712.8	$536.9	$305.1
Change in INPV	(2008$ millions)		(12.3)	(30.7)	(35.3)	(78.8)	(129.9)	(305.8)	(537.6)
	(%)		−1.46%	−3.64%	−4.19%	−9.35%	−15.41%	−36.29%	−63.79%
Product Conversion Costs.	(2008$ millions)		11.0	13.2	13.2	13.2	28.9	55.7	72.6
Capital Conversion Costs.	(2008$ millions)		0.0	3.9	3.9	37.1	58.0	69.3	189.2
Total Investment Required.	(2008$ millions)		11.0	17.0	17.0	50.3	86.9	125.0	261.8

TSL 1 represents an improvement in efficiency from the baseline level of 0.59 EF to 0.62 EF for gas-fired storage water heaters for the representative rated storage volume of 40 gallons. For electric storage water heaters TSL 1 represents an improvement in efficiency from the baseline level of 0.90 EF to 0.92 EF for the representative rated storage volume of 50 gallons. At TSL 1, DOE estimates the impacts on INPV to range from −$3.8 million to −$12.3 million, or a change in INPV of −0.45 percent to −1.46 percent. At this level, the industry cash flow is estimated to decrease by approximately 4.8 percent, to $58.1 million, compared to the base-case value of $61.0 million in the year leading up to the standards. Currently, over 75 percent of the gas-fired storage water heaters are sold at the baseline level. However, all manufacturers also offer a full line of gas-fired storage water heaters that meet the gas-fired efficiencies at TSL 1. Although the majority of the electric storage water heater shipments do not meet TSL 1, every manufacturer also offers a full line of electric storage water heaters at or above this level. Because manufacturers have existing products and manufacturers could reach the required efficiencies with relatively minor changes to the foam insulation thickness at TSL 1, manufacturers of gas-fired and electric storage water heaters would have minimal conversion costs at TSL 1. Because the technology required at TSL 1 is similar to the baseline, the INPV impacts are similar for both markup scenarios. It is hence unlikely that TSL 1 would greatly reduce manufacturers' profitability.

TSL 2 represents an improvement in efficiency from the baseline level of 0.59 EF to 0.63 EF for gas-fired storage water heaters for the representative rated storage volume of 40 gallons. For electric storage water heaters, TSL 2 represents an improvement in efficiency from the baseline level of 0.90 EF to 0.93 EF for the representative rated storage volume of 50 gallons. At TSL 2, DOE estimates the impacts on INPV to range from −$5.1 million to −$30.7 million, or a change in INPV of −0.60 percent to −3.64 percent. At this level, the industry cash flow is estimated to decrease by approximately 8.7 percent, to $55.7 million, compared to the base-case value of $61.0 million in the year leading up to the standards. Currently, over 80 percent of the gas-fired storage water heaters sold do not meet TSL 2. At TSL 2, manufacturers are expected to meet the gas-fired efficiency requirements by adding additional insulation to their existing products. The conversion costs at TSL 2 are relatively minor for gas-fired storage water heaters because most manufacturers have a full line of products at the required efficiency for TSL 2 and only minor changes in the manufacturing process would be required. Although the majority of the electric storage water heater market is below the efficiency specified for electric storage water heaters at TSL 2, more than 28 percent of the market is at or above this level. Manufacturers would have increasing conversion costs for both capital and product conversion for electric storage water heaters to modify production facilities to accommodate the extra insulation required at TSL 2. Because the technology required at TSL 2 is similar to the baseline for gas-fired and electric storage water heaters, however, it is unlikely that TSL 2 would greatly impact manufacturers' profitability.

Similar to TSL 2, TSL 3 represents an improvement in efficiency from the baseline level of 0.59 EF to 0.63 EF for gas-fired storage water heaters for the representative rated storage volume of 40 gallons. Because the efficiency requirements for gas-fired storage water heaters are the same at TSL 3 as at TSL 2, the impacts on manufacturers are the same as at TSL 2 for the gas-fired storage efficiency requirements. There are small impacts on manufacturers to improve the efficiency of the majority of the gas-fired storage shipments from the baseline. However, because these changes are expected to be relatively minor increases to the insulation thickness, the impacts on the industry are not substantial because these changes do not greatly alter the current manufacturing process. TSL 3 represents a further improvement in efficiency for electric storage water heaters from the baseline level of 0.90 EF to 0.94 EF for the representative rated storage volume of 50 gallons. To achieve the efficiency levels for TSL 3, electric storage manufacturers would be expected to further increase tank insulation thickness, with still relatively small conversion costs because many manufacturers already manufacture storage water heaters at TSL 3. DOE estimates the INPV impacts to range from −$4.9 million to −$35.3 million, or a change in INPV of −0.59 percent to −4.19 percent. At this level, the industry cash flow is estimated to decrease by approximately 8.7 percent to $55.7 million, compared to the base-case value of $61.0 million in the year leading up to the standards.

Similar to TSL 2 and TSL 3, TSL 4 represents an improvement in efficiency from the baseline level of 0.59 EF to 0.63 EF for gas-fired storage water heaters for the representative rated storage volume of 40 gallons. Because the efficiency requirements for gas-fired storage water heaters are the same at TSL 4 as at TSL 2 and TSL 3, the impacts on gas-fired manufacturers are the same. There are small impacts on manufacturers to improve the efficiency of the majority of the gas-fired storage shipments from the baseline. However, because these changes are expected to be relatively minor increases to the insulation thickness, the impacts on the industry are not substantial because these changes do not greatly alter the current manufacturing process. TSL 4 represents a further improvement in efficiency from the baseline level of 0.90 EF to 0.95 EF for electric storage water heaters at the representative rated storage volume of 50 gallons. Based on a review of units on the market at these efficiency levels, DOE expects that manufacturers would likely further increase insulation levels. Because not all manufacturers have models at this efficiency currently available on the market, however, DOE expects that electric storage water heater manufacturers would incur higher conversion costs at TSL 4 than at TSL 3. At TSL 4, DOE estimates the INPV impacts to range from −$3.5 million to −$78.8 million, or a change in INPV of −0.41 percent to −9.35 percent. At this level, the industry cash flow is estimated to decrease by approximately 33.2 percent to $40.8 million, compared to the base-case value of $61.0 million in the year leading up to the standards. Only a small number of electric storage water heaters on the market meet the efficiency level for electric storage water heaters required by TSL 4. Electric storage manufacturers would have increasing conversion costs for both capital and product conversion to greatly increase the production of low volume products. The capital conversion costs for electric storage water heaters are more substantial than for gas-fired storage water heaters because each production line would require additional foaming stations to accommodate the greatly increased insulation thicknesses and, due to slower production speeds, adding additional production lines in existing facilities to maintain current shipment volumes. Manufacturers also noted that they were concerned about TSL 4 for electric storage water heaters because of problems with the test procedure that could make it difficult replicate the efficiencies required at this TSL.

TSL 5 has the same efficiency requirements as TSL 4 for gas-fired and electric storage water heaters with rated storage volumes less than 55 gallons. Because the efficiency requirements for gas-fired and electric storage water heaters with rated storage volumes less than 55 gallons are equal to TSL 4, at TSL 5 manufacturers share the same concerns for these rated storage volumes as at TSL 4. However, the efficiency requirements for gas-fired storage water heaters with rated storage volumes greater than 55 gallons effectively require condensing technology, and the efficiency requirements for electric storage water heaters with rated storage volumes greater than 55 gallons effectively require heat pump technology. At TSL 5, DOE estimates the INPV impacts to range from −$20.9 million to −$129.9 million, or a change in INPV of −2.48 percent to −15.41 percent. At this level, the industry cash flow is estimated to decrease by approximately 55.6 percent to $27.1 million, compared to the base-case value of $61.0 million in the year leading up to the standards. The higher, negative impacts on INPV are largely caused by the additional conversion costs required to substantially change the technology commonly used in large size gas-fired and electric storage water heaters today. DOE estimates the approximately 4 percent of gas-fired storage water heater shipments with rated volumes greater than 55 gallons would require an additional $13 million in conversion costs to use condensing technology. DOE estimates the approximately 9 percent of gas-fired storage water heater shipments with rated volumes greater than 55 gallons would require an additional $24 million in conversion costs to use heat pump technology.

Much of the additional capital conversion costs calculated for large volume sizes at TSL 5 involve creating an additional gas-fired and electric assembly line in a facility adjacent to a current production facility. Because high-volume manufacturing facilities are typically arranged for units with similar assembly processes, the more complex technology used for larger rated volumes at TSL 5 could not be accommodated on existing production lines. The estimated product conversion costs at TSL 5 would involve retraining existing service and installation personnel, who have little experience installing and servicing storage water heaters that use these advanced technologies. To minimize unit damage and warranty claims and improve market acceptance, manufacturers would likely have to expend significant additional resources to hire training staff to provide more technical support.

The other portion of the product conversion costs for large rated volumes are the product development effort to redesign existing products. Manufacturers could face constraints regarding the abilities of their engineering teams to develop multiple water heater families at TSL 5, as most engineering departments have limited experience with either technology. At a minimum, the efficiency requirements at TSL 5 would require manufacturers to convert existing commercial condensing gas products for residential use. However, multiple manufacturers would also have to develop completely new platforms in order to remain cost-competitive. Even if a manufacturer were to offer incur these high conversion costs, the high product development and capital conversion costs for a small segment of the overall market make it likely that consumers will have fewer product families to choose from after the compliance date of the final rule.

Even if manufacturers offer gas condensing and electric heat pump water heaters for the large gallon sizes at TSL 5, there could be additional, negative impacts on consumers that could lead to a smaller market for these products. Consumers might no longer purchase water heaters with rated storage volumes above 55 gallons because of substantially higher increased first costs than most products currently on the market, the unfamiliar technologies, and size limitations. Because of these changes in the market, at TSL 5, manufacturers could decide that the demand for residential heat pump and condensing gas water heaters would drop to a point where the high product conversion and capital costs required for a small portion of total shipments are not justified. As a result, manufacturers would no longer manufacture residential storage water heaters at rated storage volumes above 55 gallons. In addition, consumers could be impacted if fewer contractors were willing to install these more complex products, especially if field technicians did not obtain any additional licenses and test equipment that could be required to service heat pump water heaters. These additional requirements would also likely increase installation and service costs beyond current levels since consumers would have fewer servicers/installers to choose from.

Similar to TSL 2 through TSL 4, TSL 6 represents an improvement in efficiency from the baseline level of 0.59 EF to 0.63 EF for gas-fired storage water heaters for the representative rated storage volume of 40 gallons. Similarly, the impacts on manufacturers due to the gas-fired storage efficiencies are relatively minor because the required efficiencies for all volume sizes can likely be met with relatively minor changes to the insulation thickness. For electric storage water heaters, TSL 6 represents an improvement in efficiency from the baseline level of 0.90 EF to 2.0 EF for electric storage water heaters at the representative rated storage volume of 50 gallons. At TSL 6, DOE estimates the impacts on INPV to range from −$2.0 million to −$305.8 million, or a change in INPV of −0.24 percent to −36.29 percent. At TSL 6, the industry cash flow is estimated to decrease by approximately 75.7 percent, to $14.8 million, compared to the base-case value of $61.0 million in the year leading up to the standards. To achieve efficiencies at or above TSL 6 would require the use of heat pumps for electric storage water heaters for all rated volumes, a technology option that has yet to see wide adoption in the U.S. market. The higher expected purchased part content and market pressures would be expected to reduce manufacturer profits margins substantially. Although most electric storage water heater manufacturers indicated that they are in the process of developing heat pump water heaters, all manufacturers believe that an efficiency level that requires heat pump water heater technology is not appropriate as an amended energy conservation standard. Manufacturers stated that they would face substantial costs to switch their entire electric storage water heater production over to heat pump electric storage water heaters. Several manufacturers expect that they will have to buy the heat pump modules from outside vendors since most water heater manufacturers have no experience manufacturing heat pumps and have limited space in their facilities to produce heat pump systems. Multiple manufacturers stated that even if they were to simply buy and integrate heat pump modules, there would be substantial product development and capital conversion costs because present facilities are not adequate to handle the heat pump modules. DOE estimates that manufacturers would incur almost $70 million in capital conversion costs to modify production facilities to exclusively manufacture heat pump electric storage water heaters. These capital conversion cost estimates do not include the cost of building manufacturing capacity to produce the heat pump modules because DOE believes manufacturers will likely purchase these as subassemblies.

Furthermore, manufacturers stated that they would consider moving all or part of their existing production capacity abroad if the energy conservation standard is set at TSL 6 because many manufacturers expect that they would have to redesign their facilities completely to accommodate a minimum energy conservation standard at this TSL. According to these manufacturers, building a new facility entails less business disruption risk than attempting to completely redesign and upgrade existing facilities, and lower labor rates in Mexico and other countries abroad may entice manufacturers to move their production facilities outside of the U.S. In addition, manufacturers are very concerned about the significant number of customers who would face extremely costly installations for electric storage water heater replacements if a standard effectively requiring heat pump technology is mandated. According to manufacturers, a significant percentage of electric storage water heaters are installed in space-constrained environments which cannot accommodate the additional space required for the heat pump module. This is especially true for mobile homes and other consumer sub-groups that use smaller capacity tanks.

Another concern of manufacturers at TSL 6 is the amount of additional training that would be necessary to upgrade the installation, distribution, and maintenance networks on the scale necessary to support an electric storage water heater market that used heat pump technology exclusively. Stated more simply, manufacturers are concerned that the typical installer or repair person would not have the requisite knowledge to troubleshoot or repair heat pump water heaters. Manufacturers also expressed concern about profitability if amendments to the minimum energy conservation standard for electric storage water heaters were to require the use of heat pump technology. An amended energy conservation standard that effectively mandated heat pump technology would completely change the nature of their business. The production costs for an integrated heat pump water heater at the 50-gallon representative rated storage volume are approximately four times the baseline production costs. Specifically, manufacturers believe that because this technology results in much more expensive units than the majority of products on the market today, not all of the increased costs could be passed on to the customer. In addition, the significantly higher production costs would require an additional $256 million in working capital to purchase significantly more expensive components, carry more costly inventory, and handle higher accounts receivable. DOE estimates that the working capital requirement and conversion costs would cause electric storage water heater manufacturers to incur a total one-time investment of at least $375 million in an electric storage market valued at approximately $311 million. Finally, manufacturers believe it is unlikely that they could earn the same return on these extremely large investments, so profitability would be expected to decrease after the compliance date of the amended energy conservation standards.

TSL 7 represents an improvement in efficiency from the baseline level of 0.59 EF to 0.80 EF for gas-fired storage water heaters for the representative rated storage volume of 40 gallons. TSL 7 represents an improvement in efficiency from the baseline level of 0.90 EF to 2.2 EF for electric storage water heaters at the representative rated storage volume of 50 gallons. At TSL 7, DOE estimates the impacts on INPV to range from $62.9 million to −$537.6 million, or a change in INPV of 7.47 percent to −63.79 percent. At TSL 7, the industry cash flow is estimated to decrease by approximately 171.6 percent, to −$43.7 million, compared to the base-case value of $61.0 million in the year leading up to the standards. Because TSL 7 also requires improved heat pump technology (with additional efficiency-related improvements to both the heat pump module and the water heater tank), electric storage water heater manufacturers shared the same concerns at TSL 7 as they had at TSL 6. Because additional, more-costly improvements to heat pump technology are required, however, electric storage water heater manufacturers were more concerned about the potential for energy conservation standards to greatly disrupt the industry if the amended energy conservation standard were set at TSL 7.

For gas-fired storage water heaters, TSL 7 requires manufacturers to produce fully-condensing gas-fired storage water heaters, which is significantly more complex than the insulation changes required at most lower TSLs. Currently, no manufacturer offers residential gas-fired storage water heaters with condensing technology. Manufacturers would need to redesign their products at the condensing level, which would force manufacturers to incur significant product and capital conversion costs. Some loss in product utility may also occur for units that are presently installed in space-constrained applications because condensing water heaters require greater installation space to accommodate bigger heat exchangers, fully-installed blowers, and other components that non-condensing models do not feature. At the condensing level, manufacturers would be required to purchase substantial tooling to fabricate new coil and tank designs and make changes to all subassembly and main assembly lines. DOE estimates that manufacturers would incur approximately $111 million in capital conversion costs to modify their production facilities. Some gas-fired storage water heater manufacturers stated during interviews that they would consider moving facilities offshore at TSL 7 to take advantage of lower labor costs. In addition, due to the complexity and large size of storage water heaters at this efficiency, manufacturers are concerned that installations will be far more difficult and could force many consumers to pay substantially higher installed costs if their replacement water heater does not fit into their existing space. Manufacturers are also concerned about profitability if standards were set at a level that would effectively require condensing technology. An amended energy conservation standard that effectively mandated condensing gas-fired storage water heaters would completely change the existing structure of the industry. Because this technology results in much more expensive units than the majority of products on the market today, manufacturers argued that not all of the increased costs could be passed on to the customer. In addition, the significantly higher production costs would require at least an additional $145 million in working capital to purchase significantly more expensive components, carry more costly inventory, and handle higher accounts receivable. DOE estimates that the working capital requirement and conversion costs would cause gas-fired storage water heater manufacturers to incur a total one-time investment of at least $276 million in a gas-fired storage market valued at approximately $532 million. While there is a slightly positive impact if manufacturers get the same return on these investments as in the base case, manufacturers believe that they will not earn the same return from the substantially higher capital requirements at TSL 7.

ii. Cash-Flow Analysis Results for Oil-Fired Storage Water Heaters

TABLE V.20—MANUFACTURER IMPACT ANALYSIS FOR OIL-FIRED STORAGE WATER HEATERS—PRESERVATION OF RETURN ON INVESTED CAPITAL MARKUP SCENARIO

	Units	Base case	Trial standard level						
			1	2	3	4	5	6	7
INPV	(2008$ millions)	8.7	8.5	8.5	8.5	8.5	8.5	8.5	7.4
Change in INPV	(2008$ millions)	....	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(1.3)
	(%)	....	−1.93%	−1.78%	−1.96%	−1.96%	−1.96%	−1.96%	−14.84%
Product Conversion Costs.	(2008$ millions)	....	0.3	0.3	0.3	0.3	0.3	0.3	1.0
Capital Conversion Costs.	(2008$ millions)	....	0.2	0.2	0.2	0.2	0.2	0.2	3.6
Total Investment Required.	(2008$ millions)	....	0.5	0.5	0.5	0.5	0.5	0.5	4.6

TABLE V.21—MANUFACTURER IMPACT ANALYSIS FOR OIL-FIRED STORAGE WATER HEATERS—PRESERVATION OF OPERATING PROFIT MARKUP SCENARIO

	Units	Base case	Trial standard level						
			1	2	3	4	5	6	7
INPV	(2008$ millions)	8.7	8.3	8.4	8.3	8.3	8.3	8.3	5.2
Change in INPV	(2008$ millions)	....	(0.3)	(0.3)	(0.4)	(0.4)	(0.4)	(0.4)	(3.5)
	(%)	....	−3.89%	−3.58%	−4.31%	−4.31%	−4.31%	−4.31%	−39.86%
Product Conversion Costs.	(2008$ millions)	....	0.3	0.3	0.3	0.3	0.3	0.3	1.0
Capital Conversion Costs.	(2008$ millions)	....	0.2	0.2	0.2	0.2	0.2	0.2	3.6
Total Investment Required.	(2008$ millions)	....	0.5	0.5	0.5	0.5	0.5	0.5	4.6

TSL 1 represents an improvement in efficiency for oil-fired storage water heaters from the baseline level of 0.53 EF to 0.58 EF for the representative rated storage volume of 32 gallons. At TSL 1, DOE estimates the impacts on INPV to range from −$0.2 to −$0.3 million, or a change in INPV of −1.93 percent to −3.89 percent. At this level, the industry cash flow would be expected to decrease by approximately 28.5 percent, to $0.4 million, compared to the base-case value of $0.6 million in the year leading up to the standards. At TSL 1, one of the two major manufacturers would have to incur relatively small product and capital conversion costs to slightly modify their existing product line. DOE research suggests that this TSL can be met with changes to the insulation thickness of baseline products. However, if more costly design changes were required it could have more of an impact on the industry.

TSL 2 represents an improvement in efficiency from the baseline level of 0.53 EF to 0.60 EF for the representative rated storage volume of 32 gallons. At TSL 2, DOE estimates the impacts on INPV to range from −$0.2 million to −$0.3 million, or a change in INPV of −1.78 percent to −3.58 percent. At this level, the industry cash flow is estimated to decrease by approximately 28.5 percent, to $0.4 million, compared to the base-case value of $0.6 million in the year leading up to the standards. Similar to TSL 1, at TSL 2 DOE has tentatively concluded, based on a review of existing products on the market, that TSL 2 could be met with changes to the type and thickness of the insulation. The impacts at TSL 1 are slightly worse than at TSL 2 because the technology option for existing oil-fired storage water heaters on the market results in lower product costs at TSL 2. However, if TSL 2 is met with similar insulation changes, only one of two major manufacturers would still be required to slightly modify their current residential oil-fired storage product lines at TSL 2.

TSLs 3 through TSL 6 represent an improvement in efficiency from the baseline level of 0.53 EF to 0.62 EF for the representative rated storage volume of 32 gallons. At these levels, DOE estimates the impacts on INPV to range from −$0.2 million to −$0.4 million, or a change in INPV of −1.96 percent to −4.31 percent. At this level, the industry cash flow decreases by approximately 28.5 percent, to $0.4 million, compared to the base-case value of $0.6 million in the year leading up to the standards. At these TSLs, one major manufacturer would have to incur relatively minor product and capital conversion costs to modify their existing oil-fired residential storage water heater product line. DOE has tentatively concluded based on a review of existing products on the market that the efficiency requirements at TSL 3 through TSL 6 could be met with changes to the type and thickness of the insulation. Due to the low volume of oil-fired storage water heaters, if any manufacturer had to make substantial product or capital conversion costs to reach the amended energy conservation standard using a more complex technology, these substantial costs could force them to consider exiting the residential oil-fired storage water heater market.

TSL 7 (the max-tech level) represents an improvement in efficiency from the baseline level of 0.53 EF to 0.68 EF for the representative rated storage volume of 32 gallons. At TSL 7, DOE estimates the impacts on INPV to range from −$1.3 million to −$3.5 million, or a change in INPV of −14.84 percent to −39.86 percent. At this level, the industry cash flow is estimated to decrease by approximately 342.5 percent, to −$1.3 million, compared to the base-case value of $0.6 million in the year leading up to the standards. At TSL 7, at least one major manufacturer would have to incur very substantial product and capital conversion to redesign the combustion and baffling system to include a multi flue design. Given the small size of the residential oil-fired storage water heater market, this manufacturer stated that these extremely large substantial product and capital conversion costs would be difficult to justify. At TSL 7, it is possible that this manufacturer would exit the residential oil-fired storage water heater market. Because there are only two main manufacturers that supply the vast majority of U.S. shipments of oil-fired storage water heaters, any manufacturer exiting the market could lead to a market disruption.

iii. Cash-Flow Analysis Results for Gas-Fired Instantaneous Water Heaters

TABLE V.22—MANUFACTURER IMPACT ANALYSIS FOR GAS-FIRED INSTANTANEOUS WATER HEATERS—PRESERVATION OF RETURN ON INVESTED CAPITAL MARKUP SCENARIO

	Units	Base case	Trial standard level						
			1	2	3	4	5	6	7
INPV	(2008$ millions)	603.5	604.7	604.7	604.7	604.7	604.7	604.7	683.8
Change in INPV	(2008$ millions)	....	1.2	1.2	1.2	1.2	1.2	1.2	80.3

TABLE V.22—MANUFACTURER IMPACT ANALYSIS FOR GAS-FIRED INSTANTANEOUS WATER HEATERS—PRESERVATION OF RETURN ON INVESTED CAPITAL MARKUP SCENARIO—Continued

	Units	Base case	Trial standard level						
			1	2	3	4	5	6	7
	(%)	....	0.20%	0.20%	0.20%	0.20%	0.20%	0.20%	13.31%
Product Conversion Costs.	(2008$ millions)	....	0.0	0.0	0.0	0.0	0.0	0.0	8.0
Capital Conversion Costs.	(2008$ millions)	....	0.0	0.00	0.00	0.0	0.0	0.0	9.6
Total Investment Required.	(2008$ millions)	....	0.0	0.0	0.0	0.0	0.0	0.0	17.6

TABLE V.23—MANUFACTURER IMPACT ANALYSIS FOR GAS-FIRED INSTANTANEOUS STORAGE WATER HEATERS—PRESERVATION OF OPERATING PROFIT MARKUP SCENARIO

	Units	Base case	Trial standard level						
			1	2	3	4	5	6	7
INPV	(2008$ millions)	603.5	601.7	601.7	601.7	601.7	601.7	601.7	537.6
Change in INPV	(2008$ millions)	....	(1.8)	(1.8)	(1.8)	(1.8)	(1.8)	(1.8)	(65.9)
	(%)	....	−0.30%	−0.30%	−0.30%	−0.30%	−0.30%	−0.30%	−10.91%
Product Conversion Costs.	(2008$ millions)	....	0.0	0.0	0.0	0.0	0.0	0.0	8.0
Capital Conversion Costs.	(2008$ millions)	....	0.0	0.0	0.0	0.0	0.0	0.0	9.6
Total Investment Required.	(2008$ millions)	....	0.0	0.0	0.0	0.0	0.0	0.0	17.6

TSL 1 through TSL 6 represent an improvement in efficiency from the baseline gas-fired instantaneous water heater efficiency level of 0.62 EF to 0.82 EF for the representative input capacity of 199 kBtu/h. At TSL 1 through TSL 6, DOE estimates the INPV impacts to range from $1.2 million to −$1.8 million, or a change in INPV of 0.20 percent to −0.30 percent. At this level, the industry cash flow is estimated to remain at the base-case value of $75.0 million in the year leading up to the standards. DOE research suggests that over 80 percent of gas-fired instantaneous products sold today meet or exceed this efficiency, and nearly all manufacturers of gas-fired instantaneous water heaters currently make products that meet or exceed the efficiency required by TSL 1 through TSL 6. Hence, there appears to be little risk that TSL 1 through TSL 6 would greatly harm manufacturers or reduce the number of manufacturers that sell these products.

TSL 7 (the max-tech level) represents an improvement in efficiency from the baseline level of 0.62 EF to 0.95 EF for the representative input capacity of 199 kBtu/h. At TSL 7, DOE estimates the INPV impacts to range from $80.3 million to −$65.9 million, or a change in INPV of 13.31 percent to −10.91 percent. At this level, the industry cash flows are estimated to decrease by approximately 5.9 percent to $70.5 million, compared to the base-case value of $75.0 million in the year leading up to the standards. Only one manufacturer currently offers a gas-fired instantaneous water heater that meets the max-tech efficiency on the U.S. market. Most manufacturers would incur substantial product conversion and capital conversion costs to upgrade their existing products at TSL 7. To reach 0.95 EF, a more complex condensing model would need to be developed. Because only one manufacturer offers products that meet this efficiency, TSL 7 could greatly reduce the number of gas-fired instantaneous water heaters offered for sale in the United States.

b. Direct Heating Equipment Cash-Flow Analysis Results

Traditional DHE manufacturers are extremely concerned about the potential for amended energy conservation standards to harm their business. The vast majority of the traditional DHE market is controlled by three manufacturers. The small shipment volume of products in the traditional market has greatly reduced the number of competitors in the past decade. The traditional DHE market is mostly a replacement market met by these three companies that have acquired product lines as competitors were bought and absorbed or exited the market. Most DHE manufacturers offer a wide scope of products manufactured at low production rates to ensure that they can maintain a viable portion of the replacement market in order to remain in business. Because the traditional DHE market consists of a large number of relatively low-volume, mostly replacement models, manufacturers stated that they cannot justify large investments needed to redesign their existing product lines. Manufacturers are concerned that amended energy conservation standards could greatly impact the availability of replacement products for the majority of their customers due to the limited resources that would be available to update existing products and make changes to their existing facilities. In addition, manufacturers were concerned that energy conservation standards could lower profitability at higher TSLs because demand is expected to decline in response to increases in first cost that could cause consumers to switch to other types of heating appliances.

Gas hearth manufacturers were also concerned about potentially detrimental impacts from amended energy conservation standards. While there are three major gas hearth DHE manufacturers, DOE identified an additional 12 manufacturers in the market and technology assessment (see chapter 3 of the TSD). Because consumers generally are more interested in the appearance of these products than efficiency, every manufacturer typically offers a wide range of product lines and an even greater number of individual products. Manufacturers are concerned that higher energy conservation standards could harm their business because they do not have the resources to upgrade all these existing product lines and could be forced to offer fewer products after the compliance date for the amended energy conservation standards. Manufacturers were also concerned that higher price points could lead to lower profitability. Because of the large number of manufacturers and the recent decline in shipments, manufacturers were concerned that additional production costs could not be passed on to consumers or that markups would be lowered to avoid higher price points leading to lower sales.

To assess the lower end of the range of potential impacts of amended standards on DHE manufacturers, DOE modeled the industry assuming the preservation of return on invested capital scenario. Besides the impact of shipments and the required capital and product conversion costs on INPV, this scenario assumes that manufacturers are able to maintain their base-case return, even on additional invested capital. In this scenario, operating profit increases after the compliance date of the amended energy conservation standards because manufacturers continue to earn a historical rate of return on the investments required by the amended energy conservation standards.

To assess the higher end of the range of potential impacts of amended standards on the DHE industry, DOE modeled the preservation of operating profit markup scenario. In this scenario, higher energy conservation standards result in lower manufacturer percentage markups. The preservation of operating profit markup scenario models manufacturers' concerns about the low volume of shipments and declining profitability if higher energy conservation standards were implemented. The preservation of operating profit scenario also models gas hearth manufacturer concerns that amended energy conservation standards would impact profitability due to the need to lower their markups to keep customers from switching to non-covered hearth products if the energy conservation standards significantly raised the installed prices of covered products. In the preservation of operating profit scenario, manufacturer markups decline and operating profit remains the same after the compliance date of the amended energy conservation standards as in the base case. Industry value is harmed because manufacturers do not earn additional return on the investments required by the amended standards.

i. Cash-Flow Analysis Results for Traditional Direct Heating Equipment (Gas Wall Fan, Gas Wall Gravity, Gas Floor, and Gas Room Direct Heating Equipment)

TABLE V.24—MANUFACTURER IMPACT ANALYSIS FOR TRADITIONAL DIRECT HEATING EQUIPMENT—PRESERVATION OF RETURN ON INVESTED CAPITAL MARKUP SCENARIO

	Units	Base case	Trial standard level					
			1	2	3	4	5	6
INPV	(2008$ millions)	17.9	17.5	17.3	16.9	16.7	16.2	15.7
Change in INPV	(2008$ millions)		(0.4)	(0.6)	(1.1)	(1.3)	(1.8)	(2.2)
	(%)		−2.27%	−3.42%	−5.91%	−7.16%	−9.99%	−12.28%
Product Conversion Costs.	(2008$ millions)		0.6	1.0	1.9	2.4	3.5	4.3
Capital Conversion Costs.	(2008$ millions)		1.2	2.4	4.5	5.6	4.7	6.8
Total Investment Required.	(2008$ millions)		1.84	3.40	6.39	7.98	8.14	11.03

TABLE V.25—MANUFACTURER IMPACT ANALYSIS FOR TRADITIONAL DIRECT HEATING EQUIPMENT—PRESERVATION OF OPERATING PROFIT MARKUP SCENARIO

	Units	Base case	Trial standard level					
			1	2	3	4	5	6
INPV	(2008$ millions)	17.9	16.3	14.9	11.9	10.4	9.9	7.2
Change in INPV	(2008$ millions)		(1.6)	(3.1)	(6.0)	(7.6)	(8.0)	(10.8)
	(%)		−9.11%	−17.20%	−33.54%	−42.14%	−44.84%	−59.98%
Product Conversion Costs.	(2008$ millions)		0.6	1.0	1.9	2.4	3.5	4.3
Capital Conversion Costs.	(2008$ millions)		1.2	2.4	4.5	5.6	4.7	6.8
Total Investment Required.	(2008$ millions)		1.84	3.40	6.39	7.98	8.14	11.03

For traditional DHE, TSL 1 represents an improvement in efficiency from the baseline level of 74-percent AFUE to 75-percent AFUE for gas wall fan DHE, an improvement in efficiency from the baseline level of 64-percent AFUE to 66-percent for gas wall gravity DHE, an improvement in efficiency from the baseline level of 57-percent AFUE to 58-percent AFUE for gas floor DHE (the max-tech level), and an improvement in efficiency from the baseline level of 64-percent AFUE to 66-percent AFUE for gas room DHE at their respective representative input rating ranges. DOE research suggests that manufacturers would use an intermittent ignition and a two-speed blower for gas wall fan DHE and an improved heat exchanger design for gas wall gravity, gas floor units, and gas room DHE to achieve the efficiencies required by TSL 1. At TSL 1, DOE estimates the impacts on INPV to range from $0.4 to −$1.6 million, or a change in INPV of −2.27 percent to −9.11 percent. At this level, the industry cash flow is estimated to decrease by approximately 45.7 percent, to $0.8 million, compared to the base-case value of $1.4 million in the year leading up to the standards. While some manufacturers may need to make redesigns to some of their products even at TSL 1, manufacturers generally have a significant number of products that meet the required efficiencies for most traditional DHE product types, and for this reason, a complete exit from the market by any manufacturer is unlikely.

TSL 2 represents an improvement in efficiency from the baseline level of 74-percent AFUE to 76-percent for gas wall fan DHE, an improvement in efficiency from the baseline level of 64-percent AFUE to 68-percent AFUE for gas wall gravity DHE, an improvement in efficiency from the baseline level of 57-percent AFUE to 58-percent AFUE for gas floor DHE (the max-tech level), and an improvement in efficiency from the baseline level of 64-percent AFUE to 67-percent for gas room DHE at the representative input rating ranges for each product type. DOE research suggests that at TSL 2, manufacturers would opt to use an improved heat exchanger and intermittent ignition for gas wall fan DHE, and make further improvements to the heat exchanger for gas wall gravity and gas room DHE, and use the same improved heat exchanger for gas floor DHE as at TSL 1 to reach the efficiency levels required by TSL 2. At TSL 2, DOE estimates the impacts in INPV to range from −$0.6 million to −$3.1 million, or a change in INPV of −3.42 percent to −17.20 percent. At this level, the industry cash flow is estimated to decrease by approximately 86.1 percent, to $0.2 million, compared to the base-case value of $1.4 million in the year leading up to the standards. At TSL 2, every manufacturer would face higher product development costs in order to offer a similar range of product offerings. However, at TSL 2, it is likely that more products would be discontinued because more of the current products on the market fall below the required efficiencies. As a result, manufacturers must either expend resources to cover the necessary product conversion and capital conversion costs, or they will be forced to discontinue some of their existing product lines. While TSL 2 would have a significant impact on manufacturers, most manufacturers would not be expected to face a complete redesign for most traditional DHE product types. Even if manufacturers lowered the number of product lines offered in certain product classes, manufacturers would have enough existing products that meet or exceed the required efficiencies to upgrade most of their existing product lines and maintain viable production volumes after the compliance date of the amended energy conservation standards.

TSL 3 represents an improvement in efficiency from the baseline level of 74-percent AFUE to 77-percent for gas wall fan DHE, an improvement in efficiency from the baseline level of 64-percent AFUE to 71-percent AFUE for gas wall gravity units, an improvement in efficiency from the baseline level of 57-percent AFUE to 58-percent AFUE for gas floor DHE (the max-tech level), and an improvement in efficiency from the baseline level of 64-percent AFUE to 68-percent for gas room DHE at the representative input rating ranges. DOE research suggests that manufacturers would improve baseline units by adding an intermittent ignition, a two-speed blower, and an improved heat exchanger for gas wall fan units, make further improvements to the heat exchanger used to reach TSL 2 for gas wall gravity and gas room units, and use the same improved heat exchanger for gas floor DHE as at TSL 1 and TSL 2 to reach the efficiency levels of TSL 3. At TSL 3, DOE estimates the INPV impacts to range from −$1.1 million to −$6.0 million, or a change in INPV of −5.91 percent to −33.54 percent. At this level, the industry cash flow is estimated to decrease by approximately 161.8 percent to −$0.9 million, compared to the base-case value of 1.4 million in the year leading up to the standards. The large estimated impact on INPV suggests that manufacturers would be substantially harmed if profitability were impacted.

At TSL 3, products increasingly rely on purchased parts, making it more likely that manufacturers' profitability would decline. At TSL 3, it is likely that some manufacturers would reduce the number of product lines offered in order to lower the product conversion and capital conversion costs required at TSL 3. Discontinuing product lines would still have a negative impact on the manufacturers that selectively upgrade existing product lines since many manufacturers rely on aggregated production scale from all products they sell to secure favorable purchased part and raw material prices. The fixed portion of product conversion costs, such as certification and the total capital conversion costs, typically require a minimum shipment volume in order to be economically justifiable to the manufacturer. However, at TSL 3, most manufacturers have existing products that meet the required efficiencies in three out of the four product types of traditional DHE. Because manufacturers have a substantial number of product lines that meet the required efficiencies at TSL3, even if manufacturers selectively upgrade their existing product lines, they would be expected to maintain a viable production volume after the compliance date of the amended energy conservation and not exit the market completely.

TSL 4 is the max-tech level for gas wall fan DHE. TSL 4 represents an improvement in efficiency from the baseline level of 74-percent AFUE to 80-percent for gas wall fan DHE at the representative input rating range. The efficiency requirements for gas wall gravity, gas floor, and gas room DHE are the same at TSL 4 as at TSL 3. To achieve the max-tech level for gas wall fan DHE, DOE research suggests that manufacturers would need to use an electronic ignition and induced draft. DOE anticipates that manufacturers would make the same improvements to the heat exchangers as necessary to achieve TSL 3 for gas wall gravity, gas floor, and gas-room DHE. At TSL 4, DOE estimates the INPV impacts to range from −$1.3 million to −$7.6 million, or a change in INPV of −7.16 percent to −42.14 percent. At this level, the industry cash flow is estimated to decrease by approximately 202.3 percent to −$1.4 million, compared to the base-case value of $1.4 million in the year leading up to the standards.

Most manufacturers' products are below the max-tech level for gas wall fan DHE, which further increases the total capital and product conversion costs over TSL 3. At TSL 4, most manufacturers would have to completely redesign their gas wall fan products and purchase new tooling. The discrepancy between the number of unit shipments and the number of product lines requiring significant product development to meet the potential energy conservation standards is a large driver of the negative impacts at TSL 4. When faced with these substantial costs, most manufacturers would likely discontinue products in this product class or possibly exit the market altogether. In addition, at TSL 4 every manufacturer would face significant conversion costs in every product type, making it much more likely that the industry would offer far fewer products and that the industry would have fewer competitors after the compliance date of amended standards. Besides the likelihood of multiple manufacturers discontinuing product lines or exiting the market, the large impact on INPV shows that manufacturers would also be substantially harmed if profitability were impacted for existing or redesigned products.

TSL 5 represents an improvement in efficiency from the baseline level of 74-percent AFUE to 75-percent AFUE for gas wall fan DHE, an improvement in efficiency from the baseline level of 64-percent AFUE to 72-percent AFUE for gas wall gravity units (the max-tech level), an improvement in efficiency from the baseline level of 57-percent AFUE to 58-percent AFUE for gas floor DHE (the max-tech level), and an improvement in efficiency from the baseline level of 64-percent AFUE to 83-percent AFUE (the max-tech level) for gas room DHE at the representative input rating ranges for each product type. To achieve the efficiencies required by TSL 5, DOE research suggests that manufacturers would need to use an intermittent ignition and a two-speed blower for gas wall fan DHE, use an electronic ignition for gas wall gravity DHE, use an improved heat exchanger for gas floor DHE, and use electronic ignition and a multiple heat exchanger design for gas room DHE. At TSL 5, DOE estimates the impacts on INPV to range from −$1.8 million to −$8.0 million, or a change in INPV of −9.99 percent to −44.84 percent. At this level, the industry cash flow is estimated to decrease by approximately 195.5 percent, to −$1.3 million, compared to the base-case value of $1.4 million in the year leading up to the standards.

Most traditional DHE models available on the market today are below the max-tech level for gas wall gravity and gas room DHE, which leads to higher total capital and product conversion costs and more negative impacts on INPV at TSL 5 than TSL 4. DOE research suggests that at TSL 5, most manufacturers would have to completely redesign and buy new tooling in order to offer gas wall gravity and gas room products at these efficiency levels. The small number of unit shipments and the large number of product lines that would require significant product development to meet the energy conservation standards is a large driver of the negative impacts at TSL 5. Hence, the potential number of product lines being discontinued and the number of manufacturers exiting the market at TSL 5 would be expected to be greater than at TSL 4, with even greater repercussions on consumer choice, employment, and competition.

TSL 6 is set at the max-tech level for all traditional DHE product classes. The efficiency requirements for gas wall gravity, gas floor, and gas room DHE are the same at TSL 6 as at TSL 5. However, TSL 6 also represents an improvement from 75-percent to 80-percent AFUE for gas wall fan DHE (the max-tech level). To achieve the max-tech level for gas wall fan DHE, DOE research suggests that manufacturers would need to use an electronic ignition and induced draft. As to the other products, DOE anticipates that manufacturers would need to use an electronic ignition for gas wall gravity DHE, use an improved heat exchanger for gas floor DHE, and use electronic ignition and a multiple heat exchanger design for gas room DHE. At the max-tech TSL (TSL 6), DOE estimates the INPV impacts to range from −$2.2 million to −$10.8 million, or a change in INPV of −12.28 percent to −59.98. At this level, the industry cash flow is estimated to decrease by approximately 269.5 percent to −$2.4 million, compared to the base-case value of $1.4 million in the year leading up to the standards. Most products currently available are below the max-tech level for all product classes. At the max-tech level, most manufacturers would be faced with complete product redesigns for almost all product lines and significant plant changes to remain in the market. Most manufacturers would be expected to discontinue products or exit the market altogether. Due to the low volume of shipments in the industry, it unlikely that any manufacturer could offer close to the range of products currently offered today. Hence, some product classes may cease to be commercially available. It is very likely that multiple manufacturers would exit the market at the max-tech level for every product class.

ii. Cash-Flow Analysis Results for Gas Hearth Direct Heating Equipment

TABLE V.26—MANUFACTURER IMPACT ANALYSIS FOR GAS HEARTH DIRECT HEATING EQUIPMENT—PRESERVATION OF RETURN ON INVESTED CAPITAL MARKUP SCENARIO

	Units	Base case	Trial standard level					
			1	2	3	4	5	6
INPV	(2008$ millions)	86.4	85.5	85.5	85.5	88.8	88.8	96.6
Change in INPV	(2008$ millions)		(0.9)	(0.9)	(0.9)	2.4	2.4	10.2
	(%)		−1.07%	−1.07%	−1.07%	2.80%	2.80%	11.82%
Product Conversion Costs.	(2008$ millions)		0.53	0.53	0.53	1.40	1.40	8.07
Capital Conversion Costs.	(2008$ millions)		0.20	0.20	0.20	0.53	0.53	4.03
Total Investment Required.	(2008$ millions)		0.73	0.73	0.73	1.93	1.93	12.09

TABLE V.27—MANUFACTURER IMPACT ANALYSIS FOR GAS HEARTH DIRECT HEATING EQUIPMENT—PRESERVATION OF OPERATING PROFIT MARKUP SCENARIO

	Units	Base case	Trial standard level					
			1	2	3	4	5	6
INPV	(2008$ millions)	86.4	86.2	86.2	86.2	71.6	71.6	31.2
Change in INPV	(2008$ millions)		(0.2)	(0.2)	(0.2)	(14.8)	(14.8)	(55.1)
	(%)		−0.22%	−0.22%	−0.22%	−17.13%	−17.13%	−63.83%
Product Conversion Costs.	(2008$ millions)		0.53	0.53	0.53	1.40	1.40	8.07
Capital Conversion Costs.	(2008$ millions)		0.20	0.20	0.20	0.53	0.53	4.03

TABLE V.27—MANUFACTURER IMPACT ANALYSIS FOR GAS HEARTH DIRECT HEATING EQUIPMENT—PRESERVATION OF OPERATING PROFIT MARKUP SCENARIO—Continued

	Units	Base case	Trial standard level					
			1	2	3	4	5	6
Total Investment Required.	(2008$ millions)	....	0.73	0.73	0.73	1.93	1.93	12.09

TSL 1 through TSL 3 represents an improvement in efficiency from the baseline level of 64-percent AFUE to 67-percent AFUE for gas hearth DHE at the 27,000 Btu/h to 46,000 Btu/h representative input rating range. To reach 67-percent AFUE from baseline efficiency, manufacturers would likely use an electronic ignition. At TSL 1 through TSL 3, DOE estimates the impacts on INPV to range from −$0.2 million to −$0.9 million, or a change in INPV of −0.22 percent to −1.07 percent. At this level, the industry cash flow is estimated to decrease by approximately 7.6 percent, to $2.6 million, compared to the base-case value of $2.8 million in the year leading up to the standards. Most manufacturers offer multiple products that meet this efficiency level. Because there are so many product lines at the baseline efficiency, however, there could be fairly substantial product conversion costs at this TSL because manufacturers would have to slightly redesign all of the baseline products. In addition, some manufacturers could be required to make other minor changes to their production lines to accommodate other improvements such as additional baffling. DOE research suggests that such changes may be inexpensive since they would not require the industry to replace major hard tooling at TSL 1 through TSL 3. Because of the small change in product costs at TSL 1 through TSL 3, it is unlikely that manufacturer profitability would decrease appreciably to maintain the existing shipments.

TSL 4 and TSL 5 represent an improvement in efficiency from the baseline level of 64-percent AFUE to 72-percent AFUE for gas hearth DHE at the 27,000 Btu/h to 46,000 Btu/h representative input rating range. DOE research suggests that fan-assisted gas hearth DHE products could reach 72-percent AFUE from baseline efficiency. At TSL 4 and TSL 5, DOE estimates the impacts on INPV to range from $2.4 million to −$14.8 million, or a change in INPV of 2.80 percent to −17.13 percent. At this level, the industry cash flow is estimated to decrease by approximately 19.9 percent, to $2.3 million, compared to the base-case value of $2.8 million in the year leading up to the standards. At TSL 4 and TSL 5, gas hearth manufacturers would likely reduce the scope of their product offerings to lower the required conversion costs to comply with the energy conservation standard. Many of the smaller manufacturers could consider existing the market when faced with fairly substantial product and capital conversion costs that are not justified by their shipment volumes. Much of the capital conversion costs are expected to involve changes to handle new materials like additional insulation and baffling, changes to the heat shields, and new stamping dies for many manufacturers that need to greatly alter their existing designs. Manufacturers will also incur additional product conversion costs for product development and certification because most products currently sold would not meet the efficiency requirements of TSL 4 and TSL 5. While most of the changes above the baseline require manufacturers to purchase or manufacture more costly components that increase MPC, the resulting higher MSPs also concerned manufacturers. Manufacturers stated that the market is very price sensitive, so any increase in unit price could invariably lead to fewer sales. Hence, manufacturers expect that the industry would have to lower its profit margins in order to reduce shipments impacts that could result from cost increases related to potential energy efficiency improvements.

TSL 6 represents an improvement in efficiency from the baseline level of 64-percent AFUE to 93-percent AFUE for gas hearth DHE at the 27,000 Btu/h to 46,000 Btu/h representative input rating range. To reach 93-percent AFUE from the baseline efficiency, manufacturers would need to use a condensing design. At the max-tech TSL (TSL 6), DOE estimates the impacts on INPV to range from $10.2 million to −$55.1 million, or a change in INPV of 11.82 percent to −63.83 percent. At this level, the industry cash flow is estimated to decrease by approximately 128.8 percent, to −$0.8 million, compared to the base-case value of $2.8 million in the year leading up to the standards.

At TSL 6, manufacturers indicated they would greatly reduce the scope of their product offerings to lower the required costs to comply with an amended energy conservation standard at this level. Because there are very few products on the market today that use this technology, the product development costs greatly increase at this TSL. DOE research suggests that manufacturers would likely need a secondary heat exchanger at the max-tech level, which could alter the size and structure of most existing product lines. Manufacturers expressed concern regarding their ability to use existing tooling and equipment, much of which may become obsolete when hearths have to be redesigned from the ground up to accommodate the efficiency requirements at this level. It is also very likely that many of the 10 small business manufacturers could be forced to exit the market when faced with these substantial conversion costs since they do not have the access to capital, the product development resources, or the shipment volumes to justify these conversion costs.

Manufacturers also stated that they were concerned about consumer utility issues at TSL 6. Smaller units would likely be significantly impacted at this TSL because the low inherent interior volume makes it much more difficult to accommodate a secondary heat exchanger without narrowing the area available for the logs and flame. Manufacturers also indicated that it gets progressively more difficult to imitate a natural, wood-burning flame appearance at this efficiency level, which could hurt sales and reduce consumer utility. Finally, manufacturers were concerned that the MPCs at the max-tech level are estimated to be more than double the baseline costs for the representative input rating range. In order to maintain shipments of gas hearth DHE with substantially higher costs and potential consumer utility impacts, manufacturers believe that profitability would be greatly impacted.

c. Pool Heaters Cash-Flow Analysis Results

Pool heater manufacturers expressed concern that amended energy conservation standards could cause significant harm to their industry, because pool heaters are a luxury item and have low annual usage that would prevent the majority of consumers from recouping the greater initial price at higher efficiencies. Since pool heaters are considered a luxury product, manufacturers expect sales to decline as unit costs increase. As the required efficiencies approach a condensing technology, manufacturers would have to make more substantial changes to their existing products that add significant costs that would encourage repair instead of replacement of failed units, cause fuel switching (*e.g.*, to heat pumps or solar systems), or make customers abandon heating their pool altogether.

To assess the lower end of the range of potential impacts on pool heater manufacturers, DOE modeled the preservation of return on invested capital markup scenario. Besides the impact of changes in shipments on INPV and the required capital and product conversion costs, this case represents the lower end of the potential impacts on manufacturers because it assumes that manufacturers would earn a similar return on the investments required by amended energy conservation standards. To assess the higher end of the range of potential impacts on pool heater manufacturers, DOE modeled the preservation of operating profit markup scenario (*i.e.*, constant absolute profit, regardless of cost increases, which leads to declining profit margins at higher costs). This scenario models manufacturers concerns that margins would be harmed at higher price points because they expect to lower their profit margins to minimize impacts due to lower sales.

TABLE V.28—MANUFACTURER IMPACT ANALYSIS FOR GAS-FIRED POOL HEATERS—PRESERVATION OF RETURN ON INVESTED CAPITAL MARKUP SCENARIO

	Units	Base case	Trial standard level					
			1	2	3	4	5	6
INPV	(2008$ millions)	61.4	61.4	61.8	61.1	61.9	64.5	74.2
Change in INPV	(2008$ millions)		0.1	0.4	(0.2)	0.5	3.1	12.9
	(%)		0.13%	0.66%	−0.39%	0.88%	5.03%	20.96%
Product Conversion Costs.	(2008$ millions)		0.0	0.0	2.6	2.6	4.6	5.5
Capital Conversion Costs.	(2008$ millions)		0.0	0.3	1.2	1.4	4.4	7.1
Total Investment Required.	(2008$ millions)		0.0	0.3	3.8	4.0	9.0	12.6

TABLE V.29—MANUFACTURER IMPACT ANALYSIS FOR GAS-FIRED POOL HEATERS—PRESERVATION OF OPERATING PROFIT MARKUP SCENARIO

	Units	Base case	Trial standard level					
			1	2	3	4	5	6
INPV	(2008$ millions)	61.4	61.2	60.3	55.8	53.9	41.8	16.8
Change in INPV	(2008$ millions)		(0.2)	(1.0)	(5.6)	(7.5)	(19.5)	(44.5)
	(%)		−0.29%	−1.66%	−9.06%	−12.15%	−31.82%	−72.59%
Product Conversion Costs.	(2008$ millions)		0.0	0.0	2.6	2.6	4.6	5.5
Capital Conversion Costs.	(2008$ millions)		0.0	0.3	1.2	1.4	4.4	7.1
Total Investment Required.	(2008$ millions)		0.0	0.3	3.8	4.0	9.0	12.6

TSL 1 represents an improvement in efficiency from the baseline level of 78-percent thermal efficiency to 81-percent thermal efficiency for the representative input rating of 250,000 Btu/h. At TSL 1, DOE estimates the INPV impacts to range from $0.1 million to −$0.2 million, or a change in INPV of 0.13 percent to −0.29 percent. At this level, the industry cash flow would not be expected to change from the base-case value of $2.7 million in the year leading up to the standards. Over 60 percent of current gas-fired pool heaters meet or exceed the efficiency requirements at TSL 1. DOE research suggests that changes to the heat exchanger would allow baseline products to meet TSL 1. These changes would not require major modifications to existing units, resulting in minimal impacts to manufacturers at TSL 1.

TSL 2 represents an improvement in efficiency from the baseline level of 78-percent thermal efficiency to 82-percent thermal efficiency for the representative input rating of 250,000 Btu/h. At TSL 2, DOE estimates the INPV impacts to range from $0.4 to −$1.0 million, or a change in INPV of 0.66 percent to −1.66 percent. At this level, the industry cash flow is expected to decrease by approximately 3.9 percent to $2.6 million, compared to the base-case value of $2.7 million in the year leading up to the standards. Almost half of the pool heaters currently are sold at or above this efficiency level, and nearly all manufacturers make products that can achieve the efficiency required at TSL 2. DOE research suggests that minor improvements to heat exchangers and insulation surrounding the combustion chamber would need to be made to convert lower-efficiency units to this efficiency, causing manufacturers to incur small capital conversion costs. However, because the basic designs of atmospheric pool heaters that comprise the majority of current shipments remain relatively unchanged at TSL 2, there are minimal impacts on manufacturers.

TSL 3 represents an improvement in efficiency from the baseline level of 78-percent thermal efficiency to 83-percent thermal efficiency for the representative input rating of 250,000 Btu/h. At TSL 3, DOE estimates the INPV impacts to range from −$0.2 to −$5.6 million, or a change in INPV of −0.39 percent to −9.06 percent. At this level, the industry cash flow is estimated to decrease by approximately 43.0 percent to $1.6 million, compared to the base-case value of $2.7 million in the year leading up to the standards. DOE research suggests that most manufacturers would have to improve some of their product lines to reach an 83-percent thermal efficiency by using power venting technology. DOE research also suggests that while the manufacturing production costs are not expected to increase significantly, most manufacturers would incur some product and capital conversion costs to increase their production of existing lower volume products at TSL 3. TSL 3 would eliminate most common atmospheric models on the market today, which could hurt profitability if consumer demand for gas-fired pool heaters holds at its current level despite the higher production costs at this TSL.

TSL 4 represents an improvement in efficiency from the baseline level of 78-percent thermal efficiency to 84-percent thermal efficiency for the representative input rating of 250,000 Btu/h. At TSL 4, DOE estimates the INPV impacts to range from $0.5 million to −$7.5 million, or a change in INPV of 0.88 percent to −12.15 percent. At this level, the industry cash flow is estimated to decrease by approximately 45.9 percent to $1.5 million, compared to the base-case value of $2.7 million in the year leading up to the standards. Similar to TSL 3, TSL 4 would require fairly substantial capital and product conversion costs. Because this efficiency level eliminates all atmospheric models that are currently on the market and requires additional improvements over TSL 3, the capital conversion costs are even higher at TSL 4. DOE research suggests that manufacturers would have to design products that use power venting and an improved heat exchanger, which could be costly to develop. Manufacturers stated that the high component costs at TSL 4 would result in substantially higher costs for consumers. The higher production costs and conversion costs make it more likely that manufacturers' concerns about reduced profitability would be realized at TSL 4.

TSL 5 represents an improvement in efficiency from the baseline level of 78-percent thermal efficiency to 86-percent thermal efficiency for the representative input rating of 250,000 Btu/h. At TSL 5, DOE estimates the INPV impacts to range from $3.1 million to −$19.5 million, or a change in INPV of 5.03 percent to −31.82 percent. At this level, the industry cash flow is estimated to decrease by approximately 108.9 percent to −$0.2 million, compared to the base-case value of $2.7 million in the year leading up to the standards. Over 90 percent of current shipments are below this efficiency level. Manufacturers would incur significant conversion costs at TSL 5 and would likely significantly reduce the scope of their product offerings. DOE research suggests that manufacturers would switch remaining units to sealed combustion systems and improved heat exchanger designs, adding substantial production cost and eliminating unpowered units from the market. Manufacturers believe that consumers would look for alternatives to gas-fired pool heaters or not replace failed units due to the higher product costs that would result from an amended energy conservation standard at TSL 5. Manufacturers also indicated that problems at efficiencies they consider near-condensing could force some companies to only offer fully condensing units with even greater negative paybacks for consumers. A further concern of manufacturers relates to the current installer and maintenance base for pool heaters, which would require significant additional training to be able to properly install, troubleshoot, and service increasingly complex pool heaters.

TSL 6 (max-tech level) represents an improvement in efficiency from the baseline level of 78-percent thermal efficiency to 95-percent thermal efficiency for the representative input rating of 250,000 Btu/h. At TSL 6, DOE estimates the INPV impacts to range from $12.9 million to −$44.5 million, or a change in INPV of 20.96 percent to −72.59 percent. At this level, the industry cash flow is estimated to decrease by approximately 157.2 percent to −$1.6 million, compared to the base-case value of $2.7 million in the year leading up to the standards. Almost all gas-fired pool heaters currently on the market are well below this efficiency level. Manufacturers would face significant conversion costs at TSL 6 in order to develop condensing systems or refine existing designs to achieve lower cost condensing pool heaters. DOE research suggests that heat exchanger materials would need to withstand acidic condensate created by condensing pool heaters. In light of strong concerns about consumer reaction to a substantially-increased first cost at TSL 6, manufacturers do not believe this efficiency level could be justified for residential pool heater consumers due to low usage and significantly higher costs. Manufacturers believe that consumers would not be willing to purchase such an expensive product and would either find an alternative to gas-fired pool heaters or no longer purchase a gas-fired pool heater. In addition, at TSL 6 manufacturers are also concerned about the industry's ability to educate and retrain installers and servicers of pool heaters in time for the compliance date of the standard. Condensing units with sealed combustion are more complex than the vast majority of atmospheric units on the market today and would require significant additional training for safe installation and maintenance. Manufacturers also expect product support costs to increase significantly as complexity increases the likelihood and frequency of events such as component failures and unit lockouts that would require manufacturer support and servicing, as well as increased warranty costs. Besides increasing warranty costs for manufacturers, the issues and costs associated with proper unit maintenance post-warranty could potentially cause them to switch fuel sources (*e.g.,* switching to heat pump or solar water heaters) or abandon pool heating altogether.

d. Impacts on Employment

DOE quantitatively assessed the impacts of potential amended energy conservation standards on employment for each of the three types of heating products that are the subject of this rulemaking. DOE used the GRIM to estimate the domestic labor expenditures and number of domestic production workers in the base case and at each TSL from 2008 to 2045 for the residential water heater industry and from 2008 to 2043 for the DHE and pool heater industries. DOE used statistical data from the U.S. Census Bureau, 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 are a function of the labor intensity of the equipment, the sales volume, and an assumption that wages remain fixed in real terms over time.

In each GRIM, DOE used the labor content of each product and the manufacturing production costs from the engineering analysis to estimate the annual labor expenditures in the residential water heater, DHE, and pool heater industries. DOE used Census data and interviews with manufacturers to estimate the portion of the total labor expenditures that is for U.S. (*i.e.,* domestic) labor.

The estimates of production workers in this section only cover workers up to the line-supervisor level that are directly involved in fabricating and assembling a product within the Original Equipment Manufacturer (OEM) facility. Workers that perform services that are closely associated with production operations, such as material handing with a forklift, are also included as production labor. DOE's estimates only account for production workers that manufacture the specific products covered by this rulemaking. For example, a worker on a commercial water heater line would not be included with the estimate of the number of residential water heater production workers.

The employment impacts shown in Table V.30 through Table V.34 represent the potential production employment that could result following amended energy conservation standards. The upper end of the results in these tables estimates the maximum potential increase in production workers after amended energy conservation standards. The upper end of the results assumes manufacturers would continue to produce the same scope of covered products in the same production facilities. The upper end of the range also assumes that domestic production is not shifted to lower-labor-cost countries. Because there is a real risk of manufacturers exiting the market or no longer offering the same scope of covered products in response to amended energy conservation standards, the lower end of the range of employment results in Table V.30 through Table V.34 include the estimate of the total number of U.S. production workers in the industry that could lose their job if all existing production were to no longer be made domestically. While the results present a range of employment impacts following the compliance date of amended energy conservation standards, the discussion below also includes a qualitative discussion of the likelihood of negative employment impacts at the various TSLs. Finally, the employment impacts shown are independent of the employment impacts from the broader U.S. economy, which are documented in chapter 15, Employment Impact Analysis, of the NOPR TSD.

i. Gas-Fired and Electric Storage Water Heater Employment Impacts

Using the GRIM, DOE estimates that would be 3,690 domestic gas-fired and electric storage water heater production workers in 2015 without amended energy conservation standards. Using Census Bureau data and interviews with manufacturers, DOE estimates that approximately two-thirds of gas-fired and electric storage water heaters sold in the United States are manufactured domestically. Table V.30 shows the range of the impacts of potential amended energy conservation standards on U.S. production workers in the gas-fired and electric storage water heater market.

TABLE V.30.—POTENTIAL CHANGES IN THE TOTAL NUMBER OF DOMESTIC GAS-FIRED AND ELECTRIC STORAGE WATER HEATER PRODUCTION WORKERS IN 2015

	Baseline	1	2	3	4	5	6	7
Total Number of Domestic Production Workers in 2015 (without changes in production locations) ..	3,690	3,758	3,842	3,881	3,977	4,396	7.768	9,823
Potential Changes in Domestic Production Workers in 2015*	....	(3,690) – 68	(3,690) – 152	(3,690) – 191	(3,690) – 287	(3,690) – 706	(3,690) – 4,078	(3,690) – 6,133

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

During manufacturer interviews, gas-fired and electric storage water heater manufacturers stated that they expect employment levels to remain relatively constant at TSL 1 through TSL 4. At these TSLs, baseline gas-fired and electric storage water heaters would be improved by increasing the insulation thickness around the tank. These improvements would not greatly alter the manufacturing process and are not likely to significantly change employment levels.

At TSL 5, domestic employment would be likely to increase if manufacturers built their dedicate heat pump line for large rated storage volumes in the United States. However, because the labor content to assemble fully integrated heat pump water heaters is much higher than most models currently on the market, manufacturers could also decide to build these lines in existing overseas production facilities. At TSL 5, the sourcing decisions would also impact the likely employment impacts. If manufacturers built a dedicated condensing line for large rated storage volumes in the United States, domestic employment could increase.

TSL 6 and TSL 7 could also impact domestic gas-fired and electric storage water heater employment. These TSLs effectively would require the use of integrated heat pump water heater technology for electric storage water heaters for all rate volumes. Manufacturers stated that at these levels, they initially would expect to purchase fully-assembled heat pump modules from off-shore suppliers because they do not have the manufacturing experience or the space in their existing facilities to accommodate assembling the heat hump modules. Once purchased, manufacturers would attach the modules to water heaters on lines modified to accommodate the very different assembly and testing requirements of heat pump water heaters. While the industry typically has manufacturing facilities with a mix of dedicated and non-dedicated assembly lines by fuel type, flexible assembly lines may have to be discontinued at TSL 6, because heat pump water heaters are top-heavy, take longer to test, and take significantly longer to assemble than electric storage water heaters that use resistance-heater elements. Present facilities would likely need line extensions to accommodate the additional labor required for assembling heat pump water heaters. Therefore, if manufacturers source the heat pump modules and continue to assemble electric storage water heaters in their existing facilities, it is likely that employment would increase. However, the expected increase in the labor required to manufacture heat pump water heaters may also accelerate the trend of water heater manufacturers locating new production facilities outside the United States, especially if a manufacturer decides to assemble heat pump modules in-house. Because TSL 7 requires additional improvements over TSL 6, the potential positive impacts on employment at TSL 7 are greater if manufacturers do not relocate because the additional improvements also require more labor.

At TSL 7 (the max-tech level) gas-fired storage water heaters would have to operate in a fully-condensing mode. DOE research suggests that condensing gas-fired water heaters would be more complex than standard power-vent products and less efficient products and therefore would require additional labor to assemble. If manufacturers did not change their sourcing decisions at TSL 7, it is likely there would be positive employment impacts for gas-fired storage water heaters.

ii. Oil-Fired Storage Water Heater Employment Impacts

Using the GRIM, DOE estimates there would be 38 oil-fired storage water heater production workers in the U.S. in 2015 in the absence of amended energy conservation standards. Using the Census data and interviews with manufacturers, DOE estimates that approximately 95 percent of oil-fired water heaters sold in the United States are manufactured domestically. Table V.31 shows the impacts of amended energy conservation standards on U.S. production workers in the oil-fired water heater market.

TABLE V.31—POTENTIAL CHANGES IN THE TOTAL NUMBER OF DOMESTIC OIL-FIRED STORAGE WATER HEATER PRODUCTION WORKERS IN 2015

	Trial standard level							
	Baseline	1	2	3	4	5	6	7
Total Number of Domestic Production Workers in 2015 (without changes in production locations)	38	37	40	37	37	37	37	47
Potential Changes in Domestic Production Workers in 2015 *	....	(38) – (1)	(38) – 2	(38) – (1)	(38) – (1)	(38) – (1)	(38) – (1)	(38) – 9

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

At TSL 1 through TSL 6, DOE does not expect substantial changes to domestic employment in the oil-fired storage water heater market if manufacturers are able to use the insulation type and thickness technology options in the engineering analysis to reach the efficiency requirements at these TSLs. At TSL 7, DOE research suggests that if all current suppliers continue to compete, domestic employment would likely increase slightly, because the non-proprietary, higher-efficiency heat exchangers required to reach this TSL would also require more labor to assemble. However, given the size of the oil-fired storage water heater market and the expected product conversion costs, companies that do not currently make oil-fired storage water heaters at these efficiency levels could exit the market. If the remaining manufacturers do not need to increase employment levels to meet the total market demand, employment in the residential oil-fired market could decline.

iii. Gas-Fired Instantaneous Water Heater Employment Impacts

DOE's research suggests that currently no gas-fired instantaneous water heaters are made domestically. All manufacturers or their domestic distributors do maintain offices in the United States to handle technical support, training, certification, and other requirements. However, as amended energy conservation standards for instantaneous water heaters are raised, the additional complexity of standards-compliant water heaters may require additional training and field support, thereby resulting in higher employment levels. Thus domestic employment may increase marginally due to amended energy conservation standards.

iv. Traditional Direct Heating Equipment Employment Impacts

Using the GRIM, DOE estimates there would be 300 traditional DHE production workers in the U.S. in 2013 in the absence of amended energy conservation standards. Using the Census Bureau data and interviews with manufacturers, DOE estimates that approximately 100 percent of the traditional DHE sold in the United States is manufactured domestically. Table V.32 shows the impacts of amended energy conservation standards on U.S. production workers in the traditional DHE market.

TABLE V.32—POTENTIAL CHANGES IN THE TOTAL NUMBER OF DOMESTIC TRADITIONAL DIRECT HEATING PRODUCTION WORKERS IN 2013

	Trial standard level						
	Baseline	1	2	3	4	5	6
Total Number of Domestic Production Workers in 2013 (without changes in production locations)	300	305	330	344	350	348	361

TABLE V.32—POTENTIAL CHANGES IN THE TOTAL NUMBER OF DOMESTIC TRADITIONAL DIRECT HEATING PRODUCTION WORKERS IN 2013—Continued

	Trial standard level						
	Baseline	1	2	3	4	5	6
Potential Changes in Domestic Production Workers in 2013*	....	(300) − 5	(300) − 30	(300) − 44	(300) − 50	(300) − 48	(300) − 61

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

There could be negative employment impacts for DHE at any of the considered TSLs if manufacturers' expectations are realized regarding higher prices yielding reduced demand. Besides increasing component costs, more stringent TSLs put additional pressure on manufacturers that could require them to invest in low-volume products, discontinue product lines that do not meet the required efficiency level, or exit the market altogether.

While multiple manufacturers could be adversely affected by amended energy conservation standards, at TSL 1 and TSL2, most businesses have existing products in at least three of the four traditional DHE product types. If manufacturers chose to expand production of those products that meet the required efficiencies, employment could increase. However, multiple small businesses would be adversely affected at any TSL and could decide to discontinue some product lines rather than invest in product lines with very low volumes. Any manufacturer that decided to discontinue product lines could reduce total employment within the industry if it impacted the availability of substitute replacement products. Net employment impacts if manufacturers discontinued product lines at TSL 1 and TSL 2 would depend on total product demand and the source of replacement production labor. At TSL 3 and above, products become increasingly more complex, require higher capital and product conversion costs, and, hence, are likely to lead to the discontinuation of more product lines. Additionally, every manufacturer would face product conversion costs that required a complete redesign for at least one product class at TSL 3 and above. An amended energy conservation standard at TSL 3 and above could cause small businesses to exit the market completely or stop producing certain product classes. If small and large manufacturers discontinued product lines or exited the market, domestic employment would be impacted if replacements were not available or a manufacturer exited the market and its market share was not captured by another manufacturer.

v. Gas Hearth Direct Heating Equipment Employment Impacts

Using the GRIM, DOE estimates there would be 1,243 gas hearth DHE production workers in the U.S. in 2013 in the absence of amended energy conservation standards. Based upon interviews with manufacturers, DOE estimates that approximately 80 percent of gas hearth DHE sold in the United States is manufactured domestically. Table V.33 shows the impacts of potential amended energy conservation standards on U.S. production workers in the gas hearth DHE market.

TABLE V.33—POTENTIAL CHANGES IN THE TOTAL NUMBER OF DOMESTIC GAS HEARTH DIRECT HEATING EQUIPMENT PRODUCTION WORKERS IN 2013

	Trial standard level						
	Baseline	1	2	3	4	5	6
Total Number of Domestic Production Workers in 2013 (without changes in production locations)	1,243	1,250	1,250	1,250	1,759	1,759	2,089
Potential Changes in Domestic Production Workers in 2013*	....	(1,243) − 7	(1,243) − 7	(1,243) − 7	(1,243) − 516	(1,243) − 516	(1,243) − 846

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

DOE does not expect significant employment impacts at TSL 1 through TSL 3. A substantial portion of the industry already has products that meet the requisite efficiencies required by these TSLs and DOE research suggests manufacturers can make products at these TSLs by replacing standing pilot ignition systems with electronic ignition systems. For TSL 4 through TSL 6, manufacturers would be increasingly likely to exit the market or reduce their product offerings. At TSL 4 and TSL 5, air circulating blowers are required and, at TSL 6, condensing operation is required, making these products increasingly complex. At these levels, manufacturers suggested the size of the gas hearth DHE market covered by today's rulemaking could be impacted due possible consumer reactions, which could also put additional pressure on domestic firms to consolidate or exit the market. A smaller market could reduce employment if the higher labor content required to manufacturer standards-compliant products is more than offset by a decline industry sales.

vi. Gas-Fired Pool Heater Employment Impacts

Using the GRIM, DOE estimates there would be 644 gas-fired pool heater production workers in the U.S. in 2013 in the absence of amended energy conservation standards. Using the Census Bureau data and interviews with manufacturers, DOE estimates that approximately 100 percent of gas-fired pool heaters sold in the United States are manufactured domestically. Table V.34 shows the impacts of potential amended energy conservations standards on U.S. production workers in the gas-fired pool heater industry.

TABLE V.34—POTENTIAL CHANGES IN THE TOTAL NUMBER OF DOMESTIC POOL HEATER PRODUCTION WORKERS IN 2013

	Trial standard level						
	Baseline	1	2	3	4	5	6
Total Number of Domestic Production Workers in 2013 (without changes in production locations)	644	657	678	710	737	807	975
Potential Changes in Domestic Production Workers in 2013 *		(644) – 13	(644) – 34	(644) – 66	(644) – 93	(644) – 163	(644) – 331

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

DOE expects no significant direct employment impacts on gas-fired pool heater manufacturers for TSL 1 through TSL 4 because the technology options at these TSLs involve mostly component changes that do not greatly alter the labor content. For example, the technology changes for existing products that meet TSL 3 and TSL 4 involve power venting. While this technology would alter the installation of much of the installed base and cause manufacturers to increase the production of low-volume products, the basic assembly of the pool heaters at the point of manufacture is not substantially changed. Therefore, it is unlikely that employment levels would be substantially impacted. However, the existing products in the market at TSL 5 are near-condensing products and products at TSL 6 use fully condensing technology. The higher-efficiency products are typically more complex and take longer to assemble, resulting in an increase in employment if shipments levels are maintained. However, manufacturers have stated that the higher prices of higher-efficiency products could result in a smaller number of annual shipments, which could cause a corresponding reduction in industry employment as well. At TSL 5 and TSL 6, manufacturers are particularly concerned that the closer their products become to condensing technology, the higher the product costs would be and the more likely it is that amended energy conservation standards would cause a drop in industry-wide shipments. If manufacturers experienced a drop in total shipments, the domestic employment in the gas-fired pool heater industry could be negatively affected.

e. Impacts on Manufacturing Capacity

i. Residential Gas-Fired and Electric Storage Water Heaters

Amended energy conservation standards could cause short-term capacity constraints for gas-fired storage water heaters at TSL 7 and cause short-term capacity constraints for electric storage water heaters at TSL 6 and TSL 7. However, for the remaining TSLs, manufacturers could maintain capacity levels and continue to meet market demand under amended energy conservation standards.

DOE research suggests for the efficiency requirements for gas-fired storage water heaters could be met by adding more foam insulation to all volume sizes at TSL 1 through TSL 4 and TSL 6. These changes would not require gas-fired storage water heater manufacturers to greatly alter their existing production facilities or equipment and would not cause capacity constraints. DOE also acknowledges that TSL 5 could also result in a constrained market for large volume sizes if manufacturers do not make the required investments to offer gas-fired condensing water heaters at relatively low shipment volumes. DOE also recognizes there will likely be significant impacts on manufacturers at any TSL that effectively requires gas-fired condensing.

The dramatically different technology required at the max-tech level for gas-fired storage water heaters introduces problems that could cause short-term capacity constraints in the market. At TSL 7 (the max-tech level), all manufacturers would need to redesign all of their existing products because none currently offers residential water heaters that use condensing technology. Manufacturers would also have to retrain their installers and servicers to handle technology that varies tremendously from the majority of exiting products on the market. The fundamental fabrication and production equipment of gas-fired storage water heaters are substantially different for water heaters that use condensing technology. Equipment to manufacturer required heat exchangers and new tank designs would be required, as well as substantial changes to all subassembly and main assembly lines to handle the new technology. DOE estimates that manufacturers would incur over $110 million in capital conversion costs to make these plant modifications if all residential gas-fired storage water heaters required condensing technology. For comparison, the base-case estimate for the net PPE for gas-fired storage water heaters is approximately $166 million. This comparison of the estimate of current net PPE to the required capital conversion costs indicates the plant and equipment changes require manufacturers to almost completely modify or replace a substantial portion of their existing production assets for gas-fired storage water heaters. DOE also estimates that these changes would strand approximately $26 million of existing assists, mainly the book value of tank and coil equipment that can no longer be used with condensing technology. In addition, manufacturers believe that there could be problems with quality control to manufacture substantially more complex products on high-speed production lines. These problems could further increase the capital costs required if the line rates required manufacturers to install additional production lines. Manufacturers indicated that these potential problems and the extremely substantial changes that are required to their facilities could cause a constrained market until the production equipment is installed and the high-speed manufacturing of what are currently low-volume commercial products can be expanded to meet the demand of the gas-fired residential water heater market. Although these changes are substantial, DOE believes that the 5-year period before compliance with the standard is required would allow manufacturers sufficient time to make the necessary changes to meet demand for those products. The full range of products may not be available initially, however, since manufacturers would likely prioritize high-volume product lines ahead of lower-volume product lines.

For electric storage water heaters, TSL 1 through TSL 3 would require only minor changes to existing products to increase the tank insulation thickness. At TSL 4, more substantial plant modifications would be required because changes to the insulation thickness would require more foaming stations and additional production lines due to a lower throughput. However, electric storage water heater manufacturers would be able to maintain manufacturing capacity levels and continue to meet market demand under amended energy conservation standards for these TSLs. These TSLs do not require prohibitively costly or complex changes to existing facilities or most products on the market today.

DOE also acknowledges that TSL 5 could also result in a constrained market for large volume sizes if manufacturers do not make the required investments to offer electric heat pump water heaters at relatively low shipment volumes. DOE also recognizes there will likely be significant impacts on manufacturers at any TSL that effectively requires electric heat pump water heaters.

Electric storage water heater manufacturers indicated that there could be potential capacity impacts at TSL 6 or TSL 7, which would effectively require heat pump technology. However, manufacturers of electric storage water heaters indicated that significant changes to production facilities would be required if amended energy conservation standards effectively mandated heat pump water heaters for all rated volume sizes (TSL 6 and TSL 7). Several manufacturers stated that they could move all or part of their production to Mexico to take advantage of lower labor costs if more complex heat pump water heaters were required. DOE believes manufacturers would likely source the heat pump module initially if they were required to exclusively manufacture heat pump water heaters. However, such a dramatic increase in the demand for heat pump modules could strain suppliers, especially in the short-term. Finally, manufacturers also stated that they have very little experience with manufacturing heat pump water heaters. Manufacturers indicated that the changes to their facilities (including potential plant sourcing decisions) could cause a constrained market until the production equipment is installed and any problems with high-speed manufacturing are resolved. As discussed in section IV.B.3.b, DOE acknowledges there could be issues with converting entire production lines to manufacture heat pump water heaters before the compliance date of this standard. Given the five-year delay in the compliance date with the amended standard from the issuance from the final rule, and the fact that many manufacturers are already developing heat pump water heaters, DOE believes manufacturers may be able to convert all their product lines before the compliance date of an amended energy conservation standard.

ii. Residential Oil-Fired Storage Water Heaters

While amended energy conservation standards could impact current market shares in the oil-fired storage water heater market, it is unlikely that standards would result in a constrained market. For oil-fired storage water heaters, the fundamental fabrication and assembly equipment would not be expected to change significantly in order to comply with TSL 1 through TSL 6. While DOE research suggests that products that meet TSL 1 through TSL 6 require relatively minor changes to the insulation material or thickness, the product conversion costs necessary at these TSLs could cause at least one manufacturer with significant market share to exit the residential oil-fired storage water heater market due to the low total shipment volumes. At any efficiency level that would likely require a multi-flue heat exchanger (*i.e.,* TSL 7), all but one manufacturer would need to make a significant and costly redesign of existing residential oil-fired product lines and related manufacturing facilities. These substantial changes could cause manufacturers to exit the residential oil-fired storage water heater market. However, even TSL 7 is unlikely to result in a constrained market even if any manufacturer exited the oil-fired residential water heater market. One residential oil-fired storage water heater manufacturer with significant market share has products that meet the max-tech level. Due to the low shipment volumes of oil-fired storage water heaters, this manufacturer could meet the total industry demand and industry-wide capacity would not be impacted.

iii. Gas-Fired Instantaneous Water Heaters

There may be short-term capacity constraints for gas-fired instantaneous water heaters at TSL 7. DOE research suggests that all gas-fired instantaneous water heaters are currently imported. If the amended energy conservation standards required more-efficient products than those currently offered, foreign manufacturers and parent companies would have to decide whether the relatively small market for gas-fired instantaneous water heaters in the United States could justify the required investments. DOE expects that TSL 1 through TSL 6 would be unlikely to disrupt supply to the United States because of the number of existing product lines that manufacturers could offer without substantial product develop would not greatly change at the required efficiencies. The number of existing product lines on the market drops substantially at TSL 7. There could be capacity constraints in response to amended energy conservation standards at TSL 7 if manufacturers that do not have compliant products chose not to develop them for the United States market due to the current size of the market.

iv. Traditional Direct Heating Equipment

Amended energy conservation standards could lead to a constrained traditional DHE market. DOE does not expect that traditional DHE manufacturers would need to substantially modify existing facilities in response to amended energy conservation standards at TSL 1 or TSL 2. However, at TSL 3 though TSL 6, some manufacturers would face complete product redesigns for either gas wall fan or gas room DHE. A complete redesign would entail significant product development, tooling, certification, and testing costs. Some manufacturers indicated that low shipment volumes would make these costs unjustifiable for many product lines, thereby leading to the discontinuation of those lines. Small businesses with less access to capital would be even more likely to face this problem than higher-volume, more diversified competitors, possibly resulting in further industry consolidation. Pressure that forced manufacturers to consolidate or exit the market could also strain the remaining manufacturers' capacity to increase production to meet industry demand. However at TSL 3, DOE believes that manufacturers have enough existing products in multiple product classes that they could selectively upgrade enough product lines to meet industry demand and remain in business. However, DOE believes setting an amended energy conservation standard above TSL 3 could lead to manufacturing capacity problems for certain product classes if manufacturers cannot make the tooling changes in time to meet the standard, if manufacturers do not have the resources to develop products that meet the required efficiencies, or if manufacturers discontinue product lines rather than invest an amount equal to the required conversion costs.

v. Gas Hearth Direct Heating Equipment

Gas hearth DHE manufacturers did not indicate that amended energy conservation standards would lead to a constrained market. Rather, such manufacturers are concerned that more stringent energy conservation standards could exert additional pressures on companies to consolidate or exit the market. Manufacturers predict that unit shipments would decline increasingly as the amended energy conservation standard is set closer to max-tech (*i.e.,* TSL 6). Manufacturers also indicated that the high capital conversion costs would lead all manufacturers to drop product lines or not convert all existing product lines at TSL 4 through TSL 6 because of the smaller market for covered gas hearth products that is anticipated in the event of a more stringent amended energy conservation standard. The reduction in market demand and the lower number of product lines available would likely lead to an overcapacity of covered products within the industry, even if multiple lower-volume competitors exit the market.

vi. Gas-Fired Pool Heaters

Manufacturers indicated that, while other potentially negative impacts were possible at lower TSLs, industry capacity could be impacted at more stringent TSLs. At TSL 1 through TSL 4, DOE research suggests that manufacturers could retool without causing capacity constraints in the market. If DOE were to set amended energy conservation standards at near-condensing or condensing level, most gas-fired pool heater manufacturers stated that short-term production capacity could be affected. While only TSL 6 requires fully-condensing products, manufacturers indicated that adoption of amended standards at TSL 5 and above could cause them to manufacture only fully-condensing products in order to minimize longevity and warranty issues. Thus, TSL 5 and TSL 6 would require manufacturers to incur significant product and capital conversion costs. Consequently, DOE believes setting an amended energy conservation standard at or above TSL 5 could lead to short-term capacity problems if manufacturers cannot make the necessary tooling, equipment, and assembly changes in time to meet the standard.

f. Cumulative Regulatory Burden

While any one regulation may not impose a significant burden on manufacturers, the combined effects of several impending regulations may have serious consequences for some manufacturers, groups of manufacturers, or an entire industry. Assessing the impact of a single regulation may overlook this cumulative regulatory burden. In addition to energy conservation standards, other regulations can significantly affect manufacturers' financial operations. Multiple regulations affecting the same manufacturer can strain company-wide resources and can lead companies to abandon product lines or markets with lower expected future returns than competing products. For these reasons, DOE conducts an analysis of cumulative regulatory burden as part of its rulemakings pertaining to appliance efficiency. During previous stages of this rulemaking, DOE identified several requirements, in addition to amended energy conservation standards for the three types of heating products that manufacturers will face for products manufactured three years before and three years after the anticipated compliance date of the amended energy conservation standards.

During interviews and in their written comments, manufacturers stated that the most significant of these additional regulations are regional ultra-low-NO_X requirements and environmental and safety regulations. In response to the preliminary analysis, BWC commented that there is a substantial cost increase to comply with ultra-low-NO_X requirements. (BWC, No. 46 at p. 1) Noritz also stated that ultra-low-NO_X requirements are the most significant regulation that will affect the gas-fired instantaneous water heating industry (Noritz, No. 36 at p. 3). AHRI and Rheem stated that gas-fired instantaneous water heater manufacturers will have to comply with ultra-low-NO_X emissions requirements in 2012. (AHRI, Public Meeting Transcript, No. 34.4 at p. 134; Rheem, No. 48 at p. 7)

Low and ultra-low-NO_X regulations for gas-fired water heaters are being implemented regionally by air quality management districts, including the South Coast Air Quality Management District (SCAQMD), the Bay Area Air Quality Management District (BAAQMD), the San Joaquin Valley Unified Air Pollution Control District (the Valley Air District), and the Texas Commission on Environmental Equality (TCEQ). The ultra-low-NO_X regional standards currently in place only cover gas-fired storage water heaters, but manufacturers are concerned that these standards could eventually affect additional types of gas-fired equipment. While the SCAQMD, the BAAQMD, and the Valley Air District all mandate ultra-low-NO_X requirements, the TCEQ only has low-NO_X requirements.

DOE accounted for the added cost for manufacturers of gas-fired storage water heaters to comply with regional ultra-low NO_X requirements (see section IV.C.2). DOE agrees with Noritz, AHRI, and Rheem that ultra-low-NO_X requirements may affect instantaneous gas water heaters beginning in 2012. While the SCAQMD does not distinguish between gas-fired storage and gas-fired instantaneous water heaters, the BAAQMD and the Valley Air District have separate ultra-low-NO_X regulations for natural gas-fired instantaneous water heaters. Although the compliance dates of these regulations are pending, DOE is not aware of any ultra-low-NO_X instantaneous gas-fired water heaters currently on the market. Consequently, DOE could not create a separate cost curve to account for the additional cost of instantaneous water heaters that will meet the upcoming ultra-low-NO_X emissions requirements.

There are also existing FVIR and low and ultra-low-NO_X requirements for gas-fired storage water heaters, ignition source requirements, amended energy conservation standards for other products made by heating products manufacturers, State energy conservation standards for other products, and international energy conservation standards. The cumulative burden focuses on other product-specific Federal requirements with a compliance date three years prior to and three years after the anticipated compliance dates of the amended energy conservation standards of this rulemaking. However, DOE discusses these and other regulations and includes the full details of the cumulative regulatory burden in chapter 12 of the NOPR TSD.

g. Impacts on Small Businesses

As discussed in section IV.H.1.c, using average cost assumptions to develop an industry cash-flow estimate is not adequate for assessing differential impacts among manufacturer subgroups. Small manufacturers, niche equipment manufacturers, and manufacturers exhibiting a cost structure substantially different from the industry average could be affected disproportionately. DOE used the results of the industry characterization to group manufacturers exhibiting similar characteristics. Consequently, the only subgroup DOE identified was small manufacturers.

DOE evaluated the impact of amended energy conservation standards on small manufacturers, as defined by SBA. As a result, DOE identified five residential water heater manufacturers, 12 DHE manufacturers, and one small gas-fired pool heater manufacturer that are classified as small businesses per the SBA definition. DOE describes the differential impacts on these small businesses in section VI.B of today's notice. For a complete discussion of the impacts on small businesses, see chapter 12 of the NOPR TSD.

3. National Impact Analysis

a. Significance of Energy Savings

To estimate the energy savings attributable to potential standards, DOE compared the energy consumption of the heating products under the base case (no standards) to anticipated energy consumption of these products under each TSL. Table V.35 through Table V.37 present DOE's NES estimates by product type and class for each TSL. Chapter 10 of the NOPR TSD describes these estimates in more detail.

TABLE V.35—WATER HEATERS: CUMULATIVE NATIONAL ENERGY SAVINGS IN QUADS

Product class	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7
Gas-Fired Storage	0.83	1.29	1.29	1.29	1.46	1.29	5.33
Electric Storage	0.35	0.49	0.90	1.21	2.18	9.05	10.62
Oil-Fired Storage	0.01	0.01	0.01	0.01	0.01	0.01	0.03
Gas-Fired Instantaneous	0.08	0.08	0.08	0.08	0.08	0.08	0.87
Total	1.26	1.88	2.28	2.60	3.74	10.44	16.85

TABLE V.36—DIRECT HEATING EQUIPMENT: CUMULATIVE NATIONAL ENERGY SAVINGS IN QUADS

Product class	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Gas Wall Fan	0.007	0.01	0.01	0.02	0.01	0.02
Gas Wall Gravity	0.008	0.02	0.06	0.06	0.10	0.10
Gas Floor	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Gas Room	0.002	0.00	0.01	0.01	0.03	0.03
Gas Hearth	0.136	0.14	0.14	0.30	0.30	0.93
Total	0.15	0.17	0.22	0.39	0.44	1.08

TABLE V.37—POOL HEATERS: CUMULATIVE NATIONAL ENERGY SAVINGS IN QUADS

	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Gas-Fired	0.02	0.03	0.08	0.10	0.13	0.28

b. Net Present Value of Consumer Costs and Benefits

DOE estimated the cumulative NPV to the Nation of total heating product consumer costs and savings that would result from particular standard levels. In accordance with the OMB Circular A–4, DOE calculated the NPV using both a 7-percent and a 3-percent real discount rate. The 7-percent rate is an estimate of the average before-tax rate of return to private capital in the U.S. economy, and reflects the returns to real estate and small business capital as well as corporate capital. DOE used this discount rate to approximate the opportunity cost of capital in the private sector, as OMB analysis has found the average rate of return to capital to be near this rate. In addition, DOE used the 3-percent rate to capture the potential effects of amended standards on private consumption (*e.g.,* through higher prices for products and reduced purchases of energy). This rate represents the rate at which society discounts future consumption flows to their present value. This rate can be approximated by the real rate of return on long-term government debt (*i.e.,* yield on Treasury notes minus annual rate of change in the Consumer Price Index), which has averaged about 3 percent on a pre-tax basis for the last 30 years.

Table V.38 through Table V.40 show the consumer NPV results for each TSL DOE considered for the three types of heating products, using both a 7-percent and a 3-percent discount rate. See chapter 10 of the NOPR TSD for more detailed NPV results.

TABLE V.38—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR WATER HEATERS

[Impacts for units sold from 2015 to 2045]

Product class		TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7
		billion 2008 dollars						
Discounted at 3%	Gas-Fired Storage	7.58	9.04	9.04	9.04	9.63	9.04	11.27
	Electric Storage	2.19	3.16	4.73	6.02	11.67	31.90	41.94
	Oil-Fired Storage	0.12	0.20	0.28	0.28	0.28	0.28	0.47
	Gas-Fired Instantaneous.	0.30	0.30	0.30	0.30	0.30	0.30	−5.68
	Total	10.20	12.71	14.36	15.64	21.89	41.52	47.99
Discounted at 7%	Gas-Fired Storage	2.94	3.09	3.09	3.09	3.17	3.09	−1.10
	Electric Storage	0.69	1.03	1.32	1.59	3.35	5.22	8.50
	Oil-Fired Storage	0.05	0.09	0.12	0.12	0.12	0.12	0.19

TABLE V.38—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR WATER HEATERS—Continued

[Impacts for units sold from 2015 to 2045]

	Gas-Fired Instantaneous.	0.01	0.01	0.01	0.01	0.01	0.01	−4.84
	Total	3.69	4.20	4.53	4.79	6.64	8.43	2.75

TABLE V.39—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR DIRECT HEATING EQUIPMENT

[Impacts for units sold from 2013 to 2043]

Product class		TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
		billion 2008 dollars					
Discounted at 3%	Gas Wall Fan	0.07	0.09	0.11	0.14	0.07	0.14
	Gas Wall Gravity	0.07	0.22	0.52	0.52	0.37	0.37
	Gas Floor	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
	Gas Room	0.02	0.05	0.08	0.08	0.35	0.35
	Gas Hearth	1.52	1.52	1.52	−1.06	−1.06	−3.49
	Total	1.68	1.87	2.22	−0.33	−0.26	−2.63
Discounted at 7%	Gas Wall Fan	0.03	0.04	0.04	0.04	0.03	0.04
	Gas Wall Gravity	0.03	0.09	0.20	0.20	0.06	0.06
	Gas Floor	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	Gas Room	0.01	0.02	0.03	0.03	0.14	0.14
	Gas Hearth	0.64	0.64	0.64	−1.16	−1.16	−3.78
	Total	0.71	0.79	0.91	−0.89	−0.93	−3.54

TABLE V.40—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR POOL HEATERS

[Impacts for units sold from 2013 to 2043]

	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
	billion 2008 dollars					
Discounted at 3%	0.16	0.18	0.40	0.25	−1.97	−4.51
Discounted at 7%	0.08	0.07	0.14	0.03	−1.27	−2.94

c. Net Present Value of Benefits From Energy Price Impacts

DOE estimated the cumulative NPV of the economy-wide savings in natural gas expenditures during the forecast period due to the projected decline in natural gas prices resulting from amended standards on water heaters. DOE calculated the cumulative NPV for the efficiency levels in each product class corresponding to each TSL using both a 7-percent and a 3-percent discount rate (Table V.41). (The impact of amended standards for direct heating equipment and pool heaters was not estimated for the reasons explained in section IV.F.) See chapter 10 of the NOPR TSD for further details. As discussed in section IV.F.2.g, DOE was not able to estimate the impact of the considered TSLs on electricity prices.

TABLE V.41—CUMULATIVE NPV OF THE ECONOMY-WIDE SAVINGS IN NATURAL GAS EXPENDITURES DUE TO THE PROJECTED DECLINE IN NATURAL GAS PRICES RESULTING FROM AMENDED STANDARDS FOR WATER HEATERS*

Discount Rate	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7
	billion $2008						
3 percent	3.0	4.5	5.1	5.6	7.1	23.6	47.7
7 percent	1.4	2.2	2.5	2.7	3.4	12.0	24.2

* Impacts for units sold from 2015 to 2045.

d. Impacts on Employment

Employment impacts consist of direct and indirect impacts. Direct employment impacts are any changes in the number of employees of manufacturers of the appliance products that are the subject of this rulemaking, their suppliers, and related service firms. Indirect employment impacts are changes in employment in the larger economy that occur due to the shift in expenditures and capital investment caused by the purchase and operation of more-efficient appliances. The MIA addresses the direct employment impacts that concern manufacturers of the three heating products (see section V.B.2 above).

To estimate the indirect employment impacts of potential amended energy conservation standards, DOE used an input/output model of the U.S. economy (see section IV.I)). The input/output model results suggest that amended standards would be likely to increase the net demand for labor in the economy slightly. Table V.42 presents the estimated net indirect employment impacts from the TSLs that DOE considered for water heaters. The estimated impacts from the potential amended standards for DHE and pool heaters would be much smaller. (Note that the input/output model DOE uses does not report the quality or wage level of the jobs.) See chapter 14 of the NOPR TSD for more detailed results.

TABLE V.42—NET INCREASE IN NATIONAL INDIRECT EMPLOYMENT UNDER WATER HEATER TSLS

Trial standard level	2015 *thousands*	2020 *thousands*	2030 *thousands*	2044 *thousands*
1	−0.17	1.02	2.58	3.32
2	−0.46q	1.20	3.36	4.38
3	-0.55	1.97	5.27	6.70
4	−0.62	2.58	6.75	8.49
5	−0.77	5.63	13.95	17.82
6	−2.47	18.48	45.72	55.67
7	−6.98	19.37	54.03	68.11

While DOE's analysis suggests that amended standards could increase the net demand for labor in the economy, the estimated gains would be very small relative to total national employment. Therefore, DOE has tentatively concluded that the considered standard levels would be likely to produce employment benefits sufficient to fully offset any adverse impacts on employment in the manufacturing industries related to the three types of heating products that are the subject of this rulemaking.

4. Impact on Utility or Performance of Products

As discussed in section III.D.1.d, DOE has tentatively concluded that none of the efficiency levels considered in this notice would reduce the utility or performance of the three types of heating products. Furthermore, manufacturers of these products currently offer heating products that meet or exceed the proposed standards. (42 U.S.C. 6295(o)(2)(B)(i)(IV))

5. Impact of Any Lessening of Competition

DOE has also considered any lessening of competition likely to result from amended standards. The Attorney General determines the impact, if any, of any lessening of competition likely to result from a proposed standard, and transmits its determination to the Secretary, together with an analysis of the nature and extent of the impact. (42 U.S.C. 6295(o)(2)(B)(i)(V) and (ii))

To assist the Attorney General in making such a determination, DOE has provided DOJ with copies of this notice 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

Improving the energy efficiency of heating products when economically justified would likely improve the security of the Nation's energy system by reducing overall demand for energy. (42 U.S.C. 6295(o)(2)(B)(i)(VI)) Reduced electricity demand may also improve the reliability of the electricity system.

Energy savings from amended standards for heating products could also produce environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases associated with energy production and the use of fossil fuels at the sites where heating products are used. Table V.43 and Table V.44 provide DOE's estimate of cumulative CO_2, NO_X, and Hg emissions reductions that would be expected to result from the TSLs considered in this rulemaking. In the environmental assessment (chapter 16 of the NOPR TSD), DOE reports the estimated annual change in CO_2, NO_X, and Hg emissions attributable to each TSL.

For DHE, DOE estimates a very slight increase in Hg emissions under the proposed standard. The reason for this result is that the more-efficient products save natural gas, but they also use more electricity due to electronic ignition and, for some DHE TSLs, use of a fan. This results in higher electricity generation than in the reference case, which leads to higher emissions. However, because the increase in electricity that these more efficient products are projected to use is comparatively small when compared to the reduction in natural gas usage, there will be an overall efficiency gain from the proposed standard. For CO_2 and NO_X, the higher emissions from the power sector would also be canceled out by lower household emissions from gas combustion, resulting in a total emissions decrease under the considered TSLs. This is not the case for Hg because there are no household Hg emissions to offset.

As discussed in section IV.K, DOE does not report SO_2 emissions reductions from power plants because there is uncertainty about the effect of energy conservation standards on the overall level of SO_2 emissions in the United States due to SO_2 emissions caps. DOE also did not include NO_X emissions reduction from power plants in States subject to CAIR because an energy conservation standard would not affect the overall level of NO_X emissions in those States due to the emissions caps mandated by CAIR.

TABLE V.43—SUMMARY OF EMISSIONS REDUCTIONS UNDER WATER HEATER TSLS

[Cumulative throughout forecast period]

Emission Type	TSL						
	1	2	3	4	5	6	7
CO_2 (Mt)	88.7	136.8	146.6	153.8	217.0	346.0	965.5
NO_X (kt)	68.5	106	113	118	165	254	730

TABLE V.43—SUMMARY OF EMISSIONS REDUCTIONS UNDER WATER HEATER TSLs—Continued

[Cumulative throughout forecast period]

Emission Type	TSL						
	1	2	3	4	5	6	7
Hg (t)	0.11	0.16	0.19	0.20	0.60	2.18	4.43

TABLE V.44—SUMMARY OF EMISSIONS REDUCTIONS UNDER DIRECT HEATING EQUIPMENT AND POOL HEATER TSLs

[Cumulative throughout forecast period]

Emission Type	TSL					
	1	2	3	4	5	6
Direct Heating Equipment						
CO_2 (Mt)	6.32	7.02	8.52	16.69	18.46	42.97
NO_X (kt)	5.79	6.42	7.74	15.2	16.9	39.6
Hg (t)	(0.02)	(0.02)	(0.02)	(0.00)	(0.01)	(0.01)
Pool Heaters						
CO_2 (Mt)	0.610	1.05	3.31	4.21	5.74	12.12
NO_X (kt)	0.55	0.94	2.98	3.74	5.10	10.77
Hg (t)	0.00	0.00	0.01	0.00	0.00	0.00

DOE estimated the cumulative monetary value of the economic benefits associated with CO_2 emissions reductions expected to result from amended standards for the three types of heating products. As discussed in section IV.K, in considering the potential global benefits resulting from reduced CO_2 emissions, DOE used values based on a social cost of carbon of approximately $5, $10, $20, $34 and $56 per metric ton avoided in 2007 (values expressed in 2008$). DOE also calculated the domestic benefits based on a value of approximately $1 per metric ton avoided in 2007. To monetize the CO_2 emissions reductions expected to result from amended standards for heating products in 2013–2045, DOE escalated the above values for 2007 using a three-percent escalation rate. For each of the three types of heating products, DOE calculated the cumulative monetary value for each TSL using both a 7-percent and 3-percent discount rate (see Table V.45 through Table V.50).

TABLE V.45—ESTIMATES OF THE VALUE OF CO_2 EMISSIONS REDUCTIONS FOR WATER HEATERS UNDER TRIAL STANDARD LEVELS USING 7% DISCOUNT RATE

TSL	Value of estimated CO_2 emission reductions (million 2008$)*					
	Domestic	Global				
	CO_2 value of $1/metric ton CO_2	CO_2 value of $5/metric ton CO_2	CO_2 value of $10/metric ton CO_2	CO_2 value of $20/metric ton CO_2	CO_2 value of $34/metric ton CO_2	CO_2 value of $56/metric ton CO_2
1	48.0	211	421	800	1,390	2,317
2	74.1	325	650	1,235	2,145	3,575
3	79.4	348	697	1,324	2,299	3,832
4	83.4	366	732	1,390	2,414	4,024
5	112	492	983	1,869	3,246	5,409
6	171	749	1,497	2,845	4,941	8,235
7	487	2,134	4,268	8,110	14,085	23,476

* Unit values are approximate and are based on escalating 2007$ to 2008$ for consistency with other values presented in this notice.

TABLE V.46—ESTIMATES OF THE VALUE OF CO_2 EMISSIONS REDUCTIONS FOR WATER HEATERS UNDER TRIAL STANDARD LEVELS USING 3% DISCOUNT RATE

TSL	Value of estimated CO_2 emission reductions (million 2008$)*					
	Domestic	Global				
	CO_2 value of $1/metric ton CO_2	CO_2 value of $5/metric ton CO_2	CO_2 value of $10/metric ton CO_2	CO_2 value of $20/metric ton CO_2	CO_2 value of $34/metric ton CO_2	CO_2 value of $56/metric ton CO_2
1	110	480	961	1,826	3,171	5,285
2	169	741	1,482	2,816	4,890	8,151
3	181	794	1,588	3,017	5,239	8,732

TABLE V.46—ESTIMATES OF THE VALUE OF CO_2 EMISSIONS REDUCTIONS FOR WATER HEATERS UNDER TRIAL STANDARD LEVELS USING 3% DISCOUNT RATE—Continued

TSL	Value of estimated CO_2 emission reductions (million 2008$)*					
	Domestic	Global				
	CO_2 value of $1/metric ton CO_2	CO_2 value of $5/metric ton CO_2	CO_2 value of $10/metric ton CO_2	CO_2 value of $20/metric ton CO_2	CO_2 value of $34/metric ton CO_2	CO_2 value of $56/metric ton CO_2
4	190	833	1,666	3,166	5,499	9,166
5	265	1,162	2,325	4,417	7,672	12,787
6	416	1,824	3,648	6,932	12,040	20,066
7	1,170	5,132	10,263	19,500	33,868	56,447

* Unit values are approximate and are based on escalating 2007$ to 2008$ for consistency with other values presented in this notice.

TABLE V.47—ESTIMATES OF THE VALUE OF CO_2 EMISSIONS REDUCTIONS FOR DIRECT HEATING EQUIPMENT UNDER TRIAL STANDARD LEVELS USING 7% DISCOUNT RATE

TSL	Value of estimated CO_2 emission reductions (million 2008$)*					
	Domestic	Global				
	CO_2 value of $1/metric ton CO_2	CO_2 value of $5/metric ton CO_2	CO_2 value of $10/metric ton CO_2	CO_2 value of $20/metric ton CO_2	CO_2 value of $34/metric ton CO_2	CO_2 value of $56/metric ton CO_2
1	3.69	16.2	32.4	61.5	107	178
2	4.09	18.0	35.9	68.2	119	198
3	4.96	21.8	43.6	82.8	144	240
4	9.78	42.9	85.8	163	283	472
5	10.8	47.4	94.8	180	313	521
6	25.2	111	221	420	730	1,216

* Unit values are approximate and are based on escalating 2007$ to 2008$ for consistency with other values presented in this notice.

TABLE V.48—ESTIMATES OF THE VALUE OF CO_2 EMISSIONS REDUCTIONS FOR DIRECT HEATING EQUIPMENT UNDER TRIAL STANDARD LEVELS USING 3% DISCOUNT RATE

TSL	Value of estimated CO_2 emission reductions (million 2008$)*					
	Domestic	Global				
	CO_2 value of $1/metric ton CO_2	CO_2 value of $5/metric ton CO_2	CO_2 value of $10/metric ton CO_2	CO_2 value of $20/metric ton CO_2	CO_2 value of $34/metric ton CO_2	CO_2 value of $56/metric ton CO_2
1	7.81	34.3	68.5	130	226	377
2	8.68	38.1	76.1	145	251	419
3	10.5	46.2	92.4	176	305	508
4	20.6	90.5	181	344	598	996
5	22.8	100	200	380	661	1,101
6	53.1	233	466	886	1,538	2,564

* Unit values are approximate and are based on escalating 2007$ to 2008$ for consistency with other values presented in this notice.

TABLE V.49—ESTIMATES OF THE VALUE OF CO_2 EMISSIONS REDUCTIONS FOR POOL HEATERS UNDER TRIAL STANDARD LEVELS USING 7% DISCOUNT RATE

TSL	Value of estimated CO_2 emission reductions (million 2008$)*					
	Domestic	Global				
	CO_2 value of $1/metric ton CO_2	CO_2 value of $5/metric ton CO_2	CO_2 value of $10/metric ton CO_2	CO_2 value of $20/metric ton CO_2	CO_2 value of $34/metric ton CO_2	CO_2 value of $56/metric ton CO_2
1	0.37	1.63	3.27	6.21	10.8	18.0
2	0.64	2.81	5.61	10.7	18.5	30.9
3	2.02	8.86	17.7	33.7	58.5	97.4
4	2.55	11.2	22.4	42.5	73.	123
5	3.47	15.2	30.5	57.9	101	168
6	7.33	32.8	64.3	122	212	354

* Unit values are approximate and are based on escalating 2007$ to 2008$ for consistency with other values presented in this notice.

TABLE V.50—ESTIMATES OF THE VALUE OF CO_2 EMISSIONS REDUCTIONS FOR POOL HEATERS UNDER TRIAL STANDARD LEVELS USING 3% DISCOUNT RATE

TSL	Value of estimated CO_2 emission reductions (million 2008$)*					
	Domestic	Global				
	CO_2 value of $1/metric ton CO_2	CO_2 value of $5/metric ton CO_2	CO_2 value of $10/metric ton CO_2	CO_2 value of $20/metric ton CO_2	CO_2 value of $34/metric ton CO_2	CO_2 value of $56/metric ton CO_2
1	0.75	3.31	6.62	12.6	21.8	36.4
2	1.30	5.69	11.4	21.6	37.5	62.5
3	4.09	18.0	35.9	68.2	118	197
4	5.21	22.8	45.7	86.8	151	251
5	7.10	31.1	62.2	118	205	342
6	15.0	65.7	131	250	434	723

* Unit values are approximate and are based on escalating 2007$ to 2008$ for consistency with other values presented in this notice.

DOE also estimated a range for the cumulative monetary value of the economic benefits associated with NO_X and Hg emissions reductions anticipated to result from amended standards for the three types of heating products under consideration in this rulemaking. Table V.51 through Table V.54 present the results for NO_X emissions reductions. Table V.53 presents the results for Hg emissions reductions for water heaters. The values for Hg emissions reductions for direct heating equipment and pool heater TSLs are negligible.

TABLE V.51—ESTIMATES OF THE VALUE OF NO_X EMISSIONS REDUCTIONS FOR WATER HEATERS UNDER TRIAL STANDARD LEVELS

TSL	Value at 7% discount rate *million 2008$*	Value at 3% discount rate *million 2008$*
1	7.44–76.4	15.9–163
2	11.5–118	24.5–252
3	12.3–126	26.2–269
4	12.9–132	27.4–282
5	16.4–168	36.6–377
6	23.0–236	54.1–556
7	69.1–710	159–1,632

TABLE V.52—ESTIMATES OF THE VALUE OF NO_X EMISSIONS REDUCTIONS FOR DIRECT HEATING EQUIPMENT UNDER TRIAL STANDARD LEVELS

TSL	Value at 7% discount rate *million 2008$*	Value at 3% discount rate *million 2008$*
1	0.71–7.26	1.41–14.51
2	0.78–8.04	1.56–16.07
3	0.94–9.68	1.89–19.39
4	1.87–19.2	3.73–38.32
5	2.07–21.3	4.13–42.50
6	4.86–50.0	9.67–99.45

TABLE V.53—ESTIMATES OF THE VALUE OF NO_X EMISSIONS REDUCTIONS FOR POOL HEATERS UNDER TRIAL STANDARD LEVELS

TSL	Value at 7% discount rate *million 2008$*	Value at 3% discount rate *million 2008$*
1	0.07–0.75	0.14–1.43
2	0.12–1.28	0.24–2.45
3	0.39–4.05	0.75–7.73
4	0.49–5.03	0.94–9.66
5	0.67–6.86	1.28–13.16
6	1.41–14.49	2.70–27.80

TABLE V.54—ESTIMATES OF THE VALUE OF MERCURY EMISSIONS REDUCTIONS FOR WATER HEATERS UNDER TRIAL STANDARD LEVELS

TSL	Value at 7% discount rate *million 2008$*	Value at 3% discount rate *million 2008$*
1	0.03–1.20	0.05–2.17
2	0.04–1.82	0.07–3.30
3	0.05–2.07	0.08–3.74
4	0.05–2.25	0.09–4.09
5	0.16–6.94	0.28–12.53
6	0.49–21.7	0.93–41.7
7	0.99–44.1	1.90–84.8

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.55 presents the NPV values for water heaters that would result if DOE were to add the low- and high-end estimates of the potential benefits resulting from reduced CO_2, NO_X and Hg emissions to the NPV of consumer savings calculated for each TSL considered in this rulemaking, at both a 7- and 3-percent discount rate. Table V.56 presents the NPV values for DHE that would result if DOE were to add the low- and high-end estimates of the potential global benefits resulting from reduced CO_2 emissions to the NPV of consumer savings calculated for each TSL considered in this rulemaking, at both a 7- and 3-percent discount rate. Table V.57 presents the same NPV values for pool heaters. For CO_2, only the low and high global benefit values are used for these tables ($5 and $56 in 2008$).

Although adding the value of consumer savings to the values of emission reductions provides a valuable perspective, please note the following: 1) the national consumer savings are domestic U.S. consumer monetary savings found in market transactions, while the values of emission reductions are based on ranges of estimates of imputed marginal social costs, which, in the case of CO_2, are meant to reflect global benefits; and 2) the assessments of consumer savings and emission-related benefits are performed with different computer models, leading to different time frames for the analyses. For water heaters, for example, the present value of national consumer savings is measured for the period 2015–2065 (30 years from 2015 to 2045, plus the longest lifetime of the equipment shipped in the 30th year). However, the time frames of the benefits associated with the emission reductions differ. For example, the value of CO_2 emission reductions is meant to reflect the present value of all future climate-related impacts, even those beyond 2065.

DOE seeks comment on its presentation of NPV values and on the consideration of GHG emissions in future energy conservation standards rulemakings, including alternative methodological approaches to including GHG emissions in its analysis. More specifically, DOE seeks comment on both how it integrates monetized GHG emissions or Social Cost of Carbon values, as well as other monetized benefits or costs, into its analysis and models, and also on suggested alternatives to the current approach.

TABLE V.55—ESTIMATES OF ADDING NPV OF CONSUMER SAVINGS TO NPV OF LOW- AND HIGH-END GLOBAL MONETIZED BENEFITS FROM CO_2, NO_X, AND HG EMISSIONS REDUCTIONS AT ALL TSLS FOR WATER HEATERS AT 3- AND 7-PERCENT DISCOUNT RATES

TSL	CO_2 value of $5/metric ton CO_2* and low values for NO_X and Hg** *billion 2008$*		CO_2 value of $56/metric ton CO_2* and high values for NO_X and Hg*** *billion 2008$*	
	7-percent discount rate	3-percent discount rate	7-percent discount rate	3-percent discount rate
1	3.90	10.7	6.08	15.6
2	4.54	13.5	7.90	21.1
3	4.89	15.2	8.49	23.4
4	5.17	16.5	8.95	25.1
5	7.14	23.1	12.2	35.1
6	9.20	43.4	16.9	62.2
7	4.95	53.3	27.0	106

* These values per ton represent the global negative externalities of CO_2.
** Low Value corresponds to a value of $442 per ton of NO_X emissions and $0.745 million per ton of Hg emissions.
*** High Value corresponds to a value of $4,540 per ton of NO_X emissions and $33.3 million per ton of Hg emissions.

TABLE V.56—ESTIMATES OF ADDING NPV OF CONSUMER SAVINGS TO NPV OF LOW- AND HIGH-END GLOBAL MONETIZED BENEFITS FROM CO_2, NO_X, AND HG EMISSIONS REDUCTIONS AT ALL TSLS FOR DHE AT 3- AND 7-PERCENT DISCOUNT RATES

TSL	CO_2 value of $5/metric ton CO_2* and low values for NO_X and Hg** *billion 2008$*		CO_2 value of $56/metric ton CO_2* and high values for NO_X and Hg*** *billion 2008$*	
	7-percent discount rate	3-percent discount rate	7-percent discount rate	3-percent discount rate
1	0.722	1.72	0.890	2.07
2	0.804	1.91	0.991	2.31
3	0.938	2.27	1.16	2.75
4	(0.840)	(0.233)	(0.394)	0.707
5	(0.855)	(0.156)	(0.392)	0.884
6	(3.42)	(2.38)	(2.27)	0.038

* These values per ton represent the global negative externalities of CO_2.
** Low Value corresponds to a value of $442 per ton of NO_X emissions and $0.745 million per ton of Hg emissions.
*** High Value corresponds to a value of $4,540 per ton of NO_X emissions and $33.3 million per ton of Hg emissions.

TABLE V.57—ESTIMATES OF ADDING NPV OF CONSUMER SAVINGS TO NPV OF LOW- AND HIGH-END MONETIZED BENEFITS FROM CO_2, NO_X, AND HG EMISSIONS REDUCTIONS AT ALL TSLS FOR POOL HEATERS AT 3- AND 7-PERCENT DISCOUNT RATES

TSL	CO_2 value of $5/metric ton CO_2* and low values for NO_X and Hg** *billion 2008$*		CO_2 value of $56/metric ton CO_2* and high values for NO_X and Hg*** *billion 2008$*	
	7-percent discount rate	3-percent discount rate	7-percent discount rate	3-percent discount rate
1	0.077	0.019	0.094	0.053
2	0.078	0.033	0.107	0.092
3	0.147	0.100	0.239	0.287
4	0.044	0.121	0.161	0.358
5	(1.25)	0.166	(1.09)	0.489
6	(2.90)	0.353	(2.57)	1.03

* These values per ton represent the global negative externalities of CO_2.
** Low Value corresponds to a value of $442 per ton of NO_X emissions and $0.745 million per ton of Hg emissions.
*** High Value corresponds to a value of $4,540 per ton of NO_X emissions and $33.3 million per ton of Hg emissions.

TABLE V.58—ESTIMATES OF ADDING NPV OF CONSUMER SAVINGS TO NPV OF LOW- AND HIGH-END MONETIZED BENEFITS FROM CO_2 EMISSIONS REDUCTIONS AT ALL TSLS FOR WATER HEATERS, DHE AND POOL HEATERS AT 3- AND 7-PERCENT DISCOUNT RATE

TSL	CO_2 value of $5/metric ton CO_2* and low values for NO_X and Hg** *billion 2008$*		CO_2 value of $56/metric ton CO_2* and high values for NO_X and Hg*** *billion 2008$*	
	7-percent discount rate	3-percent discount rate	7-percent discount rate	3-percent discount rate
1	4.69	12.4	2,517	5,710
2	5.41	15.4	3,808	8,647
3	5.96	17.5	4,174	9,455
4	4.36	16.4	4,622	10,428
5	4.99	23.1	6,102	14,252
6	2.85	41.3	9,807	23,392
7	1.45	51.1	25,042	59,779

* These values per ton represent the global negative externalities of CO_2.
** Low Value corresponds to a value of $442 per ton of NO_X emissions and $0.745 million per ton of Hg emissions.
*** High Value corresponds to a value of $4,540 per ton of NO_X emissions and $33.3 million per ton of Hg emissions.

7. Other Factors

In determining whether a standard is economically justified, the Secretary of Energy may consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6295(o)(2)(B)(i)(VII)) The Secretary has decided that the LCC impacts on identifiable groups of consumers, such as senior citizens and residents of multi-family housing who may be disproportionately affected by any national energy conservation standard level, is a relevant factor. The impacts on the identified consumer subgroups are described in section V.B.1 above.

DOE also believes that uncertainties associated with the heat pump water heater market (*e.g.,* product availability) are relevant to consider. These uncertainties are discussed in section V.C below.

C. Proposed Standards

When considering proposed standards, DOE recognizes that EPCA specifies that any new or amended energy conservation standard for any type (or class) of covered product shall be designed to achieve the maximum improvement in energy efficiency that the Secretary determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) In determining whether a standard is economically justified, the Secretary must determine whether the benefits of the standard exceed its burdens to the greatest extent practicable, in light of 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))

DOE considered the impacts of standards at each trial standard level, beginning with the maximum technologically feasible level, to determine whether each level was economically justified. If the max-tech level is not justified, DOE then considers the next most efficient level and undertakes the same evaluation until it reached the highest level that is both technologically feasible and economically justified, and saves a significant amount of energy.

To aid the reader as DOE discusses the benefits and/or burdens of each trial standard level, the tables in the following sections present summaries of the results of DOE's quantitative analysis at each TSL for each of the three heating products based on the methodology discussed above. Additional quantitative results (*e.g.,* the cumulative NPV to natural gas consumers of the economy-wide savings in natural gas expenditures during the forecast period due to the projected decline in natural gas prices resulting from amended standards on the three types of heating products) are provided in section V.B.3.

In addition to the quantitative results, DOE also considers other burdens and benefits that affect economic justification. These include the LCC impacts on identifiable subgroups of consumers, such as seniors and residents of multi-family housing, who may be disproportionately affected by any national energy conservation standard level, and the uncertainties associated with the heat pump water heater market.

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. 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). There is evidence that consumers undervalue future energy savings as a result of (1) A lack of information, (2) a lack of sufficient savings to warrant delaying or altering purchases (*e.g.* an inefficient ventilation fan in a new building or the delayed replacement of a water pump), (3) inconsistent (*e.g.* excessive short-term) weighting of future energy cost savings relative to available returns on other investments, (4) computational or other difficulties associated with the evaluation of relevant tradeoffs, and (5) a divergence in incentives (*e.g.* renter versus owner; builder v. purchaser). Other literature indicates that with less than perfect foresight and a high degree of uncertainty about the future, consumers may tradeoff these types of investments at a higher than expected rate between current consumption and uncertain future energy cost savings. While DOE is not prepared at present to provide a fuller quantifiable framework for this discussion, DOE seeks comments on how to assess these possibilities.

1. Water Heaters

Table V.59 presents a summary of the impacts for each water heater TSL.

TABLE V.59—SUMMARY OF RESULTS FOR WATER HEATERS

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7
National Energy Savings (quads).	1.26	1.88	2.28	2.60	3.74	10.44	16.85
3% discount rate	0.67	0.99	1.21	1.38	1.99	5.57	8.98
7% discount rate	0.32	0.47	0.58	0.66	0.96	2.71	0.32
NPV of Consumer Benefits (2008$ billion).							
3% discount rate	10.20	12.71	14.36	15.64	21.89	41.52	47.99
7% discount rate	3.69	4.20	4.53	4.79	6.64	8.43	2.75
Industry Impacts							
Gas-Fired and Electric Storage.							
Industry NPV (2008$ million).	(4)–(12)	(5)–(31)	(5)–(35)	(3)–(79)	(21)–(130)	(2)–(306)	63–(538)
Industry NPV (% change).	(0.5)–(1.5)	(0.6)–(3.6)	(0.6)–(4.2)	(0.4)–(9.4)	(2.5)–(15.4)	(0.2)–(36.3)	7.5-(63.8)
Oil-Fired Storage.							
Industry NPV (2008$ million).	(0.2)–(0.3)	(0.2)–(0.3)	(0.2)–(0.4)	(0.2)–(0.4)	(0.2)–(0.4)	(0.2)–(0.4)	(1.3)–(3.5)
Industry NPV (% change).	(1.9)–(3.9)	(1.8)–(3.6)	(2.0)–(4.3)	(2.0)–(4.3)	(2.0)–(4.3)	(2.0)–(4.3)	(14.8)–(39.9)
Gas-Fired Instantaneous.							
Industry NPV (2008$ million).	1.2–(1.8)	1.2–(1.8)	1.2–(1.8)	1.2–(1.8)	1.2–(1.8)	1.2–(1.8)	80.3–(65.9)
Industry NPV (% change).	0.2–(0.3)	0.2–(0.3)	0.2–(0.3)	0.2–(0.3)	0.2–(0.3)	0.2–(0.3)	13.3–(10.9)
Cumulative Emissions Reduction.							

TABLE V.59—SUMMARY OF RESULTS FOR WATER HEATERS—Continued

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7
CO_2 (Mt)	88.7	137	147	154	217	346	965
NO_X (kt)	68.5	106	113	118	165	254	730
Hg (t)	0.11	0.16	0.19	0.20	0.60	2.18	4.43
Value of Cumulative Emissions Reduction (2008$ million)‡.							
CO_2—3% discount rate	480–5,285	741–8,151	794–8,732	833–9,166	1,162–12,787	1,824–20,066	5,132–56,447
CO_2—7% discount rate	211–2,317	325–3,575	348–3,832	366–4,024	492–5,409	749–8,235	2,134–23,476
NO_X—3% discount rate	16–163	24–252	26–269	27–282	37–377	54.1–556	159–1,632
NO_X—7% discount rate	7–76	11–118	12–126	13–132	16–168	23.0–236	69–710
Hg—3% discount rate	0.05–2.2	0.07–3.3	0.08–3.7	0.09–4.1	0.28–12.53	0.93–41.7	1.90–84.8
Hg—7% discount rate	0.03–1.2	0.04–1.8	0.05–2.1	0.05–2.2	0.16–6.94	0.49–21.7	0.99–44.1
Mean LCC Savings* (2008$).							
Gas-Fired Storage	69	68	68	68	78	68	(55)
Electric Storage	16	23	32	39	96	224	273
Oil-Fired Storage	171	288	395	395	395	395	655
Gas-Fired Instantaneous	0	0	0	0	0	0	(307)
Median PBP (years).							
Gas-Fired Storage	1.4	2.7	2.7	2.7	3.0	2.7	14.1
Electric Storage	2.8	3.0	4.5	5.8	5.9	8.3	8.2
Oil-Fired Storage	0.7	0.4	0.5	0.5	0.5	0.5	1.4
Gas-Fired Instantaneous.	23.5	23.5	23.5	23.5	23.5	23.5	39.5
Distribution of Consumer LCC Impacts							
Gas-Fired Storage.							
Net Cost (%)	9	15	15	15	16	15	62
No Impact (%)	22	17	17	17	16	17	1
Net Benefit (%)	69	68	68	68	68	68	36
Electric Storage.							
Net Cost (%)	10	11	20	25	25	45	45
No Impact (%)	32	29	14	10	10	5	1
Net Benefit (%)	59	60	66	65	65	50	54
Oil-Fired Storage.							
Net Cost (%)	0	0	0	0	0	0	0
No Impact (%)	69	52	45	45	45	45	7
Net Benefit (%)	31	48	55	55	55	55	93
Gas-Fired Instantaneous.							
Net Cost (%)	11	11	11	11	11	11	83
No Impact (%)	85	85	85	85	85	85	6
Net Benefit (%)	4	4	4	4	4	4	12
Generation Capacity Change (GW)†.	(0.129)	(0.195)	(0.221)	(0.242)	(0.956)	(2.59)	(5.28)
Employment Impacts							
Total Potential Changes in Domestic Production Workers in 2015.							
Gas-Fired and Electric Storage.	(3,690)–68	(3,690)–152	(3,690)–191	(3,690)–287	(3,690)–706	(3,690)–4,078	(3,690)–6,133
Oil-Fired Storage	(38)–(1)	(38)–2	(38)–(1)	(38)–(1)	(38)–(1)	(38)–(1)	(38)–9
Gas-Fired Instantaneous.	Not Applicable*.						
Indirect domestic jobs (thousands) †.	3.32	4.38	6.70	8.49	17.82	55.67	68.11

Note: Parentheses indicate negative (-) values.
* For LCCs, a negative value means an increase in LCC by the amount indicated.
** The industry for gas-fired instantaneous water heaters is international.
† Changes in 2044
‡ Range of the economic value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions.

DOE first considered TSL 7, which represents the max-tech efficiency levels for all four product classes. TSL 7 would save 16.85 quads of energy, an amount DOE considers significant. TSL 7 would provide a NPV of consumer benefit of $2.75 billion, using a discount rate of 7 percent, and $48.0 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 7 are 965 Mt of CO_2, 730 kt of NO_X, and 4.43 t of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 7 is $2.13 billion to $23.48 billion, using a discount rate of 7 percent, and $5.13 to $56.45 billion, using a discount rate of 3 percent. Total electricity generating capacity in 2044 is estimated to decrease by 5.28 gigawatts (GW) under TSL 7.

At TSL 7, DOE projects that the average LCC impact for consumers is a loss of $55 for gas-fired storage water heaters, a gain of $273 for electric storage water heaters, a gain of $655 for oil-fired storage water heaters, and a loss of $307 for gas-fired instantaneous water heaters. The median payback period is 14.1 years for gas-fired storage water heaters, 8.2 years for electric storage water heaters, 1.4 years for oil-fired storage water heaters, and 39.5 years for gas-fired instantaneous water heaters (which is substantially longer than the mean lifetime of the product). At TSL 7, the fraction of consumers experiencing an LCC benefit is 36 percent for gas-fired storage water heaters, 54 percent for electric storage water heaters, 93 percent for oil-fired storage water heaters, and 12 percent for gas-fired instantaneous water heaters. The fraction of consumers experiencing an LCC cost is 62 percent for gas-fired storage water heaters, 45 percent for electric storage water heaters, 0 percent for oil-fired storage water heaters, and 83 percent for gas-fired instantaneous water heaters.

At TSL 7, the projected change in the INPV is estimated to decrease up to $538 million for gas-fired and electric storage water heaters, a decrease of up to $3.5 million for residential oil-fired storage water heaters, and a decrease of up to $66 million for gas-fired instantaneous water waters, in 2008$. For gas and electric storage water heaters, the impacts are driven primarily by the assumptions regarding the ability for manufacturers to produce products at these efficiency levels in the volumes necessary to serve the entire market. Manufacturers would need to redesign almost all of their products at TSL 7, which would force manufacturers to incur significant product and capital conversion costs. Some loss in product utility may also occur for units that are presently installed in space-constrained applications because condensing and heat pump technologies would typically cause water heaters to have a larger footprint. At TSL 7, DOE recognizes the risk of very large negative impacts if manufacturers' expectations about reduced profit margins are realized. In particular, if the high end of the range of impacts is reached as DOE expects, TSL 7 could result in a net loss of 63.8 percent in INPV for gas-fired and electric storage water heaters, a net loss of 39.9 percent in INPV for oil-fired storage water heaters, and a net loss of 10.9 percent in INPV for gas-fired instantaneous water heaters.

At TSL 7, the average LCC savings are lower for all of the considered consumer subgroups than for the full household sample for electric and gas-fired storage water heaters. In the case of electric storage water heaters, the multi-family subgroup would experience an average negative LCC savings of $357 (*i.e.,* the average LCC would increase), and three-fourths of the households would experience a net cost. For the other subgroups, the fraction of households that would experience a net cost is close to or just above 50 percent, which is slightly higher than for the full household sample. The impact on the multi-family subgroup is primarily due to the lower hot water use per family among these households.

For gas-fired storage water heaters at TSL 7, condensing operation would be required. DOE has several concerns related to the condensing gas-fired storage water heater market. At the time of the NOPR analysis, there were no condensing gas-fired storage water heaters available to residential consumers in the United States. DOE is concerned about the ability of manufacturers to convert all product lines to manufacture condensing gas-fired storage water heaters in the volumes needed by the compliance date of the standard, because the manufacturers' ability to afford the necessary conversion costs is uncertain. In addition, uncertainties exist about whether manufacturers will be able to train enough installers and servicers of condensing gas-fired water heaters to serve the relevant market by the compliance date of the standard. As with electric storage heat pump water heaters, DOE is concerned that a typical installer or repair person will not have the knowledge required to troubleshoot or repair condensing gas-fired storage water heaters since they are more complex than traditional gas-fired storage water heaters. It is unclear whether reliable installation and servicing could be achieved by the effective date for compliance with the standard.

TSL 7 also includes an efficiency level for electric storage water heaters that will require the use of heat pump technology. The substantial average savings for customers estimated by DOE's analysis for TSL 7 are primarily driven by the results for heat pump water heaters. However, DOE has concerns about issues with the current heat pump water heater market that may prevent heat pump technology from being ready for full scale implementation. DOE fully discusses these concerns and seeks comments from interested parties on a variety of issues associated with heat pump water heaters in its discussion of the benefits and burdens of TSL 6, below.

The Secretary tentatively concludes that at TSL 7, the benefits of energy savings, positive NPV of consumer benefits, generating capacity reductions, and emission reductions would be outweighed by the economic burden on a significant fraction of consumers due to the large increases in first costs associated with electric heat pump water heaters and gas-fired condensing water heaters, the disproportionate impacts to consumers in multi-family housing, the large capital conversion costs that could result in a large reduction in INPV for the manufacturers, as well as the uncertainty associated with providing products at the max-tech level on a scale necessary to serve the entire market. Consequently, the Secretary has tentatively concluded that TSL 7 is not economically justified.

Next, DOE considered TSL 6. The efficiency levels in TSL 6 include the ENERGY STAR program level for electric storage water heaters, which requires heat pump water heaters. TSL 6 would save 10.4 quads of energy, an amount DOE considers significant. TSL 6 would increase consumer NPV by $8.4 billion, using a discount rate of 7 percent, and increase the NPV by $41.5 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 6 are 346 Mt of CO_2, 254 kt of NO_X, and 2.18 t of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 6 is $749 billion to $8.235 billion, using a discount rate of 7 percent, and $1.824 billion to $20.066 billion, using a discount rate of 3 percent. Total generating capacity in 2044 is estimated to decrease by 2.59 GW under TSL 6.

At TSL 6, DOE projects that the average LCC impact is a gain of $68 for gas-fired storage water heaters, a gain of $224 for electric storage water heaters, a gain of $395 for oil-fired storage water heaters, and no change for gas-fired instantaneous water heaters. The median payback period is 2.7 years for gas-fired storage water heaters, 8.3 years for electric storage water heaters, 0.5 years for oil-fired storage water heaters, and 23.5 years for gas-fired instantaneous water heaters (which is longer than the mean lifetime of the product). At TSL 6, the fraction of consumers experiencing an LCC benefit is 68 percent for gas-fired storage water heaters, 50 percent for electric storage water heaters, 55 percent for oil-fired storage water heaters, and 4 percent for gas-fired instantaneous water heaters. The fraction of consumers experiencing an LCC cost is 15 percent for gas-fired storage water heaters, 45 percent for electric storage water heaters, 0 percent for oil-fired storage water heaters, and 11 percent for gas-fired instantaneous water heaters.

At TSL 6, the projected change in INPV ranges from a decrease of up to $305.8 million for gas-fired and electric storage water heaters, a decrease of up to $0.4 million for oil-fired storage water heaters, and a decrease of up to $1.8 million for gas-fired instantaneous water heaters, in 2008$. The negative impacts on INPV are driven largely by the required efficiencies for electric storage water heaters which effectively require heat pump technology. The oil-fired storage water heater and gas-fired instantaneous water heater efficiencies do not require substantial changes to the existing operations for some manufacturers. The significant changes for electric storage water heaters help to drive the INPVs negative, especially if profitability is impacted after the compliance date of the amended energy conservation standard. In particular, if the high end of the range of impacts is reached as DOE expects, TSL 6 could result in a net loss of 36.3 percent in INPV for gas-fired and electric storage water heaters, a net loss of 4.3 percent in INPV for oil-fired storage water heaters, and a net loss of 0.3 percent in INPV for gas-fired instantaneous water heaters.

TSL 6 includes efficiency levels for electric storage water heaters that are currently only achievable through the use of advanced heat pump technologies. DOE's analysis indicates that dramatic reductions in energy use and substantial economic savings are possible for electric water heaters with the use of these technologies. The average savings for electric water heater customers estimated by DOE's analysis for TSL 6 are primarily driven by the results for heat pump water heaters. While DOE finds the potential energy savings resulting from a national heat pump water heater standard very favorable, DOE has some concerns regarding the manufacturability and the market for heat pump water heaters, which are further discussed below.

Heat pump technologies are currently used in space heating and cooling, and other refrigeration-cycle products, indicating that this technology is a viable design option. The use of heat pump water heaters adds dramatically to the MSP estimates, increasing the MSP more than $400 over the baseline electric storage water heater. In part due to this change, the total installed cost to the consumer increases by an average of $900 for heat pump water heaters compared to traditional electric storage water heaters that use electric resistance heating elements. Even though there are potential benefits of adopting an amended energy conservation standard requiring heat pump technologies, DOE is concerned about the uncertainties currently experienced in the heat pump water heater market.

Although most manufacturers are in the process of developing a heat pump water heater to offer to consumers in response to the ENERGY STAR program or have recently began to offer a heat pump water heater model for sale, heat pump water heaters were not offered for sale at the time DOE's analysis was developed. DOE's shipments model projects that by 2015 heat pump water heaters will achieve approximately five percent market share. The manufacturer impacts are driven primarily by the assumptions regarding the ability of manufacturers to produce heat pump water heaters in the full range of rated storage volumes in the quantities necessary to serve the entire market. Though most electric storage water heater manufacturers indicated that they are in the process of developing heat pump water heaters, all manufacturers believe that an efficiency level that requires heat pump water heater technology is not appropriate as an amended energy conservation standard. Several manufacturers expect that they will have to buy the heat pump modules from outside vendors because most water heater manufacturers have no experience manufacturing heat pumps and have limited space in their facilities to produce heat pump systems. Manufacturers stated that they would consider moving all or part of their existing production capacity abroad if the energy conservation standard is set at TSL 6 because many manufacturers expect to have to redesign their facilities completely to accommodate a minimum energy conservation standard requiring heat pump water heaters. DOE is concerned about the capability of manufacturers to convert all product lines to manufacture heat pump water heaters in the volumes needed by the compliance date of the standard, because producing exclusively heat pump water heaters will require $119 million in conversion costs plus an additional $256 million in working capital for a $375 million cash requirement. In addition, water heater manufacturers would be dependent upon the ability of heat pump component manufacturers (*e.g.,* compressor manufacturers) to ramp up production to support the new market by the compliance date of the amended standard. DOE invites comments on the viability for high-volume production of heat pump water heaters in the full range of rated storage volumes and also requests information or data that would allow an assessment of such viability to be conducted. (See Issue 11 under ''Issues on Which DOE Seeks Comment'' in section VII.E of this NOPR.)

DOE also notes that the service industry has very little experience with integrated heat pump water heater designs because heat pump water heaters have only been available in the U.S. market in the past for short periods of time, and have only recently become available to the U.S. market once again. DOE is concerned that a typical installer or repair person would not have the requisite knowledge to troubleshoot or repair heat pump water heaters because they are more complex than traditional electric storage water heaters. It is unclear whether reliable installation and servicing could be achieved on the scale needed by the compliance date of the amended standard.

In addition, although DOE's analysis reveals that heat pump water heaters are capable of being installed in all of the types of installations currently serviced by the residential electric storage water heating market, DOE found that in certain situations (especially indoor locations) installations could be very costly for consumers, requiring them to alter their existing space to accommodate a heat pump water heater. DOE estimates 30 to 40 percent of installations would require such building modifications. In part for this reason, DOE estimated that 12 percent of electric storage water heater consumers would experience an increase of more than $500 in their LCC compared to the base case.

Another concern DOE has regarding heat pump water heaters is the impact on consumer utility in the instances when electric storage water heaters are installed in conditioned indoor spaces. DOE estimates that 39 percent of electric storage water heaters are installed in conditioned spaces. In these cases, the cold air given off by the heat pump module may negatively impact consumer comfort due to uneven heating and cooling.

DOE strongly considered TSL 6 as the proposed standard level for residential water heaters. DOE is concerned, however, about the ability for manufacturers to ramp up production in time to meet the demand by the compliance date of amended standards, the potential large increases in total installed cost to certain consumers, the ability for the service industry to gain the knowledge and experience necessary to provide reliable service to consumers, the potential impacts on multi-family households, and the potential impacts on the space conditioning of the residence. DOE seeks comments and data from interested parties that will allow DOE to further bring clarity to the issues surrounding heat pump water heaters, and determine how the issues discussed in the paragraphs above could be adequately addressed prior to the compliance date of an amended national energy conservation standard for water heaters that would effectively require the use of such technology. (See Issue 16 under ''Issues on Which DOE Seeks Comment'' in section VII.E of this NOPR.) For today's proposed rule, the Secretary tentatively concludes that at TSL 6, the benefits of energy savings, generating capacity reductions, and emission reductions would be outweighed by the negative economic impacts on those consumers that would have to make structural changes to accommodate the larger footprint of the heat pump water heaters, the economic burden on a large fraction of consumers due to the large increases in first costs associated with heat pump water heaters, the disproportionate impacts to consumers in multi-family housing and others with comparatively low usage rates, the large capital conversion costs that could result in a large reduction in INPV for the manufacturers, and the uncertainties associated with the heat pump water heater market. DOE is particularly concerned about product availability for the heat pump water heater market since it is unclear whether manufacturers would be able to produce equipment in the volumes necessary to serve the entire market. DOE will revisit this decision and strongly reconsider adoption of TSL 6 in the final rule in light of any comments and data submitted by interested parties.

Next, DOE considered TSL 5, in which DOE paired efficiency levels that would effectively require different technologies for large-volume and small-volume gas-fired and electric storage water heaters in an effort to promote advance technology penetration into the market and potentially save additional energy. Specifically, TSL 5 would effectively require heat pump technology for electric storage water heaters greater than 55 gallons and condensing technology for gas-fired storage water heaters greater than 55 gallons.

TSL 5 would save 3.7 quads of energy, an amount DOE considers significant. Under TSL 5, the NPV of consumer benefit would be $6.64 billion, using a discount rate of 7 percent, and $21.89 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 5 are 217 Mt of CO_2, 165 kt of NO_X, and 0.60 t of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 5 is $0.492 to $5.409 billion, using a discount rate of 7 percent, and $1.162 to $12.787 billion, using a discount rate of 3 percent. Total generating capacity in 2044 is estimated to decrease by 0.96 GW under TSL 5.

At TSL 5, DOE projects that the average LCC impact is a gain (consumer cost savings) of $78 for gas-fired storage water heaters, a gain of $96 for electric storage water heaters, a gain of $395 for oil-fired storage water heaters, and no change for gas-fired instantaneous water heaters. The median payback period is 3.0 years for gas-fired storage water heaters, 5.9 years for electric storage water heaters, 0.5 years for oil-fired storage water heaters, and 23.5 years for gas-fired instantaneous water heaters (which is longer than the mean lifetime of the product). At TSL 5, the fraction of consumers experiencing an LCC benefit is 68 percent for gas-fired storage water heaters, 65 percent for electric storage water heaters, 55 percent for oil-fired storage water heaters, and 4 percent for gas-fired instantaneous water heaters. The fraction of consumers experiencing an LCC cost is 16 percent for gas-fired storage water heaters, 25 percent for electric storage water heaters, 0 percent for oil-fired storage water heaters, and 11 percent for gas-fired instantaneous water heaters.

At TSL 5, the projected change in INPV ranges from a decrease of up to $129.9 million for gas-fired and electric storage water heaters, a decrease of up to $0.4 million for oil-fired storage water heaters, and a decrease of up to $1.8 million for gas-fired instantaneous water heaters, in 2008$. The negative impacts on INPV are driven largely by the required efficiencies for gas-fired and electric storage water heaters with rated storage volumes above 55 gallons. TSL 5 would effectively require heat pump technology and condensing technology for the electric and gas-fired storage water heaters at these volume sizes. The efficiency requirements at TSL 5 for electric storage water heater with a rated volume less than 55 also result in negative impacts because such large increases in insulation also require manufacturers to implement changes to their existing equipment. The oil-fired storage water heater and gas-fired instantaneous water heater efficiencies at TSL 5 do not require substantial changes to the existing operations for some manufacturers. The significant changes gas-fired and electric storage water heaters with rated storage volumes greater than 55 gallons help to drive the INPVs negative, especially if profitability is impacted after the compliance date of the amended energy conservation standard. In particular, if the high end of the range of impacts is reached as DOE expects, TSL 5 could result in a net loss of 15.4 percent in INPV for gas-fired and electric storage water heaters, a net loss of 4.3 percent in INPV for oil-fired storage water heaters, and a net loss of 0.3 percent in INPV for gas-fired instantaneous water heaters.

DOE believes TSL 5 would provide an effective mechanism for increasing the market penetration for advanced-technology water heaters. Given DOE's concerns with TSL 6 (which includes a national heat pump water heater standard for electric storage water heaters across the entire range of rated storage volumes) as described above, DOE also strongly considered proposing TSL 5. TSL 5 results in positive NPV of consumer benefit for both electric and gas-fired storage water heaters, while also providing additional energy and carbon savings.

Using DOE's shipments model and market assessment, DOE estimated approximately 4 percent of gas-fired storage water heater shipments and 11 percent of models would fall into the large-volume water heater category using the TSL 5 division (*i.e.,* large water heaters with storage volumes above 55 gallons). Similarly, DOE estimated approximately 9 percent of electric storage water heater shipments and 27 percent of models would fall into the large-volume water heater category using the TSL 5 division. Compared to TSL 6, TSL 5 effectively requires heat pump technology for a relatively small fraction of the electric storage water heater market, reduces the number of installations that would necessitate significant building modifications due to the size of heat pump water heaters, reduces the number of installations that have space conditioning impacts from cool air produced by the heat pump water heater operation, results in higher average savings and lower median payback periods, and reduces the negative impacts on consumer subgroups. For gas-fired storage water heaters, compared to a national condensing standard level (TSL 7), TSL 5 requires condensing technology for a relatively small fraction of the gas storage water heater market, reduces the number of installations that require significant building modifications due to the size of condensing gas water heaters, and results in higher average LCC savings and lower median payback period.

Even though DOE has identified a number of benefits associated with TSL 5, DOE is aware that there are multiple issues associated with promulgating an amended energy conservation standard that affects only a subset of the products on the market. Potential issues with TSL 5 affecting both heat pump water heaters and condensing gas-fired water heaters include: (1) Consumer acceptance; (2) training; (3) product substitution; (4) engineering resource constraints; (5) product discontinuation; and (6) manufacturing issues.

First, consumers may elect not to buy the larger volume water heaters for a number of reasons, including increased first cost, being unfamiliar with the advanced technologies being used, and installation size constraints. Both heat pump and condensing water heaters are significantly more expensive than baseline water heaters of the same nominal capacity and take up more space per nominal gallon of capacity. As a result, consumers may buy multiple water heaters that are under the capacity limit and use them in parallel to achieve the same nominal capacity, although at a higher standby loss.

Furthermore, the current water heater service and installation infrastructure has little to no experience installing and servicing these advanced-technology storage water heaters, leading to possible reluctance of contractors to install these products. To minimize unit damage and warranty claims and to improve market acceptance, manufacturers would likely have to expend significant additional resources to hire training staff to tour the country and to provide technical support at headquarters. Additionally, field technicians likely would need additional licenses and test equipment to be able to service heat pump water heaters properly (for example, to recover refrigerant). These additional requirements would likely increase installation and service costs beyond current levels, since consumers will have fewer servicers/installers to choose from and the products have become more complex.

Due to the price discrepancy between the cost of commercial equipment (not covered by the heat pump and condensing requirement) and residential products of the same capacity, the use of commercially-classified storage water heater equipment in residential applications would likely significantly expand beyond current levels under TSL 5. Such substitutions have health and safety considerations such as the typical lack of FVIR protection and the higher allowable set-point temperatures for commercial equipment.

Manufacturers would likely face constraints regarding the abilities of their engineering teams to develop multiple water heater families, as most engineering departments have limited experience with either advanced technology. At a minimum, condensing gas-fired products would require manufacturers to convert existing commercial equipment lines to residential use. However, multiple manufacturers are expected to have to develop completely new platforms in order to remain cost-competitive.

In light of the above, manufacturers could decide that the demand for residential heat pump and condensing gas water heaters would likely drop to a point where product conversion and capital costs required to modify their operations are not justified. As a result, some manufacturers would likely no longer manufacture residential storage water heaters at rated storage volumes above the division point (*i.e.,* 56 gallons and above). Even if a manufacturer were to offer products, development and capital costs make it likely that consumers would have fewer product families to choose from than presently exist. Mass-manufacturing facilities visited by DOE were typically fine-tuned for units with similar assembly processes and cannot accommodate units with a wide scope of assembly requirements. Units that fall outside these standardized (high-volume) production settings would likely have to be assembled on a separate line in a new facility adjacent to current manufacturing space. The costs to retrofit a manufacturing plant to allow production of these units are high and the industry reaction is uncertain. DOE seeks comments about whether manufacturers would upgrade just one of their facilities (and produce all heat pump and/or condensing units there) or would upgrade multiple facilities to minimize shipping costs and distribution costs. Additionally, manufacturers could continue the trend to relocate to new facilities or expand existing facilities abroad.

DOE strongly considered TSL 5 and believes it would provide additional energy and carbon savings, while mitigating some of the issues associated with a national heat pump water heater standard. However, DOE has identified a number of potential issues with TSL 5 related to proposing standards that effectively require different technologies for different subsets of products. For today's proposed rule, the Secretary tentatively concludes that at TSL 5, the benefits of energy savings, generating capacity reductions, economic savings for most consumers, and the emission reductions would be outweighed by the large capital conversion costs that could result in a large reduction in INPV for the manufacturers, the uncertainties associated with the rapid introduction of new product technologies, the large increases in first costs, especially for those consumers that would have to make structural changes, and the uncertainties associated with a promulgation of an amended energy conservation standards that only affects a subset of the market. DOE seeks comments and data from interested parties that will assist DOE in bringing further clarity to some of the issues surrounding the product division used in the two slope energy-efficiency equations, promulgation of different standards for a subset of products, the heat pump water heater market, the condensing water heater market, as well as help DOE determine how these issues can be adequately addressed prior to the compliance date of an amended energy conservation standard for residential water heaters. (See Issue 17 under ''Issues on Which DOE Seeks Comment'' in section VII.E of this NOPR.) DOE will revisit this decision and strongly consider adoption of TSL 5 in the final rule in light of any comments and data submitted by interested parties.

Next, DOE considered TSL 4. TSL 4 would save 2.6 quads of energy, an amount DOE considers significant. Under TSL 4, the NPV of consumer benefit would be $4.8 billion, using a discount rate of 7 percent, and $15.6 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 4 are 154 Mt of CO_2, 118 kt of NO_X, and 0.2 t of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 4 is $0.366 to $4.024 billion, using a discount rate of 7 percent, and $0.833 to $9.166 billion, using a discount rate of 3 percent. Total generating capacity in 2044 is estimated to decrease by 0.24 GW under TSL 4.

At TSL 4, DOE projects that the average LCC impact is a gain of $68 for gas-fired storage water heaters, a gain of $39 for electric storage water heaters, a gain of $395 for oil-fired storage water heaters, and no change for gas-fired instantaneous water heaters. The median payback period is 2.7 years for gas-fired storage water heaters, 5.8 years for electric storage water heaters, 0.5 years for oil-fired storage water heaters, and 23.5 years for gas-fired instantaneous water heaters (which is longer than the mean lifetime of the product). At TSL 4, the fraction of consumers experiencing an LCC benefit is 68 percent for gas-fired storage water heaters, 65 percent for electric storage water heaters, 55 percent for oil-fired storage water heaters, and 4 percent for gas-fired instantaneous water heaters. The fraction of consumers experiencing an LCC cost is 15 percent for gas-fired storage water heaters, 25 percent for electric storage water heaters, 0 percent for oil-fired storage water heaters, and 11 percent for gas-fired instantaneous water heaters. For gas-fired instantaneous water heaters, 85 percent of consumers would not be impacted at TSL 4 because DOE projects that they would purchase an appliance of equal or higher efficiency than the TSL 4 level.

At TSL 4, the projected change in INPV ranges from a decrease of up to $79 million for gas-fired and electric storage water heaters, a decrease of up to $0.4 million for oil-fired storage water heaters, and a decrease of up to $1.8 million for gas-fired instantaneous water heaters, in 2008$. The impacts on manufacturers are less significant at TSL4 because the technology used at TSL 4 does not greatly differ from baseline models for gas-fired, electric, and oil-fired storage water heaters. In addition, most manufacturers of gas-fired instantaneous water heaters offer products that meet or exceed the efficiencies required at TSL 4. If the high end of the range of impacts is reached as DOE expects, TSL 4 could result in a net loss of 9.4 percent in INPV for gas-fired and electric storage water heaters, a net loss of 4.3 percent in INPV for oil-fired storage water heaters, and a net loss of 0.3 percent in INPV for gas-fired instantaneous water heaters.

After considering the analysis, comments on the January 13, 2009, notice and the preliminary TSD, and the benefits and burdens of TSL 4, the Secretary tentatively concludes that this TSL will offer the maximum improvement in efficiency that is technologically feasible and economically justified, and will result in significant conservation of energy. Further, benefits from carbon dioxide reductions (at a central value of $20) would increase NPV by between $366 million and $4,024 million (2008$) at a 7% discount rate and between $833 million and $9,166 million at a 3% discount rate. These benefits from carbon dioxide emission reductions, when considered in conjunction with the consumer savings NPV and other factors described above support DOE's tentative conclusion that trial standard level 4 is economically justified. Therefore, the Department today proposes to adopt TSL 4 as amended energy conservation standards for water heaters as shown in Table V.60.

TABLE V.60—PROPOSED MINIMUM ENERGY FACTOR REQUIREMENTS FOR RESIDENTIAL WATER HEATERS (TSL 4)

Product class	Energy factor requirement	
Gas-fired Storage	For tanks with a Rated Storage Volume at or below 60 gallons:. EF = 0.675 − (0.0012 × Rated Storage Volume in gallons).	For tanks with a Rated Storage Volume above 60 gallons: EF = 0.717 −(0.0019 × Rated Storage Volume in gallons)
Electric Storage	For tanks with a Rated Storage Volume at or below 80 gallons:. EF = 0.96 − (.0003 × Rated Storage Volume in gallons).	For tanks with a Rated Storage Volume above 80 gallons: EF = 1.088 − (.0019 × Rated Storage Volume in gallons)
Oil-fired Storage	EF = 0.68 − (.0019 × Rated Storage Volume in gallons)	
Gas-fired Instantaneous	EF = 0.82 − (.0019 × Rated Storage Volume in gallons)	

DOE also calculated the annualized values for certain benefits and costs under the considered TSLs. The annualized values refer to consumer operating cost savings, consumer incremental product and installation costs, the quantity of emissions reductions for CO_2, NO_X, and Hg, and the monetary value of CO_2 emissions reductions (using a value of $20/t CO_2, which is in the middle of the values considered by DOE for valuing the potential global benefits resulting from reduced CO_2 emissions).

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 for the time-series of costs and benefits using a discount rate of either three or seven percent. From the present value, DOE then calculated the fixed annual payment over the analysis time period (2015 to 2045 for water heaters) that yielded 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 are a steady stream of payments.

Table V.61 presents the annualized values for each TSL considered for water heaters. The tables also present the annualized net benefit that results from summing the two monetary benefits and subtracting the consumer incremental product and installation costs. Although summing the value of operating savings with the value of CO_2 reductions provides a valuable perspective, please note the following. The operating cost savings are domestic U.S. consumer monetary savings found in market transactions while the CO_2 value is based on an estimate of imputed marginal SCC, which is meant to reflect the global benefits of CO_2 reductions. In addition, the SCC value considers a longer time frame than the period considered for operating cost savings.

TABLE V.61—ANNUALIZED BENEFITS AND COSTS FOR WATER HEATERS BY TRIAL STANDARD LEVEL

TSL	Category	Unit	Primary estimate (AEO reference case)		Low estimate (AEO low growth case)		High estimate (high growth case)	
			7%	3%	7%	3%	7%	3%
	Benefits							

TABLE V.61—ANNUALIZED BENEFITS AND COSTS FOR WATER HEATERS BY TRIAL STANDARD LEVEL—Continued

TSL	Category	Unit	Primary estimate (AEO reference case)		Low estimate (AEO low growth case)		High estimate (high growth case)	
			7%	3%	7%	3%	7%	3%
1	Monetized Operating Cost Savings.	Million 2008$	709.5	885.3	663.7	824.2	755.3	946.6
	Quantified Emissions Reductions.	CO_2 (Mt)	2.63	2.83	3.04	3.01	0.52	0.77
		NO_X (kt)	2.04	2.19	2.38	2.35	0.47	0.67
		Hg (t)	0.005	0.004	(0.002)	(0.006)	0.005	0.007
	Monetized Avoided CO_2 Value (at $19/t).	Million 2008$	90.4	108.0	105.1	126.5	17.6	30.8
	Costs							
	Monetized Incremental Product and Installation Costs.	Million 2008$	292.9	282.3	277.2	265.3	308.7	299.4
	Net Benefits							
	Monetized Value	Million 2008$	507.0	711.0	491.6	685.4	464.3	677.9
2	Benefits							
	Monetized Operating Cost Savings.	Million 2008$	1,051.1	1,309.8	984.4	1,220.4	1,117.9	1,399.4
	Quantified Emissions Reductions.	CO_2 (Mt)	4.07	4.37	4.68	4.63	0.85	1.24
		NO_X (kt)	3.16	3.38	3.66	3.61	0.77	1.07
		Hg (t)	0.007	0.006	(0.003)	(0.009)	0.008	0.011
	Monetized Avoided CO_2 Value (at $19/t).	Million 2008$	139.6	166.5	161.9	194.6	28.9	49.2
	Costs							
	Monetized Incremental Product and Installation Costs.	Million 2008$	576.2	557.9	545.2	524.1	607.5	591.9
	Net Benefits							
	Monetized Value	Million 2008$	614.5	918.5	601.1	890.8	539.4	856.8
3	Benefits							
	Monetized Operating Cost Savings.	Million 2008$	1,297.3	1,610.6	1,210.0	1,496.1	1,384.7	1,725.0
	Quantified Emissions Reductions.	CO_2 (Mt)	4.36	4.68	5.05	5.00	0.72	1.13
		NO_X (kt)	3.38	3.62	3.95	3.90	0.67	0.99
		Hg (t)	0.008	0.007	(0.003)	(0.010)	0.009	0.012
	Monetized Avoided CO_2 Value (at $19/t).	Million 2008$	149.6	178.4	175.0	210.3	24.1	45.2
	Costs							
	Monetized Incremental Product and Installation Costs.	Million 2008$	785.3	761.4	742.9	715.3	828.0	807.9
	Net Benefits							
	Monetized Value	Million 2008$	661.7	1,027.7	642.0	991.2	580.8	962.4
4	Benefits							
	Monetized Operating Cost Savings.	Million 2008$	1,487.1	1,842.4	1,383.7	1,708.4	1,590.5	1,976.2
	Quantified Emissions Reductions.	CO_2 (Mt)	4.58	4.92	5.34	5.28	0.61	1.04
		NO_X (kt)	3.54	3.79	4.17	4.11	0.58	0.92
		Hg (t)	0.009	0.008	(0.003)	(0.011)	0.010	0.013
	Monetized Avoided CO_2 Value (at $19/t).	Million 2008$	157.1	187.3	184.8	222.1	20.2	41.9

TABLE V.61—ANNUALIZED BENEFITS AND COSTS FOR WATER HEATERS BY TRIAL STANDARD LEVEL—Continued

TSL	Category	Unit	Primary estimate (AEO reference case)		Low estimate (AEO low growth case)		High estimate (high growth case)	
			7%	3%	7%	3%	7%	3%
	Costs							
	Monetized Incremental Product and Installation Costs.	Million 2008$	945.5	917.3	894.4	861.7	997.0	973.4
	Net Benefits							
	Monetized Value	Million 2008$	698.8	1,112.4	674.1	1,068.9	613.7	1,044.7
5	Benefits							
	Monetized Operating Cost Savings.	Million 2008$	2,163.1	2,670.6	2,005.0	2,469.3	2,320.8	2,871.2
	Quantified Emissions Reductions.	CO_2 (Mt)	6.18	6.83	14.38	14.84	3.11	3.56
		NO_X (kt)	4.72	5.20	11.09	11.41	2.43	2.78
		Hg (t)	0.023	0.022	0.038	0.030	0.011	0.017
	Monetized Avoided CO_2 Value (at $19/t).	Million 2008$	211.2	261.2	318.5	383.1	26.2	52.1
	Costs							
	Monetized Incremental Product and Installation Costs.	Million 2008$	1,413.1	1,376.1	1,336.7	1,292.6	1,490.2	1,460.4
	Net Benefits							
	Monetized Value	Million 2008$	961.2	1555.7	668.3	1176.7	830.6	1410.8
6	Benefits							
	Monetized Operating Cost Savings.	Million 2008$	6,331.1	7,745.0	5,801.0	7,097.1	6,857.9	8,387.1
	Quantified Emissions Reductions.	CO_2 (Mt)	9.49	10.72	15.61	16.89	(2.13)	(1.50)
		NO_X (kt)	7.02	7.90	11.90	12.82	(1.58)	(1.08)
		Hg (t)	0.077	0.075	0.038	0.036	0.004	0.012
	Monetized Avoided CO_2 Value (at $19/t).	Million 2008$	321.6	410.0	537.9	646.5	(86.7)	(62.2)
	Costs							
	Monetized Incremental Product and Installation Costs.	Million 2008$	5,405.0	5,315.6	5,112.0	4,992.4	5,700.5	5,641.7
	Net Benefits							
	Monetized Value	Million 2008$	1,247.7	2,839.3	689.0	2,104.7	1,157.4	2,745.4
7	Benefits							
	Monetized Operating Cost Savings.	Million 2008$	9,837.9	12,187.1	9,105.6	11,255.5	10,568.4	13,115.0
	Quantified Emissions Reductions.	CO_2 (Mt)	26.82	30.05	39.27	39.00	3.17	5.19
		NO_X (kt)	20.41	22.79	30.34	29.99	2.91	4.51
		Hg (t)	0.157	0.153	0.078	0.056	0.007	0.024
	Monetized Avoided CO_2 Value (at $19/t).	Million 2008$	916.6	1,153.3	1,357.0	1,634.6	85.6	192.1
	Costs							
	Monetized Incremental Product and Installation Costs.	Million 2008$	9,527.4	9,348.7	9,010.5	8,779.1	10,048.9	9,923.2

TABLE V.61—ANNUALIZED BENEFITS AND COSTS FOR WATER HEATERS BY TRIAL STANDARD LEVEL—Continued

TSL	Category	Unit	Primary estimate (AEO reference case)		Low estimate (AEO low growth case)		High estimate (high growth case)	
			7%	3%	7%	3%	7%	3%
	Net Benefits							
	Monetized Value	Million 2008$	1,227.2	3,991.8	1,452.1	4,110.9	605.1	3,383.9

2. Direct Heating Equipment

Table V.62 presents a summary of the impacts for each TSL considered for DHE.

TABLE V.62—SUMMARY OF RESULTS FOR DIRECT HEATING EQUIPMENT

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
National Energy Savings (quads)	0.15	0.17	0.22	0.39	0.44	1.08
3% discount rate	0.09	0.10	0.12	0.22	0.24	0.61
7% discount rate	0.04	0.05	0.06	0.11	0.12	0.31
NPV of Consumer Benefits (2008$ billion):						
3% discount rate	1.68	1.87	2.22	(0.33)	(0.26)	(2.63)
7% discount rate	0.71	0.79	0.91	(0.89)	(0.93)	(3.54)
Industry Impacts:						
Traditional Direct Heating Equipment:						
Industry NPV (2008$ million)	(0.4)–(1.6)	(0.6)–(3.1)	(1.1)–(6.0)	(1.3)–(7.6)	(1.8)–(8.0)	(2.2)–(10.8)
Industry NPV (% change)	(2.3)–(9.1)	(3.4)–(17.2)	(5.9)–(33.5)	(7.2)–(42.1)	(10.0)–(44.8)	(12.3)–(60.0)
Gas Hearth Direct Heating Equipment:						
Industry NPV (2008$ million)	(0.2)–(0.9)	(0.2)–(0.9)	(0.2)–(0.9)	2.4–(14.8)	2.4–(14.8)	10.2–(55.1)
Industry NPV (% change)	(0.2)–(1.1)	(0.2)–(1.1)	(0.2)–(1.1)	2.8–(17.1)	2.8–(17.1)	11.8–(63.8)
Cumulative Emissions Reduction*:						
CO_2 (Mt)	6.3	7.0	8.5	16.7	18.5	43.0
NO_X (kt)	5.8	6.4	7.7	15.2	16.9	39.6
Value of Cumulative Emissions Reduction (2008$ million)‡:						
CO_2—3% discount rate	34.3–377	38.1–419	46.2–508	90.5–996	100–1,101	233–2,564
CO_2—7% discount rate	16.2–178	18.0–198	21.8–240	42.9–472	47.4–521	111–1,216
NO_X—3% discount rate	1.4–14.5	1.6–16.1	1.9–19.4	3.7–38.3	4.1–42.5	9.7–99.4
NO_X—7% discount rate	0.7–7.3	0.8–8.0	0.9–9.7	1.9–19.2	2.1–21.3	4.9–50.0
Mean LCC Savings** (2008$):						
Gas Wall Fan	73	90	104	135	73	135
Gas Wall Gravity	25	83	192	192	68	68
Gas Floor	13	13	13	13	13	13
Gas Room	42	96	143	143	646	646
Gas Hearth	96	96	96	(70)	(70)	(253)
Median PBP (years):						
Gas Wall Fan	3.1	3.9	6.0	9.8	3.1	9.8
Gas Wall Gravity	8.1	6.5	8.3	8.3	13.0	13.0
Gas Floor	14.7	14.7	14.7	14.7	14.7	14.7
Gas Room	8.1	4.9	5.3	5.3	7.0	7.0
Gas Hearth	0.0	0.0	0.0	25.9	25.9	37.5
Distribution of Consumer LCC Impacts						
Gas Wall Fan:						
Net Cost (%)	3	5	30	44	3	44
No Impact (%)	59	55	14	5	59	5
Net Benefit (%)	38	41	56	52	38	52
Gas Wall Gravity:						
Net Cost (%)	12	19	39	39	59	59
No Impact (%)	70	40	0	0	0	0
Net Benefit (%)	18	41	61	61	41	41
Gas Floor:						
Net Cost (%)	25	25	25	25	25	25
No Impact (%)	57	57	57	57	57	57
Net Benefit (%)	18	18	18	18	18	18
Gas Room:						
Net Cost (%)	19	19	20	20	26	26
No Impact (%)	50	25	25	25	25	25
Net Benefit (%)	31	56	55	55	49	49

TABLE V.62—SUMMARY OF RESULTS FOR DIRECT HEATING EQUIPMENT—Continued

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Gas Hearth:						
Net Cost (%)	9	9	9	69	69	81
No Impact (%)	51	51	51	13	13	0
Net Benefit (%)	40	40	40	17	17	19
Generation Capacity Change (GW)***	+0.023	+0.025	+0.031	+0.045	+0.049	+0.119
Employment Impacts:						
Total Potential Changes in Domestic Production Workers in 2013:						
Traditional Direct Heating Equipment	(300)–5	(300)–30	(300)–44	(300)–50	(300)–48	(300)–61
Gas Hearth Direct Heating Equipment	(1,243)–7	(1,243)–7	(1,243)–7	(1,243)–516	(1,243)–516	(1,243)–846
Indirect domestic jobs (thousands)***	0.16	0.18	0.23	0.08	0.09	0.24

Parentheses indicate negative (−) values.
* Hg emissions increase slightly (0.01 to 0.02 t) for the considered TSLs.
** For LCCs, a negative value means an increase in LCC by the amount indicated.
*** Changes in 2042.
‡ Range of the economic value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions.

DOE first considered TSL 6, the max-tech level. TSL 6 would save 1.08 quads of energy, an amount DOE considers significant. TSL 6 would decrease consumer NPV by $3.54 billion, using a discount rate of 7 percent, and by $2.63 billion, using a discount rate of 3 percent.

The emissions reductions at TSL 6 are 43.0 Mt of CO_2 and 39.6 kt of NO_X. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 6 is $111 to $1,216 million, using a discount rate of 7 percent, and $233 to $2,564 million, using a discount rate of 3 percent. Total generating capacity in 2044 is estimated to increase slightly under TSL 6.

At TSL 6, DOE projects that the average LCC impact for consumers is a gain of $135 for gas wall fan DHE, $68 for gas wall gravity DHE, $13 for gas floor DHE, $646 for gas room DHE and a loss of $253 for gas hearth DHE. The median payback period is 9.8 years for gas wall fan DHE, 13.0 years for gas wall gravity DHE, 14.7 years for gas floor DHE, 7.0 years for gas room DHE and 37.5 for gas hearth DHE (which is significantly longer than the mean lifetime of the product). At TSL 6, the fraction of consumers experiencing an LCC benefit is 52 percent for gas wall fan DHE, 41 percent for gas wall gravity DHE, 18 percent for gas floor DHE, 49 percent for gas room DHE and 19 percent for gas hearth DHE. The fraction of consumers experiencing an LCC cost is 44 percent for gas wall fan DHE, 59 percent for gas wall gravity DHE, 25 percent for gas floor DHE, 26 percent for gas room DHE and 81 percent for gas hearth DHE.

At TSL 6, the projected change in INPV ranges from a decrease of up to $10.8 million for traditional DHE and a decrease of up to $55.1 million for gas hearth DHE, in 2008$. Very few manufacturers offer products at the max-tech level for both traditional and gas hearth DHE. At TSL 6, almost every manufacturer would face substantial product and capital conversion costs to completely redesign most of their current products and existing production facilities. In addition, higher component costs could significantly harm profitability. If the high end of the range of impacts is reached as DOE expects, TSL 6 could result in a net loss of 60.0 percent in INPV for traditional DHE and a net loss of 63.8 percent in INPV for gas hearth DHE. In addition to the large, negative impacts on INPV at TSL 6, the required capital and product conversion costs could cause material harm to a significant number of small businesses in both the traditional and gas hearth DHE market. The conversion costs could cause many of these small businesses to exit the market.

The Secretary tentatively concludes that at TSL 6, the benefits of energy savings, generating capacity reductions, and emission reductions would be outweighed by the negative impacts on consumer NPV, the economic burden on some consumers, the large capital conversion costs that could result in a large reduction in INPV for the manufacturers, and the potential impacts on a significant number of small businesses. Consequently, the Secretary has tentatively concluded that TSL 6 is not economically justified.

Next, DOE considered TSL 5. TSL 5 would save 0.44 quads of energy, an amount DOE considers significant. TSL 5 would decrease consumer NPV by $0.93 billion, using a discount rate of 7 percent, and by $0.26 billion, using a discount rate of 3 percent.

The emissions reductions at TSL 5 are 18.5 Mt of CO_2 and 16.9 kt of NO_X. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 5 is $47.4 to $521 million, using a discount rate of 7 percent, and $100 to $1,101 million, using a discount rate of 3 percent. Total generating capacity in 2044 is estimated to increase slightly under TSL 5.

At TSL 5, DOE projects that the average LCC impact for consumers is a gain of $73 for gas wall fan DHE, $68 for gas wall gravity DHE, $13 for gas floor DHE, $646 for gas room DHE and a loss of $70 for gas hearth DHE. The median payback period is 3.1 years for gas wall fan DHE, 13.0 years for gas wall gravity DHE, 14.7 years for gas floor DHE, 7.0 years for gas room DHE, and 25.9 for gas hearth DHE. At TSL 5, the fraction of consumers experiencing an LCC benefit is 38 percent for gas wall fan DHE, 41 percent for gas wall gravity DHE, 18 percent for gas floor DHE, 49 percent for gas room DHE, and 17 percent for gas hearth DHE. The fraction of consumers experiencing an LCC cost is 3 percent for gas wall fan DHE, 59 percent for gas wall gravity DHE, 25 percent for gas floor DHE, 26 percent for gas room DHE, and 69 percent for gas room DHE.

At TSL 5, the projected change in INPV ranges from a decrease of up to $8 million for traditional DHE and a decrease of up to $15 million for gas hearth DHE, in 2008$. While some manufacturers offer a limited number of products at TSL 5, most of the current products would have to be redesigned to meet the required efficiencies at TSL 5. In addition, higher component costs for both traditional and gas hearth DHE could significantly harm profitability. If the high end of the range of impacts is reached as DOE expects, TSL 5 could result in a net loss of 44.8 percent in INPV for traditional DHE and a net loss of 17.1 percent in INPV for gas hearth DHE. In addition to the large, negative impacts on INPV at TSL 5, the required capital and product conversion costs could cause material harm to a significant number of small businesses in both the traditional and gas hearth DHE market. These manufacturers could be forced to discontinue many of their existing product lines and, possibly, exit the market altogether.

The Secretary tentatively concludes that at trial standard level 5, the benefits of energy savings, generating capacity reductions, and emission reductions would be outweighed by the negative impacts on consumer NPV, the economic burden on some consumers, the large capital conversion costs that could result in a large reduction in INPV for the manufacturers, and the potential for small businesses to have to reduce or discontinue a significant number of their product lines. Consequently, the Secretary has tentatively concluded that trial standard level 5 is not economically justified.

Next, DOE considered TSL 4. TSL 4 would save 0.39 quads of energy, an amount DOE considers significant. TSL 4 would provide a NPV of consumer benefit of $0.89 billion, using a discount rate of 7 percent, and $0.33 billion, using a discount rate of 3 percent.

The emissions reductions at TSL 4 are 16.7 Mt of CO_2 and 15.2 kt of NO_X. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 4 is $42.9 to $472 million, using a discount rate of 7 percent, and $90.5 to $996 million, using a discount rate of 3 percent. Total generating capacity in 2044 is estimated to increase slightly under TSL 4.

At TSL 4, DOE projects that the average LCC impact for consumers is a gain of $73 for gas wall fan DHE, $68 for gas wall gravity DHE, $13 for gas floor DHE, $646 for gas room DHE, and a loss of $70 for gas hearth DHE. The median payback period is 9.8 years for gas wall fan DHE, 8.3 years for gas wall gravity DHE, 14.7 years for gas floor DHE, 5.3 years for gas room DHE and 25.9 years for gas hearth DHE (which is significantly beyond the mean lifetime of the equipment). At TSL 4, the fraction of consumers experiencing an LCC benefit is 52 percent for gas wall fan DHE, 61 percent for gas wall gravity DHE, 18 percent for gas floor DHE, 55 percent for gas room DHE, and 17 percent for gas hearth DHE. The fraction of consumers experiencing an LCC cost is 44 percent for gas wall fan DHE, 39 percent for gas wall gravity DHE, 25 percent for gas floor DHE, 20 percent for gas room DHE and 69 percent for gas hearth DHE.

At TSL 4, the projected change in INPV ranges from a decrease of up to $8 million for traditional DHE and decrease of up to $15 million for gas hearth DHE. While some manufacturers offer a limited number of products at TSL 4, most of the current products would have to be redesigned to meet the required efficiencies at TSL 4. In addition, higher component costs for both traditional and gas hearth DHE could significantly harm profitability. If the high end of the range of impacts is reached as DOE expects, TSL 4 could result in a net loss of 42.1 percent in INPV for traditional DHE and a net loss of 17.1 percent in INPV for gas hearth DHE. In addition to the large, negative impacts on INPV at TSL 4, the required capital and product conversion costs could cause material harm to a significant number of small businesses in both the traditional and gas hearth DHE market. These manufacturers could be forced to reduce their product offerings to remain competitive.

The Secretary tentatively concludes that at trial standard level 4, the benefits of energy savings, generating capacity reductions, and emission reductions would be outweighed by the negative impacts on consumer NPV, the economic burden on some consumers, the large capital conversion costs that could result in a large reduction in INPV for the manufacturers, and the potential for small businesses of DHE to reduce their product offerings. Consequently, the Secretary has tentatively concluded that trial standard level 4 is not economically justified.

Next, DOE considered TSL 3. TSL 3 would save 0.22 quads of energy, an amount DOE considers significant. TSL 3 would provide a NPV of consumer benefit of $0.91 billion, using a discount rate of 7 percent, and $2.22 billion, using a discount rate of 3 percent.

The emissions reductions at TSL 3 are 8.5 Mt of CO_2 and 7.7 kt of NO_X. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 3 is $21.8 to $240 million, using a discount rate of 7 percent, and $46.2 to $508 million, using a discount rate of 3 percent. Total electric generating capacity in 2044 is estimated to increase slightly under TSL 3.

At TSL 3, DOE projects that the average LCC impact for consumers is a gain of $104 for gas wall fan DHE, $192 for gas wall gravity DHE, $13 for gas floor DHE, $143 for gas room DHE, and $96 for gas hearth DHE. The median payback period is 6.0 years for gas wall fan DHE, 8.3 years for gas wall gravity DHE, 14.7 years for gas floor DHE, 5.3 years for gas room DHE, and 0.0 years for gas hearth DHE. At TSL 3, the fraction of consumers experiencing an LCC benefit is 56 percent for gas wall fan DHE, 61 percent for gas wall gravity DHE, 18 percent for gas floor DHE, 55 percent for gas room DHE, and 40 percent for gas hearth DHE. The fraction of consumers experiencing an LCC cost is 30 percent for gas wall fan DHE, 39 percent for gas wall gravity DHE, 25 percent for gas floor DHE, 20 percent for gas room DHE, and 9 percent for gas hearth DHE.

At TSL 3, the projected change in INPV ranges from a decrease of up to $6 million for traditional DHE and decrease of up to $1 million for gas hearth DHE. Most traditional direct heating manufacturers have existing products that meet the efficiencies required at TSL 3 in three out of four product categories. The impacts on gas hearth manufacturers are less significant at TSL 3 because manufacturers offer a wide range of product lines that meet the required efficiencies at TSL 3 and most products that do not meet TSL 3 could be upgraded with inexpensive purchased parts and fairly small conversion costs. If the high end of the range of impacts is reached, TSL 3 could result in a net loss of 33.5 percent in INPV for traditional DHE and a net loss of 1.1 percent in INPV for gas hearth DHE. In addition, the required capital and product conversion costs faced by small businesses decrease, mitigating the potential harm to a significant number of small businesses.

After considering the analysis, comments on the January 13, 2009, notice and the preliminary TSD, and the benefits and burdens of TSL 3, the Secretary tentatively concludes that this trial standard level will offer the maximum improvement in efficiency that is technologically feasible and economically justified, and will result in significant conservation of energy. Further, benefits from carbon dioxide reductions (at a central value of $20) would increase NPV by between $21.8 million and $240 million (2008$) at a 7% discount rate and between $46.2 million and $508 million at a 3% discount rate. These benefits from carbon dioxide emission reductions, when considered in conjunction with the consumer savings NPV and other factors described above support DOE's tentative conclusion that trial standard level 3 is economically justified. Therefore, the Department today proposes to adopt the energy conservation standards for DHE at TSL 3, as shown in Table V.63.

TABLE V.63—PROPOSED MINIMUM AFUE REQUIREMENTS FOR DIRECT HEATING EQUIPMENT (TSL 3)

Direct heating equipment design type	Product class input capacity range Btu/h	Annual fuel utilization efficiency %
Gas wall fan	up to 42,000	76
	over 42,000	77
Gas wall gravity	up to 27,000	70
	over 27,000 and up to 46,000	71
	over 46,000	72
Gas floor	up to 37,000	57
	over 37,000	58
Gas room	up to 20,000	62
	over 20,000 and up to 27,000	67
	over 27,000 and up to 46,000	68
	over 46,000	69
Gas hearth	up to 20,000	61
	over 20,000 and up to 27,000	66
	over 27,000 and up to 46,000	67
	over 46,000	68

DOE also calculated the annualized values for certain benefits and costs under the considered TSLs. The annualized values refer to consumer operating cost savings, consumer incremental product and installation costs, the quantity of emissions reductions for CO_2, NO_X, and Hg, and the monetary value of CO_2 emissions reductions (using a value of $20/t CO_2, which is in the middle of the values considered by DOE for valuing the potential global benefits resulting from reduced CO_2 emissions).

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 for the time-series of costs and benefits using a discount rate of either three or seven percent. From the present value, DOE then calculated the fixed annual payment over the analysis time period (2013 to 2043 for DHE) that yielded 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 are a steady stream of payments. Table V.64 presents the annualized values for each TSL considered for DHE.

TABLE V.64—ANNUALIZED BENEFITS AND COSTS FOR DIRECT HEATING EQUIPMENT BY TRIAL STANDARD LEVEL

TSL	Category	Unit	Primary Estimate (AEO reference case)		Low Estimate (AEO low growth case)		High Estimate (AEO high growth case)	
			7%	3%	7%	3%	7%	3%
	Benefits							
1	Monetized Operating Cost Savings.	Million 2008$	97.7	121.1	93.5	115.5	100.7	125.0
	Quantified Emissions Reductions.	CO_2 (Mt)	0.18	0.20	0.32	0.34	0.10	0.11
		NO_X (kt)	0.16	0.18	0.27	0.28	0.10	0.12
		Hg (t)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
	Monetized Avoided CO_2 Value (at $19/t).	Million 2008$	6.1	7.2	0.5	0.5	15.4	29.0
	Costs							
	Monetized Incremental Product and Installation Costs.	Million 2008$	28.1	27.4	28.1	27.4	28.1	27.4
	Net Benefits							
	Monetized Value	Million 2008$	75.7	100.9	65.8	88.7	88.0	126.5
	Benefits							
2	Monetized Operating Cost Savings.	Million 2008$	108.8	135.0	104.1	128.9	112.2	139.3
	Quantified Emissions Reductions.	CO_2 (Mt)	0.20	0.22	0.35	0.37	0.11	0.12
		NO_X (kt)	0.18	0.20	0.30	0.32	0.11	0.13
		Hg (t)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)

TABLE V.64—ANNUALIZED BENEFITS AND COSTS FOR DIRECT HEATING EQUIPMENT BY TRIAL STANDARD LEVEL—Continued

TSL	Category	Unit	Primary Estimate (AEO reference case)		Low Estimate (AEO low growth case)		High Estimate (AEO high growth case)	
			7%	3%	7%	3%	7%	3%
	Monetized Avoided CO_2 Value (at $19/t).	Million 2008$	6.7	8.1	0.8	0.9	25.3	46.4
	Costs							
	Monetized Incremental Product and Installation Costs.	Million 2008$	31.3	30.5	31.3	30.5	31.3	30.5
	Net Benefits							
	Monetized Value	Million 2008$	84.2	112.6	73.6	99.3	106.1	155.2
	Benefits							
3	Monetized Operating Cost Savings.	Million 2008$	132.2	164.4	126.4	156.9	136.2	169.6
	Quantified Emissions Reductions.	CO_2 (Mt)	0.24	0.27	0.43	0.46	0.13	0.14
		NO_X (kt)	0.22	0.24	0.36	0.38	0.14	0.15
		Hg (t)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)
	Monetized Avoided CO_2 Value (at $19/t).	Million 2008$	8.2	9.8	2.5	2.9	21.0	42.6
	Costs							
	Monetized Incremental Product and Installation Costs.	Million 2008$	41.8	40.6	41.8	40.6	41.8	40.6
	Net Benefits							
	Monetized Value	Million 2008$	98.5	133.5	87.1	119.2	115.4	171.6
	Benefits							
4	Monetized Operating Cost Savings.	Million 2008$	250.4	310.9	239.6	297.0	257.9	320.7
	Quantified Emissions Reductions.	CO_2 (Mt)	0.48	0.52	0.85	0.89	0.32	0.36
		NO_X (kt)	0.43	0.48	0.71	0.75	0.32	0.36
		Hg (t)	0.001	0.000	(0.003)	(0.004)	(0.000)	0.000
	Monetized Avoided CO_2 Value (at $19/t).	Million 2008$	16.1	19.2	3.0	3.5	17.7	39.5
	Costs							
	Monetized Incremental Product and Installation Costs.	Million 2008$	337.8	329.1	337.8	329.1	337.8	329.1
	Net Benefits							
	Monetized Value	Million 2008$	(71.3)	1.0	(95.2)	(28.6)	(62.2)	31.1
	Benefits							
5	Monetized Operating Cost Savings.	Million 2008$	279.4	347.3	267.3	331.8	287.7	358.3
	Quantified Emissions Reductions.	CO_2 (Mt)	0.53	0.58	0.93	0.99	0.35	0.40
		NO_X (kt)	0.48	0.53	0.79	0.83	0.35	0.40
		Hg (t)	0.001	0.000	(0.003)	(0.004)	(0.000)	0.000

TABLE V.64—ANNUALIZED BENEFITS AND COSTS FOR DIRECT HEATING EQUIPMENT BY TRIAL STANDARD LEVEL—Continued

TSL	Category	Unit	Primary Estimate (AEO reference case)		Low Estimate (AEO low growth case)		High Estimate (AEO high growth case)	
			7%	3%	7%	3%	7%	3%
	Monetized Avoided CO_2 Value (at $19/t).	Million 2008$	17.8	21.2	4.1	4.7	65.3	152.0
	Costs							
	Monetized Incremental Product and Installation Costs.	Million 2008$	371.6	361.8	371.6	361.8	371.6	361.8
	Net Benefits							
	Monetized Value	Million 2008$	(74.5)	6.7	(100.1)	(25.3)	(18.6)	148.5
	Benefits							
6	Monetized Operating Cost Savings.	Million 2008$	686.8	850.9	656.6	811.8	707.9	878.5
	Quantified Emissions Reductions.	CO_2 (Mt)	1.24	1.35	2.21	2.33	0.81	0.92
		NO_X (kt)	1.13	1.23	1.87	1.98	0.82	0.93
		Hg (t)	0.001	0.001	(0.007)	(0.011)	(0.000)	0.000
	Monetized Avoided CO_2 Value (at $19/t).	Million 2008$	41.5	49.4	8.6	10.0	74.7	181.1
	Costs							
	Monetized Incremental Product and Installation Costs.	Million 2008$	1,036.2	997.3	1,036.2	997.3	1,036.2	997.3
	Net Benefits							
	Monetized Value	Million 2008$	(307.9)	(97.0)	(371.0)	(175.6)	(253.5)	62.3

3. Pool Heaters

Table V.65 presents a summary of the energy savings and economic impacts for each TSL considered for pool heaters.

TABLE V.65—SUMMARY OF RESULTS FOR POOL HEATERS

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
National Energy Savings (quads)	0.02	0.03	0.08	0.10	0.13	0.28
3% discount rate	0.01	0.02	0.05	0.06	0.08	0.16
7% discount rate	0.00	0.01	0.03	0.03	0.04	0.09
NPV of Consumer Benefits (2008$ billion):						
3% discount rate	0.16	0.18	0.40	0.25	(1.97)	(4.51)
7% discount rate	0.08	0.07	0.14	0.03	(1.27)	(2.94)
Industry Impacts:						
Industry NPV (2008$ million)	0.1–(0.2)	0.4–(1.0)	(0.2)–(5.6)	0.5–(7.5)	3.1–(19.5)	12.9–(44.5)
Industry NPV (% change)	0.1–(0.3)	0.7–(1.7)	(0.4)–(9.1)	0.9–(12.1)	5.0–(31.8)	21.0–(72.6)
Cumulative Emissions Reduction*:						
CO_2 (Mt)	0.61	1.05	3.31	4.21	5.74	12.12
NO_X (kt)	0.55	0.94	2.98	3.74	5.10	10.77
Value of Cumulative Emissions Reduction (2008$ million) ‡:						
CO_2—3% discount rate	3.3 to 36	5.7 to 63	18 to 197	23 to 251	31 to 342	66 to 723
CO_2—7% discount rate	1.6 to 18	2.8 to 31	8.9 to 97	11 to 123	15 to 168	33 to 354
NO_X—3% discount rate	0.1 to 1.4	0.2 to 2.4	0.7 to 7.7	0.9 to 9.7	1.3 to 13.2	2.7 to 27.8
NO_X—7% discount rate	0.1 to 0.7	0.1 to 1.3	0.4 to 4.0	0.5 to 5.0	0.7 to 6.9	1.4 to 14.5
Mean LCC Savings** (2008$)	24	18	39	(13)	(555)	(1,323)
Median PBP (years)	2.5	7.4	10.6	13.0	28.6	28.1
Distribution of Consumer LCC Impacts:						

TABLE V.65—SUMMARY OF RESULTS FOR POOL HEATERS—Continued

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Net Cost (%)	6	31	52	59	90	96
No Impact (%)	64	46	24	22	6	1
Net Benefit (%)	30	22	24	20	5	3
Generation Capacity Change (GW)***	+ 0.002	+ 0.004	+ 0.011	+ 0.012	+ 0.016	+ 0.034
Employment Impacts:						
Total Potential Changes in Domestic Production Workers in 2013	(644)–13	(644)–34	(644)–66	(644)–93	(644)–163	(644)–331
Indirect domestic jobs (thousands)***	3.32	4.38	6.70	8.49	50.59	14.82

Parentheses indicate negative (−) values.
* The impacts for Hg emissions are negligible (less than 0.01 ton).
** For LCCs, a negative value means an increase in LCC by the amount indicated.
*** Changes in 2042.
‡ Range of the economic value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions.

DOE first considered TSL 6, the max-tech level. TSL 6 would save 0.28 quads of energy, an amount DOE considers significant. TSL 6 would decrease consumer NPV by $2.9 billion, using a discount rate of 7 percent, and by $4.5 billion, using a discount rate of 3 percent.

The emissions reductions at TSL 6 are 12.1 Mt of CO_2 and 10.8 kt of NO_X. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 6 is $33 million to $354 million, using a discount rate of 7 percent, and $66 million to $723 million, using a discount rate of 3 percent. Total generating capacity in 2044 is estimated to increase slightly under TSL 6.

At TSL 6, DOE projects that the average LCC impact for consumers is a loss of $1,323. The median payback period is 28.1 years (which is substantially longer than the mean lifetime of the product). At TSL 6, the fraction of consumers experiencing an LCC benefit is 3 percent. The fraction of consumers experiencing an LCC cost is 96 percent.

At TSL 6, the projected change in INPV to decrease by up to $44.5 million for gas-fired pool heaters. Currently, gas-fired pool heaters that meet the efficiencies required by TSL 6 are manufactured in extremely low volumes by a limited number of manufacturers. The significant impacts on manufacturers arise from the large costs to develop or increase the production of fully condensing products. In addition, manufacturers are significantly harmed if profitability is negatively impacted to keep consumers in the market for a luxury item that is significantly more expensive than most products currently sold. If the high end of the range of impacts is reached as DOE expects, TSL 6 could result in a net loss of 72.6 percent in INPV for gas-fired pool heaters.

The Secretary tentatively concludes that at TSL 6, the benefits of energy savings and emission reductions would be outweighed by the negative economic impacts to the Nation, the economic burden on some consumers (as indicated by the large increase in total installed cost), and the large capital conversion costs that could result in a large reduction in INPV for the manufacturers. Consequently, the Secretary has tentatively concluded that TSL 6 is not economically justified.

Next, DOE considered TSL 5. TSL 5 would save 0.13 quads of energy, an amount DOE considers significant. TSL 5 would decrease consumer NPV by $1.3 billion, using a discount rate of 7 percent, and by $2.0 billion, using a discount rate of 3 percent.

The emissions reductions at TSL 5 are 5.7 Mt of CO_2 and 5.1 kt of NO_X. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 5 is $15 million to $168 million, using a discount rate of 7 percent, and $31 million to $342 million, using a discount rate of 3 percent. Total generating capacity in 2044 is estimated to increase slightly under TSL 5.

At TSL 5, DOE projects that the average LCC impact for consumers is a loss of $555. The median payback period is 28.6 years (which is substantially longer than the mean lifetime of the product). At TSL 5, the fraction of consumers experiencing an LCC benefit is 5 percent. The fraction of consumers experiencing an LCC cost is 90 percent.

At TSL 5, the projected change in INPV to decrease by up to $19.5 million for gas-fired pool heaters. Currently, gas-fired pool heaters that meet the efficiencies required by TSL 5 are manufactured in extremely low volumes by a limited number of manufacturers, as with TSL 6. The significant adverse impacts on manufacturers arise from the large costs to develop or increase the production of products with multiple efficiency improvements. In addition, the potential for manufacturers to be significantly harmed increases if consumers purchasing decisions are impacted and shipments decline due to the large increases in first cost for a luxury item. If the high end of the range of impacts is reached as DOE expects, TSL 5 could result in a net loss of 31.8 percent in INPV for gas-fired pool heaters.

The Secretary tentatively concludes that at TSL 5, the benefits of energy savings and emission reductions would be outweighed by the negative economic impacts to the Nation, the economic burden on some consumers (as indicated by the large increase in total installed cost), and the large capital conversion costs that could result in a large reduction in INPV for the manufacturers. Consequently, the Secretary has tentatively concluded that TSL 5 is not economically justified.

Next, DOE considered TSL 4. TSL 4 would save 0.10 quads of energy, an amount DOE considers significant. TSL 4 would increase consumer NPV by $0.03 billion, using a discount rate of 7 percent, and by $0.25 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 4 are 4.2 Mt of CO_2 and 3.7 kt of NO_X. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 4 is $11 million to $123 million, using a discount rate of 7 percent, and $23 million to $251 million, using a discount rate of 3 percent. Total generating capacity in 2044 is estimated to increase slightly under TSL 4.

At TSL 4, the estimated increase in the installed cost is $335. Because this increase is substantially balanced by a decrease in operating costs, DOE projects that the average LCC impact for consumers is a loss of $13 (note that this quantity represents only 0.2 percent of the average total LCC). The median payback period is 13.0 years, compared to a typical product life of 8 years. At TSL 4, the fraction of consumers experiencing an LCC benefit is 20 percent. The fraction of consumers experiencing a net increase in LCC (mainly due to having low pool heater operation) is 59 percent. Of these consumers, the average net increase in LCC would be about $172, which is about 3 percent of the average LCC for these consumers.

At TSL 4, DOE projects that INPV decreases by up to $7.5 million for gas-fired pool heaters. At TSL 4, manufacturers believe that profitability could be harmed in order to keep consumers in the market for a luxury item that is more expensive than the most common products currently sold. If the high end of the range of impacts is reached as DOE expects, TSL 4 could result in a net loss of 12.1 percent in INPV for gas-fired pool heaters.

After considering the analysis, comments on the January 13, 2009, notice and the preliminary TSD, and the benefits and burdens of TSL 4, the Secretary tentatively concludes that this trial standard level will offer the maximum improvement in efficiency that is technologically feasible and economically justified, and will result in significant conservation of energy. Further, benefits from carbon dioxide reductions (at a central value of $20) would increase NPV by between $11 million and $123 million (2008$) at a 7% discount rate and between $23 million and $251 million at a 3% discount rate. These benefits from carbon dioxide emission reductions, when considered in conjunction with the consumer savings NPV and other factors described above support DOE's tentative conclusion that trial standard level 4 is economically justified. Therefore, the Department today proposes to adopt the energy conservation standards for pool heaters at TSL 4, which requires a thermal efficiency of 84 percent for gas-fired pool heaters as shown in Table V.66. As discussed above, approximately 59 percent of consumers with pool heaters would experience a life cycle cost from the proposed standard for pool heaters, TSL 4. Further, DOE estimates that one-quarter of these consumers would experience LCC of less than 2%. Although most consumers would experience some savings or very small increases in life cycle costs, DOE is seeking comment regarding the appropriateness of proposing TSL 4 for pool heaters since this efficiency level would increase life-cycle costs for most consumers. DOE also seeks comment on its consideration of TSL 3 as an alternative for the final standard level for pool heaters. (See Issue 18 under ''Issues on Which DOE Seeks Comment'' in section VII.E of this NOPR.)

TABLE V.66—PROPOSED MINIMUM THERMAL EFFICIENCY REQUIREMENTS FOR POOL HEATERS (TSL 4)

Product class	Thermal efficiency %
Gas-fired Pool Heaters	84

DOE also calculated the annualized values for certain benefits and costs under the considered pool heater TSLs. The annualized values refer to consumer operating cost savings, consumer incremental product and installation costs, the quantity of emissions reductions of CO_2, NO_X, and Hg, and the monetary value of CO_2 emissions reductions (using a value of $20/t CO_2, which is in the middle of the values considered by DOE for valuing the potential global benefits resulting from reduced CO_2 emissions).

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 for the time-series of costs and benefits using a discount rate of either three or seven percent. From the present value, DOE then calculated the fixed annual payment over the analysis time period (2013 to 2043 for pool heaters) that yielded 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 are a steady stream of payments. Table V.67 presents the annualized values for each TSL considered for pool heaters.

TABLE V.67—ANNUALIZED BENEFITS AND COSTS FOR POOL HEATERS BY TRIAL STANDARD LEVEL

TSL	Category	Unit	Primary estimate (AEO reference case)		Low estimate (AEO low growth case)		High estimate (AEO high growth case)	
			7%	3%	7%	3%	7%	3%
	Benefits							
1	Monetized Operating Cost Savings.	Million 2008$	9.52	10.93	9.10	10.43	9.80	11.26
	Quantified Emissions Reductions.	CO_2 (Mt)	0.02	0.02	0.02	0.03	0.01	0.01
		NO_X (kt)	0.017	0.018	0.021	0.022	0.013	0.014
		Hg (t)	0.000	0.000	(0.000)	(0.000)	(0.000)	0.000
	Monetized Avoided CO_2 Value (at $19/t).	Million 2008$	0.61	0.70	0.82	0.94	0.47	0.54
	Costs							
	Monetized Incremental Product and Installation Costs.	Million 2008$	2.06	1.98	2.06	1.98	2.06	1.98
	Net Benefits							
	Monetized Value	Million 2008$	8.07	9.65	7.86	9.39	8.21	9.82
	Benefits							

TABLE V.67—ANNUALIZED BENEFITS AND COSTS FOR POOL HEATERS BY TRIAL STANDARD LEVEL—Continued

TSL	Category	Unit	Primary estimate (AEO reference case)		Low estimate (AEO low growth case)		High estimate (AEO high growth case)	
			7%	3%	7%	3%	7%	3%
2	Monetized Operating Cost Savings.	Million 2008$	16.35	18.78	15.64	17.92	16.83	19.35
	Quantified Emissions Reductions.	CO_2 (Mt)	0.03	0.03	0.04	0.04	0.02	0.03
		NO_X (kt)	0.029	0.030	0.036	0.038	0.023	0.024
		Hg (t)	0.000	0.000	(0.000)	(0.000)	(0.000)	0.000
	Monetized Avoided CO_2 Value (at $19/t).	Million 2008$	1.06	1.20	1.40	1.62	0.80	0.93
	Costs							
	Monetized Incremental Product and Installation Costs.	Million 2008$	8.98	8.66	8.98	8.66	8.98	8.66
	Net Benefits							
	Monetized Value	Million 2008$	8.42	11.33	8.06	10.88	8.65	11.62
	Benefits							
3	Monetized Operating Cost Savings.	Million 2008$	50.33	57.83	48.16	55.20	51.79	59.57
	Quantified Emissions Reductions.	CO_2 (Mt)	0.10	0.11	0.13	0.14	0.08	0.08
		NO_X (kt)	0.091	0.095	0.113	0.120	0.072	0.077
		Hg (t)	0.000	0.000	(0.000)	(0.001)	(0.000)	0.000
	Monetized Avoided CO_2 Value (at $19/t).	Million 2008$	3.33	3.80	4.42	5.10	2.55	2.93
	Costs							
	Monetized Incremental Product and Installation Costs.	Million 2008$	36.72	35.38	36.72	35.38	36.72	35.38
	Net Benefits							
	Monetized Value	Million 2008$	16.94	26.25	15.86	24.92	17.62	27.12
	Benefits							
4	Monetized Operating Cost Savings.	Million 2008$	59.88	68.79	57.29	65.66	61.62	70.86
	Quantified Emissions Reductions.	CO_2 (Mt)	0.13	0.13	0.16	0.17	0.09	0.10
		NO_X (kt)	0.112	0.119	0.134	0.143	0.085	0.091
		Hg (t)	0.000	0.000	(0.000)	(0.001)	(0.000)	0.000
	Monetized Avoided CO_2 Value (at $19/t).	Million 2008$	4.20	4.84	5.24	6.08	3.01	3.47
	Costs							
	Monetized Incremental Product and Installation Costs.	Million 2008$	56.66	54.59	56.66	54.59	56.66	54.59
	Net Benefits							
	Monetized Value	Million 2008$	7.41	19.04	5.88	17.15	7.97	19.74
	Benefits							
5	Monetized Operating Cost Savings.	Million 2008$	82.08	94.30	78.54	90.00	84.48	97.14
	Quantified Emissions Reductions.	CO_2 (Mt)	0.17	0.18	0.21	0.23	0.12	0.13
		NO_X (kt)	0.153	0.162	0.183	0.195	0.116	0.124
		Hg (t)	0.000	0.000	(0.000)	(0.001)	(0.000)	0.000

TABLE V.67—ANNUALIZED BENEFITS AND COSTS FOR POOL HEATERS BY TRIAL STANDARD LEVEL—Continued

TSL	Category	Unit	Primary estimate (AEO reference case)		Low estimate (AEO low growth case)		High estimate (AEO high growth case)	
			7%	3%	7%	3%	7%	3%
	Monetized Avoided CO_2 Value (at $19/t).	Million 2008$	5.72	6.58	7.15	8.25	4.11	4.73
	Costs							
	Monetized Incremental Product and Installation Costs.	Million 2008$	207.11	204.15	207.11	204.15	207.11	204.15
	Net Benefits							
	Monetized Value	Million 2008$	(119.31)	(103.27)	(121.42)	(105.90)	(118.52)	(102.28)
	Benefits							
6	Monetized Operating Cost Savings.	Million 2008$	174.79	200.78	167.22	191.59	179.91	206.84
	Quantified Emissions Reductions.	CO_2 (Mt)	0.37	0.39	0.45	0.48	0.26	0.27
		NO_X (kt)	0.324	0.343	0.388	0.411	0.244	0.261
		Hg (t)	0.000	0.000	(0.001)	(0.002)	(0.000)	0.000
	Monetized Avoided CO_2 Value (at $19/t).	Million 2008$	12.04	13.94	15.10	17.45	8.65	9.98
	Costs							
	Monetized Incremental Product and Installation Costs.	Million 2008$	464.57	452.23	464.57	452.23	464.57	452.23
	Net Benefits							
	Monetized Value	Million 2008$	(277.74)	(237.52)	(282.25)	(243.19)	(276.01)	(235.41)

VI. Procedural Issues and Regulatory Review

A. Review Under Executive Order 12866

Section 1(b)(1) of Executive Order 12866, ''Regulatory Planning and Review,'' 58 FR 51735 (Oct. 4, 1993), requires each agency to identify in writing the market failure or other problem that it intends to address, and that warrants agency action (including where applicable, the failure of private markets or public institutions), as well as assess the significance of that problem, to enable assessment of whether any new regulation is warranted. The problems that today's 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 heating products 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, DOE has determined that today's regulatory action is a ''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 today's proposed rule and that the Office of Information and Regulatory Affairs (OIRA) in the OMB review this proposed rule. DOE presented to OIRA for review the draft proposed rule and other documents prepared for this rulemaking, including the RIA, and has included these documents in the rulemaking record. They are available for public review in the Resource Room of DOE's Building Technologies Program, 950 L'Enfant Plaza, SW., Suite 600, Washington, DC 20024, (202) 586–2945, between 9:00 a.m. and 4:00 p.m., Monday through Friday, except Federal holidays.

The RIA is contained in the TSD prepared for the rulemaking. The RIA consists of: (1) A statement of the problem addressed by this regulation, and the mandate for government action; (2) a description and analysis of the feasible policy alternatives to this regulation; (3) a quantitative comparison of the impacts of the alternatives; and (4) the national economic impacts of the proposed standards.

The RIA calculates the effects of feasible policy alternatives to mandatory standards for heating products, and provides a quantitative comparison of the impacts of the alternatives. DOE evaluated each alternative in terms of its ability to achieve significant energy savings at reasonable costs, and compared it to the effectiveness of the proposed rule. DOE analyzed these alternatives using a series of regulatory scenarios for the three types of heating products. It modified the heating product NIA models to allow inputs for these policy alternatives. Of the four product classes of residential water heaters subject to proposed standards, this RIA concerns only gas-fired storage and electric storage water heaters, which together represent the majority of shipments. Of the five product classes of DHE, this RIA concerns only gas wall fan DHE and gas hearth DHE, which together represent the majority of DHE shipments.

DOE identified the following major policy alternatives for achieving increased energy efficiency in the three types of heating products:

- No new regulatory action;
- Consumer rebates;
- Consumer tax credits;
- Manufacturer tax credits;
- Voluntary energy efficiency targets;
- Bulk government purchases;
- Early replacement programs; and
- The proposed approach (energy conservation standards).

DOE evaluated each alternative in terms of its ability to achieve significant energy savings at reasonable costs and compared it to the effectiveness of the proposed rule. Table VI.1 through Table VI.5 show the results for energy savings and consumer NPV.

TABLE VI.1—IMPACTS OF NON-REGULATORY ALTERNATIVES FOR GAS-FIRED STORAGE WATER HEATERS THAT MEET THE PROPOSED STANDARD (TSL 4)

Policy alternative	Primary energy savings *quads*	Net present value* *billion 2008$*	
		7% discount rate	3% discount rate
No New Regulatory Action	0.00	0.00	0.00
Consumer Rebates	0.51	1.19	3.46
Consumer Tax Credits	0.31	0.72	2.08
Manufacturer Tax Credits	0.15	0.36	1.04
Voluntary Energy Efficiency Targets	0.12	0.29	0.83
Early Replacement	0.001	−0.02	−0.04
Bulk Government Purchases	0.005	0.01	0.04
Proposed Standard	1.29	3.09	9.04

* DOE determined the NPV from 2015 to 2045.

TABLE VI.2—IMPACTS OF NON-REGULATORY ALTERNATIVES FOR ELECTRIC STORAGE WATER HEATERS THAT MEET THE PROPOSED STANDARD (TSL 4)

Policy alternative	Primary energy savings *quads*	Net present value* *billion 2008$*	
		7% discount rate	3% discount rate
No New Regulatory Action	0.00	0.00	0.00
Consumer Rebates	0.42	0.47	1.87
Consumer Tax Credits	0.25	0.28	1.12
Manufacturer Tax Credits	0.13	0.14	0.56
Voluntary Energy Efficiency Targets	0.09	0.19	0.60
Early Replacement	0.0023	−0.03	−0.05
Bulk Government Purchases	0.0017	0.004	0.01
Proposed Standard	1.21	1.59	6.02

* DOE determined the NPV from 2015 to 2045.

TABLE VI.3—IMPACTS OF NON-REGULATORY ALTERNATIVES FOR GAS WALL FAN DHE THAT MEET THE PROPOSED STANDARD (TSL 3)

Policy alternative	Primary energy savings *quads*	Net present value* *billion 2008$*	
		7% discount rate	3% discount rate
No New Regulatory Action	0.00	0.00	0.00
Consumer Rebates	0.003	0.010	0.023
Consumer Tax Credits	0.002	0.006	0.006
Manufacturer Tax Credits	0.001	0.003	0.003
Voluntary Energy Efficiency Targets	0.0003	0.001	0.001
Early Replacement	<0.0001	−0.00001	−0.00003
Bulk Government Purchases†	NA	NA	NA
Proposed Standard	0.013	0.042	0.11

* DOE determined the NPV from 2013 to 2043.

† DOE did not evaluate the bulk government purchase alternative for gas wall fan DHE because the market share associated with publicly-owned housing is minimal.

TABLE VI.4—IMPACTS OF NON-REGULATORY ALTERNATIVES FOR GAS HEARTH DHE THAT MEET THE PROPOSED STANDARD (TSL 3)

Policy alternative	Primary energy savings quads	Net present value* *billion 2008$*	
		7% discount rate	3% discount rate
No New Regulatory Action	0.00	0.00	0.00
Consumer Rebates	0.03	0.15	0.36
Consumer Tax Credits	0.02	0.09	0.22
Manufacturer Tax Credits	0.01	0.05	0.11
Voluntary Energy Efficiency Targets	0.012	0.06	0.15
Early Replacement	<0.001	−0.005	−0.006
Bulk Government Purchases†	NA	NA	NA
Proposed Standard	0.14	0. 64	1.52

* DOE determined the NPV from 2013 to 2043.
† DOE did not evaluate the bulk government purchase alternative for gas hearth DHE because the market share associated with publicly-owned housing is minimal.

TABLE VI.5—IMPACTS OF NON-REGULATORY ALTERNATIVES FOR POOL HEATERS THAT MEET THE PROPOSED STANDARDS (TSL 4)

Policy alternative	Primary energy savings *quads*	Net present value* *billion 2008$*	
		7% discount rate	3% discount rate
No New Regulatory Action	0.00	0.00	0.00
Consumer Rebates	0.02	0.01	0.04
Consumer Tax Credits	0.01	0.003	0.03
Manufacturer Tax Credits	0.005	0.002	0.01
Voluntary Energy Efficiency Targets	0.004	0.005	0.02
Early Replacement	<0.001	−0.002	−0.003
Bulk Government Purchases †	NA	NA	NA
Proposed Standard	0.10	0.03	0.25

* DOE determined the NPV from 2013 to 2043.
† DOE did not evaluate the bulk government purchase alternative for pool heaters because there is no market share associated with publicly-owned housing.

The NPV amounts shown in Table VI.1 through Table VI.5 refer to the NPV of consumer benefits. The costs to the government of each policy (such as rebates or tax credits) are not included in the costs for the NPV since, on balance, consumers in the aggregate both pay for rebates and tax credits through taxes and receive their benefits. The following paragraphs discuss the cumulative effect of each policy alternative listed in Table VI.1 through Table VI.5. (See the regulatory impact analysis in the NOPR TSD for details.) For comparison with the results reported below for the non-regulatory policies, the combined impacts of the proposed standards for the considered products are projected as 2.75 quads of national energy savings and an NPV of $5.39 billion (at a 7-percent discount rate).

No new regulatory action. The case in which no regulatory action is taken constitutes the ''base case'' (or ''no action'') scenario. Since this is the base case, energy savings and NPV are zero by definition.

Rebates. If consumers were offered a rebate that covered a portion of the incremental price difference between products meeting baseline efficiency levels and those meeting the energy efficiency levels in the proposed standard, DOE estimates that the percentage of consumers purchasing the more-efficient products would increase by 17.5 percent to 40 percent, depending on the product and the product class. DOE assumed this policy would permanently transform the market so that the increased percentage of consumers purchasing more-efficient products seen in the first year of the program would be maintained throughout the forecast period. At the estimated participation rates, the rebates would provide 0.98 quads of national energy savings and an NPV of $1.83 billion (at a 7-percent discount rate) for the considered products. Although DOE estimates that rebates would provide national benefits, they are expected to be much smaller than the benefits resulting from the proposed national standards.

Consumer Tax Credits. If consumers were offered a tax credit that covered a portion of the incremental price difference between products meeting baseline efficiency levels and those meeting the energy efficiency levels in the proposed standards, DOE's research suggests that the number of consumers buying a water heater, pool heater, or DHE that would take advantage of the tax credit would be approximately 60 percent of the number that would take advantage of rebates. As a result of the tax credit, the percentage of consumers purchasing more-efficient products would increase by 10.5 percent to 24 percent, depending on the product and product class. Therefore, tax credits would yield a fraction of the benefits of rebates. DOE assumed this policy would permanently transform the market so that the increased percentage of consumers purchasing more-efficient products seen in the first year of the program would be maintained throughout the forecast period. At the estimated participation rates, consumer tax credits would provide 0.59 quads of national energy savings and an NPV of $1.10 billion (at a seven-percent discount rate) for the considered products.

Manufacturer Tax Credits. DOE believes even smaller benefits would result from a manufacturer tax credit program that would effectively result in a lower price to the consumer by an amount that covers part of the incremental price difference between products meeting baseline efficiency levels and those meeting the proposed standards. Because these tax credits would go to manufacturers instead of consumers, DOE believes that fewer consumers would be aware of this program than a consumer tax credit program. DOE assumes that 50 percent of the consumers who would take advantage of consumer tax credits would buy more-efficient products offered through a manufacturer tax credit program. Thus, as a result of the manufacturer tax credit, the percentage of consumers purchasing the more-efficient products would increase by 5.2 percent to 12 percent (*i.e.,* 50 percent of the impact of consumer tax credits), depending on the product class.

DOE assumed this policy would permanently transform the market so that the increased percentage of consumers purchasing more-efficient products seen in the first year of the program would be maintained throughout the forecast period. At the estimated participation rates, the rebates would provide 0.30 quads of national energy savings and an NPV of $0.56 billion (at a seven-percent discount rate) for the considered products. Thus, DOE estimated that manufacturer tax credits would yield a fraction of the benefits that consumer tax credits and rebates would provide.

Voluntary Energy Efficiency Targets. The Federal government's ENERGY STAR program has voluntary energy efficiency targets for gas-fired and electric storage water heaters and gas-fired instantaneous water heaters. Some equipment purchases that result from the ENERGY STAR program already are reflected in DOE's base-case scenario. DOE evaluated the potential impacts of increased marketing efforts by ENERGY STAR that would encourage the purchase of products meeting the proposed standard. DOE modeled the voluntary efficiency program based on this scenario and assumed that the resulting increased percentage of consumers purchasing more-efficient products would be maintained throughout the forecast period. DOE estimated that the enhanced effectiveness of voluntary energy efficiency targets would provide 0.23 quads of national energy savings and an NPV of $0.55 billion (at a 7-percent discount rate) for the considered products. Although this would provide national benefits, they would be much smaller than the benefits resulting from the proposed national standards.

Early Replacement Incentives. This policy alternative envisions a program to replace old, inefficient water heaters, DHE, and pool heaters with models meeting the efficiency levels in the proposed standards. DOE projected a 4-percent increase in the annual retirement rate of the existing stock in the first year of the program. It assumed the program would last as long as it took to completely replace all of the eligible existing stock in the year that the program begins (2013 or 2015). DOE estimated that such an early replacement program would provide negligible national energy savings and NPV for the considered products. The national energy savings benefits would be negligible in comparison with the benefits resulting from the proposed national standards, and the NPV would actually be negative.

Bulk Government Purchases. Under this policy alternative, the government would be encouraged to purchase increased amounts of equipment that meet the efficiency levels in the proposed standards. Federal, State, and local government agencies could administer such a program. At the Federal level, this would be an enhancement to the existing Federal Energy Management Program (FEMP). DOE modeled this program by assuming an increase in installation of equipment meeting the efficiency levels of the proposed standards among those households for whom government agencies purchase or influence the purchase of water heaters. (Because the market share of DHE units in publicly-owned housing is minimal and the market share of pool heaters in publicly-owned housing is zero, the Department did not consider bulk government purchases for those products.) DOE estimated that bulk government purchases would provide negligible national energy savings (0.01 quads) and NPV ($0.14 billion) for the considered products, benefits that are much smaller than those estimated for the proposed national standards.

Proposed Standards. DOE proposes to adopt the efficiency levels listed in section V.C. As indicated in the paragraphs above, none of the alternatives DOE examined would save as much energy as today's proposed standards. Also, several of the alternatives would require new enabling legislation because authority to carry out those alternatives may not exist.

Additional Policy Evaluation. In addition to the above non-regulatory policy alternatives, DOE evaluated the potential impacts of a policy that would allow States to require that some water heaters installed in new homes have an efficiency level higher than the Federal standard. At present, States are prohibited to require efficiency levels higher than the Federal standard; the considered policy would remove this prohibition in the case of residential water heaters. DOE notes that removing the prohibition would require either legislative authority or DOE approval, after a case-by-case basis consideration on the merits, of waivers submitted by States. For the present rulemaking, DOE evaluated the impacts that such a policy would have for electric storage water heaters.

Specifically, DOE estimated the impacts for a policy case in which several States adopted provisions in their building codes that would require electric storage water heaters to meet efficiency level 6 (2.0 EF, heat pump with two-inch insulation). DOE assumed that such codes would affect 25 percent of water heaters in all new homes built in the United States in 2015 and that the percentage would increase linearly to 75 percent by 2045. (DOE did not attempt to define the specific geographic areas that would be affected.) In this policy case, all other water heaters (those bought for replacement in existing homes) would meet the proposed standard level of 0.95 (efficiency level 5). DOE's analysis accounts for the estimate that some new homes would have a water heater with EF greater than or equal to 2.0 (*e.g.*, heat pump technology) in the absence of any amended standards (the base case).

Table VI.6 shows the additional estimated national energy savings that would result from the considered building code policy, as well as the net present value of additional benefits to consumers (the purchasers of new homes that have electric water heaters that have an EF of at least 2.0). The table also shows the estimated national energy savings and NPV for electric storage water heaters under the proposed standards. The energy savings from this State building code requirement for new homes would be greater than the savings from the proposed standard for electric storage water heaters. This contrasts with the non-regulatory policy alternatives discussed above, whose savings are lower than those of the proposed standards.

TABLE VI.6—IMPACTS OF POLICY ALLOWING STATES TO INCORPORATE REQUIREMENTS FOR HIGH-EFFICIENCY ELECTRIC STORAGE WATER HEATERS IN BUILDING CODES

Policy alternative	Primary energy savings *quads*	Net present value *billion 2008$*	
		7% discount rate	3% discount rate
Proposed Standard (TSL 4) (Electric Storage Water Heaters)	1.21	1.59	6.02
Proposed Standard (TSL 4) AND Policy Allowing States to Require Higher-Efficiency Electric Storage Water Heaters in New Homes	1.69	2.13	8.33

B. Review Under the Regulatory Flexibility Act

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

For the manufacturers of the three types of heating products, 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, 30850 (May 15, 2000), as amended at 65 FR 53533, 53545 (September 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/idc/groups/public/documents/sba_homepage/serv_sstd_tablepdf.pdf.* Residential water heater and pool heater manufacturing are classified under NAICS 335228, ''Other Major Household Appliance Manufacturing'' and DHE 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 both of these categories as shown in Table VI.7.

TABLE VI.7—SBA AND NAICS CLASSIFICATION OF SMALL BUSINESSES POTENTIALLY AFFECTED BY THIS RULE

Industry description	Revenue limit	Employee limit	NAICS
Residential Water Heater Manufacturing	N/A	500	335228
Direct Heating Manufacturing	N/A	500	333414
Pool Heater Manufacturing	N/A	500	335228

DOE reviewed the potential standard levels considered in today's NOPR under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. To better assess the potential impacts of this rulemaking on small entities, DOE conducted a more focused inquiry of the companies that could be small business manufacturers of products covered by this rulemaking. During its market survey, DOE used all available public information to identify potential small manufacturers. DOE's research involved several industry trade association membership directories (including AHRI, HPBA, and APSP), product databases (*e.g.,* AHRI, CEC, and ENERGY STAR databases), individual company Web sites, and marketing research tools (*e.g.,* Dunn and Bradstreet reports) to create a list of every company that manufactures or sells water heaters, DHE, and gas-fired pool heaters 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 previous DOE public meetings. DOE reviewed all 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 water heaters, DHE, and pool heaters. DOE screened out companies that did not offer products covered by this rulemaking, did not meet the definition of a ''small business,'' or are foreign owned and operated. Ultimately, DOE identified five small residential water heater manufacturers, 12 small DHE manufacturers, and one small pool heater manufacturer that produce covered products and can be considered small businesses. Next, DOE attempted to contact these potential small business manufacturers to request an interview about the possible impacts on small business manufacturers. The results of discussions with manufacturers are set forth below. From these discussions, DOE determined the expected impacts of the rule on affected small entities.

DOE looked at each type of heating product (water heaters, pool heaters, and direct heating) separately for purposes of determining whether certification was appropriate or an initial regulatory flexibility analysis was needed.

1. Water Heater Industry

The majority of residential water heaters are currently manufactured in the United States. Three large manufacturers control the overwhelming majority of storage water heater sales. Many foreign-owned and foreign-operated manufacturers of instantaneous gas-fired water heaters offer products for sale in the United States and make up part of the remaining domestic residential water heater market. A very small portion of the remaining residential water heater market is supplied by a combination of international and domestic companies, all of which have less than a one-percent total market share. Part of the remaining market is also supplied by domestic companies that focus primarily on commercial, niche, or other products, but also manufacture residential water heaters that are covered by this rulemaking.

DOE identified five domestic small businesses that manufacture residential water heaters. Each company's product offerings were examined to help determine the potential impact of amended energy conservation standards.

Only one of the small businesses identified by DOE manufactures primarily products that are covered by this rulemaking. This company offers two gas-fired instantaneous water heaters and is also developing a heat pump water heater. The products offered by this manufacturer are expected to meet the ENERGY STAR criteria for residential water heaters and to achieve efficiencies higher than the levels being proposed in this NOPR. Therefore, DOE believes that none of the products offered by this manufacturer would be impacted by the proposed energy conservation standards for residential water heaters.

Three of the small businesses identified by DOE manufacture covered oil-fired residential water heaters, but focus mainly on other products. One of these three small businesses holds a significant portion of the residential oil-fired water heater market. The products offered by this manufacturer exceed the efficiencies of the proposed standard levels for residential oil-fired storage water heaters. Therefore, DOE does not believe that the products offered by this manufacturer would be impacted by the proposed energy conservation standards for residential water heaters. The two other two small businesses that manufacture residential oil-fired storage water heaters both have a lower market share and collectively ship fewer than 5,000 units per year. The first of these companies with low market share offers one residential oil-fired water heater model, but it would not need to be upgraded at the proposed energy conservation standard level. In addition, this manufacturer specializes in products outside of the scope of coverage for this rulemaking (*e.g.,* commercial gas-fired storage water heaters, indirect water heaters, commercial electric storage water heaters, storage tanks, and boilers). The other company with low market share in the residential oil-fired market offers seven different oil-fired storage water heater models. However, this company does not certify these products on public databases and does not provide information about the input capacity or efficiency in its product literature, making it difficult to determine whether these are commercial or residential products and if they would need to be upgraded in response to the proposed energy conversation standards. However, from a review of the company Web site, DOE believes this manufacturer is also focused mostly on non-covered products.

The final small manufacturer of residential water heaters has a full line of residential electric storage water heaters that would need to be upgraded or, possibly, discontinued in response to the proposed energy conservation standards. Depending on the importance of this residential line, this small business could exit the residential electric storage market rather than invest in the changes necessary to upgrade and recertify its existing electric storage products. However, this manufacturer has less than a one-percent market share in the residential storage water heater market. Product certification databases and the company Web site also indicate that this manufacturer focuses primarily on commercial water heaters and other non-covered products including indirect water heaters and boilers. Because of its focus on non-covered products, it is unlikely that this small business would be forced out of business in response to the proposed energy conservation standards.

Because only one small manufacturer with very low market share in the electric storage water heater market and potentially one small business with very low market share in the residential oil-fired market would potentially be impacted by the proposed energy conservation standards in today's rule, DOE certifies that the standards for water heaters set forth in the proposed rule, if promulgated, would not have a significant economic impact on a substantial number of small entities. Accordingly, DOE has not prepared a regulatory flexibility analysis for the water heaters portion of this rulemaking. DOE will transmit the certification and supporting statement of factual basis to the Chief Counsel for Advocacy of the Small Business Administration for review under 5 U.S.C. 605(b).

DOE requests comment on the above analysis, as well as any information concerning small businesses that could be impacted by this rulemaking and the nature and extent of those potential impacts of the proposed energy conservation standards on small residential water heater manufacturers. (See Issue 19 under ''Issues on Which DOE Seeks Comment'' in section VII.E of this NOPR.)

2. Pool Heater Industry

The vast majority of residential pool heaters are currently manufactured in the United States. Four manufacturers supply over 95 percent of the market. Based on its market research, DOE identified only one small manufacturer of residential gas-fired pool heaters. The small manufacturer specializes in high-efficiency products that exceed the proposed energy conservation standard level, and, therefore, DOE does not believe the products offered by this manufacturer would be impacted by the proposed amended energy conservation standards for residential pool heaters. Additionally, this small business manufacturer has a very low share of the residential gas-fired pool heater market. Because only one small business manufacturer of residential gas-fired pool heaters with small market share exists and because this company's product exceeds the proposed energy conservation standard levels, DOE certifies that the standards for pool heaters set forth in the proposed rule, if promulgated, would not have a significant economic impact on a substantial number of small entities in the gas-fired pool heater industry. Accordingly, DOE has not prepared a regulatory flexibility analysis for the pool heaters portion of this rulemaking. DOE will transmit this certification and supporting statement of factual basis to the Chief Counsel for Advocacy of the Small Business Administration for review under 5 U.S.C 605(b).

DOE requests comment on the above analysis, as well as any information concerning small businesses that could be impacted by this rulemaking and the nature and extent of those potential impacts of the proposed energy conservation standards on small residential gas-fired pool heater manufacturers. (See Issue 20 under ''Issues on Which DOE Seeks Comment'' in section VII.E of this NOPR.)

3. Direct Heating Equipment Industry Characteristics

As discussed in further detail below, DOE determined that it cannot certify that the proposed energy conservation standard levels for DHE, if promulgated, would not have a significant economic impact on a substantial number of small entities. This determination results from the large number of small DHE manufacturers and the expected impact of the proposed standards on these manufacturers, as well as the likely greater impact of the proposed standards on these small businesses.

Consequently, DOE has prepared an IRFA for the direct heating equipment portion of this rulemaking, a copy of which DOE will transmit to the Chief Counsel for Advocacy of the SBA for review under 5 U.S.C 605(b). As presented and discussed below, the IFRA describes potential impacts on small DHE manufacturers associated with the required capital and product conversion costs at each TSL and discusses alternatives that could minimize these impacts.

a. Description and Estimated Number of Small Entities Regulated

After examining structure of the DHE industry, DOE determined it necessary to divide potential impacts on small DHE manufacturers into two broad categories: (1) Impacts on small manufacturers of traditional DHE (*i.e.,* manufacturers of gas wall fan, gas wall gravity, gas floor, and gas room DHE); and (2) impacts on small manufacturers of gas hearth products. The IRFA presents the results for traditional DHE and gas hearth DHE separately to be consistent with the MIA results in section V.B.2.b, which also separate DHE in this manner. Traditional DHE and gas hearth DHE are made by different manufacturers (*i.e.,* all manufacturers of gas hearth products do not manufacture traditional DHE, and vice versa, with one exception).

i. Traditional Direct Heating Equipment

Three major manufacturers control almost 100 percent of the traditional DHE market. Two of the three major manufacturers of traditional DHE are small businesses. One of the small businesses produces only traditional DHE and has products in all four traditional DHE product classes (*i.e.,* gas wall fan, gas wall gravity, gas floor, and gas room DHE). The second business produces all five products classes of DHE, including gas hearth DHE. DOE identified a third small business with less than a one-percent share of the traditional DHE market. This company offers two gas wall gravity models, but is mainly focused on specialty hearth products not covered by this rulemaking.

ii. Gas Hearth Direct Heating Equipment

DOE identified 10 small manufacturers of gas hearth DHE. Before issuing this NOPR, DOE attempted to contact the small business manufacturers of gas hearth DHE. One of the small businesses consented to being interviewed during the MIA interviews, and DOE received feedback from an additional two small businesses through survey responses. DOE also obtained information about small business impacts while interviewing manufacturers that exceed the small business size threshold of 500 employees in this industry. Both small business manufacturers and large manufacturers indicated that the number of competitors in the market has been declining in recent years due to industry consolidation and smaller companies exiting the market. Three major domestic manufacturers now supply a majority of the marketplace. None of the three major manufacturers is considered a small business. The remainder of the market is either imported (mostly by Canadian companies) or produced by one of 12 domestic manufacturers that hold varying market shares.

b. Reasons for the Proposed Rule

Title III of EPCA sets forth a variety of provisions designed to improve energy efficiency. Part A of Title III (42 U.S.C. 6291–6309) provides for the ''Energy Conservation Program for Consumer Products Other Than Automobiles.'' The program covers consumer products and certain commercial equipment, including residential DHE, and the statute directs DOE to consider new and amended energy conservation standards for those products. (42 U.S.C. 6292(9)) DOE is proposing in today's notice to amend energy conservation standards for DHE, as required by EPCA. (42 U.S.C. 6295(e)(4))

c. Objectives of, and Legal Basis for, the Proposed Rule

EPCA provides criteria for prescribing new or amended standards for covered products and equipment. (42 U.S.C 6295(o)) As indicated above, any new or amended standard for the products 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)), although EPCA precludes DOE from adopting any standard that would not result in significant conservation of energy. (42 U.S.C. 6295(o)(3)(B)) Moreover, DOE may not prescribe a standard: (1) For certain products, if no test procedure has been established for the product; or (2) if DOE determines by rule that the standard is not technologically feasible or economically justified. (42 U.S.C. 6295(o)(3)) DOE's current test procedures for water heaters, vented DHE, and pool heaters appear at Title 10 Code of Federal Regulations (CFR) part 430, subpart B, appendices E, O and P, respectively. EPCA also provides that, in deciding whether a standard is economically justified, DOE must, after receiving comments on the proposed standard, determine whether the benefits of the standard exceed its burdens by considering to the greatest extent practicable seven enumerated factors (described in section II.B above of the preamble). (42 U.S.C. 6295(o)(2)(B)(i))

EPCA prescribes energy conservation standards for direct heating products, (42 U.S.C. 6295(e)(3)) and directs DOE to conduct two cycles of rulemakings to determine whether to amend these standards. (42 U.S.C. 6295(e)(4)) This rulemaking represents the first round of amendments to the energy conservation standards for DHE.

d. Description and Estimate of Compliance Requirements

i. Traditional Direct Heating Equipment

The number of manufacturers in the traditional DHE market has declined over the past decade and leveled off with three major manufacturers remaining. While DOE explicitly analyzed one representative input capacity range for the gas wall gravity, gas wall fan, gas floor, and gas room types of DHE, manufacturers offer product lines that typically span multiple BTU ranges with many different features. This can result in many individual products, or stock keeping units (SKUs), offered by each manufacturer per product line. The wide range of product offering by manufacturers is a legacy of a higher-volume market that now typically supplies replacement units. The remaining manufacturers have stayed in business by consolidating brands and the legacy products of companies that are no longer in business to take increasing shares of a smaller total market. Because each product line is manufactured in low volumes, the discrepancy between unit shipments and the number of product lines requiring significant product and capital conversion costs results in negative impacts for all manufacturers. Many product development costs (*e.g.,* testing, certification, and marketing) are somewhat fixed, making manufacturing scale an important consideration in determining whether the product conversion costs are economically justified. Similarly, even though any capital conversion costs can be capitalized over a number of years, these costs must be paid up front and have a large enough volume to justify an added per-unit cost.

DOE calculated its capital and product conversion costs for traditional DHE by estimating a per-product-line cost and assuming that every manufacturer would face the same per-product-line cost within each product class. DOE also assumed that any product line that did not meet the efficiency level being analyzed would be upgraded, thereby requiring product conversion and capital conversion costs. DOE used public data to calculate the number of product lines that would need to be upgraded at each TSL for each product class. To show how the small businesses could be differentially harmed, DOE compared the conversion costs for a typical large manufacturer and a typical small manufacturer within the industry. To calculate the conversion costs for a typical small manufacturer and a typical large manufacturer, DOE used publicly-available information to determine the average number of product lines that met each efficiency level in each product category for a typical small manufacturer and a typical large manufacturer of traditional DHE. For both small and large, DOE multiplied the number of product lines that fell below the required efficiency level by its estimate of the per-line capital and product conversion cost. Table VI.8 and Table VI.9 show DOE's estimates for the average number of product lines at each TSL for a typical small manufacturer and a typical large manufacturer of traditional DHE, respectively.

TABLE VI.8—NUMBER OF PRODUCT LINES OF A TYPICAL SMALL MANUFACTURER

	Number of gas wall fan-type product lines at each TSL	Number of gas wall gravity-type product lines at each TSL	Number of gas floor-type product lines at each TSL	Number of gas room-type product lines at each TSL	Total product lines for all product classes
Baseline	2	*1.5	0.5	1	5
TSL 1	0	1	0.5	0.5	2
TSL 2	1	0.5	0.5	0.5	2.5
TSL 3	0.5	0	0.5	0	1
TSL 4	1	0	0.5	0	1.5
TSL 5	0	1	0.5	0	1.5
TSL 6	1	1	0.5	0	2.5

* Fractions of product lines result from taking the average number of product lines from publicly-available information.

TABLE VI.9—NUMBER OF PRODUCT LINES OF TYPICAL LARGE MANUFACTURER

	Number of gas wall fan-type product lines at each TSL	Number of gas wall gravity-type product lines at each TSL	Number of gas floor-type product lines at each TSL	Number of gas room-type product lines at each TSL	Total product lines for all product classes
Baseline	1	0	1	0	2
TSL 1	1	1	1	0	3
TSL 2	2	3	1	0	6
TSL 3	2	0	1	1	4
TSL 4	0	0	1	1	2
TSL 5	1	0	1	0	2
TSL 6	0	0	1	0	1

Amended energy conservation standards have the potential to differentially affect the small businesses, because they generally lack the large-scale resources to alter their existing products and production facilities for those TSLs requiring major redesigns. While all manufacturers would be expected to be negatively impacted by amended energy conservation standards to varying degrees, the small businesses would face higher product conversion costs at lower TSLs than their large competitor. Both large and small manufacturers have several product offerings in each product class, sometimes at varying efficiency levels, but the larger manufacturer produces products with higher efficiencies in larger volumes. As a result, the small manufacturers would have to upgrade more product lines than the large manufacturer at lower TSLs. As shown in Table VI.10 and Table VI.11, modifying facilities and developing new, more-efficient products would cause a typical small manufacturer to incur higher product conversion costs than a typical larger manufacturer for TSL 1 through TSL 5.

TABLE VI.10—TOTAL CONVERSION COSTS FOR A TYPICAL SMALL MANUFACTURER OF TRADITIONAL DIRECT HEATING EQUIPMENT

	Capital conversion costs for a typical small manufacturer (2008$ millions)	Product conversion costs for a typical small manufacturer (2008$ millions)	Total conversion costs for a typical small manufacturer (2008$ millions)
Baseline	0	0	0
TSL 1	0.58	0.29	0.86
TSL 2	1.03	0.44	1.47
TSL 3	1.61	0.69	2.31
TSL 4	1.89	0.80	2.69
TSL 5	1.57	1.20	2.77
TSL 6	2.13	1.40	3.53

TABLE VI.11—TOTAL CONVERSION COSTS FOR A TYPICAL LARGE MANUFACTURER OF TRADITIONAL DIRECT HEATING EQUIPMENT

	Capital conversion costs for a typical large manufacturer (2008$ millions)	Product conversion costs for a typical large manufacturer (2008$ millions)	Total conversion costs for a typical large manufacturer (2008$ millions)
Baseline	0	0	0
TSL 1	0.05	0.06	0.11
TSL 2	0.31	0.15	0.46
TSL 3	1.24	0.54	1.77
TSL 4	1.82	0.77	2.59
TSL 5	1.52	1.08	2.60
TSL 6	2.49	1.47	3.96

Because the larger manufacturer offers more products at higher efficiencies, a typical small manufacturer faces disproportionate costs at the lower TSLs in absolute terms at TSL 1 through TSL 5. However, at TSL 4 through TSL 6 a typical small manufacturer and a typical large manufacturer face similar product and capital conversion costs because a similar number of product lines fall below the required efficiencies. Despite being similar in absolute terms, at these TSLs the small manufacturers would be more likely to be disproportionately harmed at any TSL because they have a much lower volume across which to spread similar costs. To show how a smaller scale would harm a typical small business manufacturer, DOE used estimates of the market shares within the industry for each product class to estimate the typical annual revenue, operating profit, research and development expense, and capital expenditures for a typical large manufacturer and a typical small manufacturer using the financial parameters in the DHE GRIM. Comparing the conversion costs of a typical small manufacturer to a typical large manufacturer with operating profit (earnings before interest and taxation (EBIT)) is a rough estimate of how quickly the investments could be recouped. Table VI.12 and Table VI.13 show these comparisons.

TABLE VI.12—COMPARISON OF A TYPICAL SMALL MANUFACTURER'S CONVERSION COSTS TO ANNUAL EXPENSES, REVENUE, AND OPERATING PROFIT

	Capital conversion cost as a percentage of annual capital expenditures (percent)	Product conversion cost as a percentage of annual R&D expense (percent)	Total conversion cost as a percentage of annual revenue (percent)	Total conversion cost as a percentage of annual EBIT (percent)
Baseline	....	....	....	....
TSL 1	170	128	6	163
TSL 2	242	155	8	221
TSL 3	378	245	12	347
TSL 4	443	283	14	404
TSL 5	367	425	15	416
TSL 6	499	495	19	531

TABLE VI.13—COMPARISON OF A TYPICAL LARGE MANUFACTURER'S CONVERSION COSTS TO ANNUAL EXPENSES, REVENUE, AND OPERATING PROFIT

	Capital conversion cost as a percentage of annual capital expenditures (percent)	Product conversion cost as a percentage of annual R&D expense (percent)	Total conversion cost as a percentage of annual revenue (percent)	Total conversion cost as a percentage of annual EBIT (percent)
Baseline	....	....	....	....
TSL 1	7	12	0	10
TSL 2	42	30	1	40
TSL 3	167	110	5	154
TSL 4	246	158	8	225
TSL 5	206	220	8	225
TSL 6	337	300	12	344

Table VI.12 and Table VI.13 illustrate that, although the investments required at each TSL can be considered substantial for all companies, the impacts could be greater for a typical small business because of much lower production volumes and a comparable number of product offerings. At higher TSLs, it is more likely that manufacturers of traditional DHE would reduce the number of product lines they offer to keep their conversion costs at manageable levels. At higher TSLs, small manufacturers would face increasingly difficult decisions on whether to invest the capital required to be able to continue offering a full range of products, cut product lines, consolidate to maintain a large enough combined scale to spread the required conversion costs and operating expenses, or exit the market altogether. Because of the high conversion costs, manufacturers would likely eliminate their lower-volume product lines. Small manufacturers might only be able to afford to selectively upgrade their most popular products and be forced to discontinue lower-volume products because the product development costs that would be required to upgrade all of their existing product lines would be too high.

DOE's product line analysis reveals the potential for small businesses to be disproportionately harmed by the proposed standard levels and higher TSLs. Small traditional direct heating manufacturers have less access to capital than their larger competitor. Larger manufacturers profit from offering a variety of products and have the ability to fund required capital and product conversion costs using cash generated from all products. Unlike large manufacturers, the small manufacturers cannot leverage resources from other departments. With these considerations, it is more likely that the small businesses would have to spend an even greater proportion of their annual R&D and capital expenditures than shown in the industry-wide figures.

In addition, small manufacturers have less buying power than their larger competitor. Traditional DHE is a low-volume industry, which can make it difficult for any manufacturer to take advantage of bulk purchasing power or economies of scale. The two small businesses have approximately half the market share of their large competitor, which puts them at a disadvantage when purchasing components and raw materials. In addition, the large manufacturer has a parent company that manufactures products and equipment other than traditional DHE. This manufacturer's larger scale and additional manufacturing capacity (required for products and equipment other than DHE) also give the company more leverage with its suppliers as it purchases greater volumes of components and raw materials. During the manufacturer interviews, the small businesses commented that to comply with amended energy conservation standards, they would likely need to buy more purchased parts instead of producing most of the final product in-house. Because the large manufacturer has an advantage in purchasing power that would likely allow it to buy purchased parts at lower costs, an amended energy conservation standard that requires more purchased parts may differentially harm the profitability of the small businesses.

Even though there is a potential for small businesses to be negatively impacted by the proposed standards, DOE believes that manufacturers, including the small businesses, would be able to maintain viable number of product offerings at TSL 3, the proposed standard level. A typical small business offers product families in three out of the four product types that would meet or exceed the proposed standard levels in today's NOPR. For example, products are currently available on the market at the proposed standard level for gas wall gravity DHE, which comprise over 60 percent of the traditional DHE market. The proposed standard levels do not require manufacturers, including those that are small, to completely redesign all their product lines. For those product lines that would need to be redesigned, DOE believes that small manufacturers would offer fewer product lines after amended energy conservation standards. However, DOE believes that the proposed standards would allow the small manufacturers to selectively upgrade their existing product lines and maintain viable production volumes after the compliance date of the amended energy conservation standards. DOE seeks comment on the potential impacts of amended standards on the small traditional DHE manufacturers. (See Issue 21 and 22 under ''Issues on Which DOE Seeks Comment'' in section VII.E of this NOPR.)

ii. Gas Hearth-Type Direct Heating Equipment

While the three large manufacturers have a larger product offering than the smaller manufacturers, both small and large manufacturers typically offer a wide range of covered gas hearth DHE. During interviews, manufacturers indicated that product lines typically are not based on efficiency. Rather, product lines are groups of gas stoves, gas inserts, or gas fireplaces with similar appearances and shapes that span input ratings to appeal to a range of customers with different heating and aesthetic requirements. A product line is typically built on the same production platform and shares many of the same appearance and optional features. However, because products lines are based on appearance, features, and dimensions, product lines do not necessarily have the same efficiency across all input capacities.

DOE calculated the anticipated capital and product development costs for gas hearth DHE by estimating per-line cost. DOE used certification databases, product catalogs, interviews with manufacturers, and sources of public information to estimate the number of product lines that meet each TSL for every gas hearth DHE manufacturer for which data was available. If a product line contained several products that met different efficiencies at different capacities, DOE assumed that the product line would be redesigned in response to amended energy conservation standards whenever the least-efficient product did not meet the required efficiency level.

To show how small manufacturers would be potentially impacted compared to the large manufacturers, DOE assumed that the entire gas hearth DHE industry was comprised of the 12 manufacturers identified in the market and technology assessment (see chapter 3 of the TSD for more information). Using all available public data, DOE then identified the product lines and the efficiency levels for each product line made by these manufacturers. DOE used this information calculate the product line offerings of a ''typical'' large manufacturer and small manufacturer. Table VI.14 and Table VI.15 show DOE's estimates for the product lines of a typical small and a typical large gas hearth manufacturer.

TABLE VI.14—NUMBER OF PRODUCT LINES OF A TYPICAL SMALL MANUFACTURER

	AFUE (percent)	Number of product lines
Baseline	64	5
TSL 1, 2, and 3	67	3
TSL 4 and 5	72	1
TSL 6	93	0

TABLE VI.15—NUMBER OF PRODUCT LINES OF TYPICAL LARGE MANUFACTURER

	AFUE (percent)	Number of product lines
Baseline	64	8
TSL 1, 2, and 3	67	6
TSL 4 and 5	72	3
TSL 6	93	0

Table VI.14 shows that a typical small manufacturer currently offers nine total product lines: 5 at baseline efficiency (*i.e.,* 64 percent AFUE), 3 at 67 percent AFUE, and 1 at 72 percent AFUE. Table VI.14 suggests that a typical small manufacturer would need to upgrade up to five product lines at TSL 1 through TSL 3, up to eight product lines at TSL 4 and TSL 5, and up to nine at TSL 6. Table VI.15 shows that a typical large manufacturer currently offers 17 total product lines: Eight at the baseline (64 percent AFUE), six at 67 percent AFUE, and three at 72 percent AFUE. Table VI.15 suggests that a typical large manufacturer would upgrade up to eight product lines at TSL 1 through TSL 3, up to 14 product lines at TSL 4 and TSL 5, and up to 17 at TSL 6. However, DOE recognizes that not all manufacturers of gas hearth DHE currently report the efficiency of their products using the DOE test procedure, and as a result they may offer products at other efficiencies. DOE requests comment on its characterization of a typical large and a typical small gas hearth DHE manufacturer. (See Issue 23 under ''Issues on Which DOE Seeks Comment'' in section VII.E of this NOPR.)

To calculate the capital and product conversion costs for a typical large and a typical small manufacturer, DOE multiplied its estimate of the per-product-line capital and product conversion costs by the number of product lines a typical large and a typical small manufacturer would need to upgrade at each TSL. As described in section IV.H.2 above, DOE assumed manufacturers would only upgrade fifty percent of their existing product lines that did not meet the required efficiencies at each TSL for gas hearth DHE. Table VI.16 and Table VI.17 show DOE's estimates for the product and capital conversion costs that a typical large manufacturer and a typical small manufacturer would be expected to incur at each TSL.

TABLE VI.16—TOTAL CONVERSION COSTS FOR A TYPICAL SMALL MANUFACTURER OF GAS HEARTH DIRECT HEATING EQUIPMENT

	Capital conversion costs for a typical small manufacturer	Product conversion costs for a typical small manufacturer	Total conversion costs for a typical small manufacturer
Baseline			
TSL 1, 2, and 3	$25,000	$66,667	$91,667
TSL 4 and 5	75,000	200,000	275,000
TSL 6	400,000	800,000	1,200,000

TABLE VI.17—TOTAL CONVERSION COSTS FOR A TYPICAL LARGE MANUFACTURER OF GAS HEARTH DIRECT HEATING EQUIPMENT

	Capital conversion costs for a typical large manufacturer	Product conversion costs for a typical large manufacturer	Total conversion costs for a typical large manufacturer
Baseline			
TSL 1, 2, and 3	$50,000	$133,333	$183,333
TSL 4 and 5	125,000	333,333	458,333
TSL 6	800,000	1,600,000	2,400,000

Because a typical large manufacturer has significantly higher market shares and a greater number product lines, a large manufacturer would have higher conversion costs on an absolute basis than a typical small manufacturer. However, at every TSL, a typical small business manufacturer could be disproportionately impacted. To show how a much smaller manufacturing scale could harm small business manufacturers as compared to large manufacturers, DOE used the market share of a typical large manufacturer and a typical small manufacturer to estimate the annual revenue, EBIT, R&D expense, and capital expenditures for a typical large and typical small manufacturer. DOE then compared these costs to the required capital and product conversion costs at each TSL for a typical large and typical small manufacturer. Table VI.18 through Table VI.19 show these comparisons.

TABLE VI.18—COMPARISON OF A TYPICAL SMALL GAS HEARTH DIRECT HEATING EQUIPMENT MANUFACTURER'S CONVERSION COSTS TO ANNUAL EXPENSES, REVENUE, AND PROFIT

	Capital conversion cost as a percentage of annual capital expenditures (percent)	Product conversion cost as a percentage of annual R&D expense (percent)	Total conversion cost as a percentage of annual revenue (percent)	Total conversion cost as a percentage of annual EBIT (percent)
Baseline	....	....	....	–
TSL 1, 2, and 3	33.2	141.8	2.9	83.0
TSL 4 and 5	99.7	425.5	8.8	248.9
TSL 6	531.9	1,702.2	38.3	1,086.2

TABLE VI.19—COMPARISON OF A TYPICAL LARGE GAS HEARTH-TYPE DIRECT HEATING EQUIPMENT MANUFACTURER'S CONVERSION COSTS TO ANNUAL EXPENSES, REVENUE, AND PROFIT

	Capital conversion cost as a percentage of annual capital expenditures (percent)	Product conversion cost as a percentage of annual R&D expense (percent)	Total conversion cost as a percentage of annual revenue (percent)	Total conversion cost as a percentage of annual EBIT (percent)
Baseline	....	....	....	....
TSL 1, 2, and 3	3.2	13.5	0.3	7.9
TSL 4 and 5	7.9	33.8	0.7	19.8
TSL 6	50.7	162.1	3.6	103.4

DOE's product line analysis illustrates that small businesses have the potential to be differentially impacted by any amended energy conservation standard because the small businesses have a disproportionate number of product lines relative to their much smaller scale. For TSLs 4, 5 and 6, amended energy conservation standards could force a typical small business to hire additional engineers, discontinue product lines, or selectively upgrade more popular products with their present limited engineering and product development resources. Because the annual shipments of small manufacturers are several times lower than those of major manufacturers and small manufacturers typically only manufacture gas hearth DHE, small companies have less buying power than their larger competitors. The much larger production volumes of large manufacturers give them more leverage to negotiate lower prices with component and material suppliers. Because these conversion costs are more substantial relative to the size of a typical small business, large manufacturers could take additional market share from small manufacturers at TSL 4 through TSL 6. Because TSLs 4 and 5 require additional plant modifications, the added conversion costs make it more likely that small manufacturers could discontinue some of their least popular product lines at TSL 4 and TSL 5. At TSL 6, the substantial conversion costs could cause even a large manufacturer to potentially decide to offer fewer product lines, to bring down the significant product conversion costs. Consequently, it is increasingly likely that higher conversion costs could cause many small businesses to exit the market or become severely constrained with the number of product lines offered at TSLs 4, 5, and 6.

At TSLs 1 through 3, a typical small manufacturer would not face prohibitively large conversion costs to meet the amended energy conservation standards. At these TSLs, the amended energy conservation standards could be met with products that use electric ignition, which is not particularly capital intensive. These changes would also not require significant investments in product development costs by small businesses. The most substantial portion of the conversion costs at TSLs 1 through 3 would be testing, recertifying, and remarketing all the existing product lines that currently meet the baseline efficiencies. In addition, at TSL 1 through TSL 3, it is likely that small manufacturers would not discontinue a large number of product lines to lower product and capital conversion costs because these costs are not substantial. A typical small manufacturer has multiple product lines that meet and exceed the required efficiencies at TSL 3. Also, the proposed standard levels do not require manufacturers to substantially redesign product lines that fall below TSL 3.

DOE's analysis indicates that a typical small manufacturer of gas hearth DHE already offers multiple product lines that meet and exceed the required efficiencies at TSL 3, the proposed energy conservation standard. In addition, the proposed standard levels do not require substantial redesign to existing product lines that do not meet the proposed TSL 3. Because most of the product lines that do not meet the proposed TSL could be upgraded with relatively minor changes, DOE believes that manufacturers, including the small businesses, will be able to maintain a viable number of product offerings at the proposed standard level. DOE seeks comment on the potential impacts on the small gas hearth DHE manufacturers. (See Issue 24 under ''Issues on Which DOE Seeks Comment'' in section VII.E of this NOPR.)

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

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

f. Significant Alternatives to the Proposed Rule

The discussion above analyzes impacts on small businesses that would result from the other TSLs DOE considered. Though TSLs lower than the proposed TSLs are expected to reduce the impacts on small entities, DOE is required by EPCA to establish standards that achieve the maximum improvement in energy efficiency that are technically feasible and economically justified, and result in a significant conservation of energy. Thus DOE rejected the lower TSLs.

In addition to the other TSLs being considered, the NOPR TSD includes a regulatory impact analysis. For DHE, this report discusses the following policy alternatives: (1) No standard, (2) consumer rebates, (3) consumer tax credits, (4) manufacturer tax credits, and (5) early replacement. While these alternatives may mitigate the economic impacts on small entities compared to the proposed standards, the energy savings of these regulatory alternatives are at least four times smaller than those expected from the proposed standard levels. Thus, DOE rejected these alternatives and is proposing the standards set forth in this rulemaking.

DOE continues to seek input from businesses that would be affected by this rulemaking and will consider comments received in the development of any final rule.

C. Review Under the Paperwork Reduction Act of 1995

This rule contains a collection-of-information requirement subject to the Paperwork Reduction Act (PRA) which has been approved by OMB under control number 1910–1400. Public reporting burden for compliance reporting for energy and water conservation standards is estimated to average 30 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate, or any other aspect of this data collection, including suggestions for reducing the burden, to DOE (see **ADDRESSES**) and by e-mail to *Christine_J._Kymn@omb.eop.gov.*

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

DOE has prepared a draft environmental assessment (EA) of the impacts of the proposed rule, pursuant to the National Environmental Policy Act of 1969 (42 U.S.C. 4321 *et seq.*), the regulations of the Council on Environmental Quality (40 CFR parts 1500–1508), and DOE's regulations for compliance with the National Environmental Policy Act (10 CFR part 1021). This assessment includes an examination of the potential effects of emission reductions likely to result from the rule in the context of global climate change, as well as other types of environmental impacts. The draft EA has been incorporated into the TSD. Before issuing a final rule for the three type of heating products, DOE will consider public comments and, as appropriate, determine whether to issue a finding of no significant impact (FONSI) as part of a final EA or to prepare an environmental impact statement (EIS) for this rulemaking.

E. Review Under Executive Order 13132

Executive Order 13132, ''Federalism,'' 64 FR 43255 (August 4, 1999) imposes certain requirements on 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 today's proposed rule and has determined that it would not have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of today's 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(d)) 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'' (61 FR 4729 (Feb. 7, 1996)) imposes on Executive agencies the general duty to adhere to the following requirements: (1) Eliminate drafting errors and ambiguity; (2) write regulations to minimize litigation; and (3) provide a clear legal standard for affected conduct rather than a general standard and promote simplification and burden reduction. 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 (Pub. L. 104–4) (UMRA) requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. 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 of the rule on the national economy. (2 U.S.C. 1532(a),(b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a proposed ''significant intergovernmental mandate,'' and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect small governments. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA (62 FR 12820) (also available at *http://*

www.gc.doe.gov). Although today's proposed rule does not contain a Federal intergovernmental mandate, it may impose expenditures of $100 million or more on the private sector.

Today's proposed rule would likely result in a final rule that could impose expenditures of $100 million or more between 2013 and 2045 in the residential sector. Therefore, DOE must publish a written statement assessing the costs, benefits, and other effects of the rule on the national economy. Section 205 of UMRA also requires DOE to identify and consider a reasonable number of regulatory alternatives before promulgating a rule for which UMRA requires such a written statement. DOE must select from those alternatives the most cost-effective and least burdensome alternative that achieves the objectives of the rule, unless DOE publishes an explanation for doing otherwise or the selection of such an alternative is inconsistent with law.

As required by EPCA (42 U.S.C. 6295(o)), today's proposed energy conservation standards for the three types of heating products would achieve the maximum improvement in energy efficiency that DOE has determined to be both technologically feasible and economically justified. DOE may not select a regulatory alternative that does not meet this statutory standard. A full discussion of the alternatives considered by DOE is presented in the ''Regulatory Impact Analysis'' section of the TSD for this proposed rule. Also, section 202(c) of UMRA authorizes an agency to prepare the written statement required by UMRA in conjunction with or as part of any other statement or analysis that accompanies the proposed rule. (2 U.S.C. 1532(c)) The TSD, preamble, and regulatory impact analysis for today's proposed rule contain a full discussion of the rule's costs, benefits, and other effects on the national economy, and, therefore satisfy UMRA's written statement requirement.

H. Review Under the Treasury and General Government Appropriations Act, 1999

Section 654 of the Treasury and General Government Appropriations Act, 1999 (Pub. L. 105–277) requires Federal agencies to issue a Family Policymaking Assessment for any rule that may affect family well-being. This rule would not have any impact on the autonomy or integrity of the family as an institution. Accordingly, DOE has concluded that it is not necessary to prepare a Family Policymaking Assessment.

I. Review Under Executive Order 12630

DOE has determined under Executive Order 12630, ''Governmental Actions and Interference with Constitutionally Protected Property Rights,'' 53 FR 8859 (March 18, 1988), that this regulation would not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution.

J. Review Under the Treasury and General Government Appropriations Act, 2001

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516 note) provides for agencies to review most disseminations of information to the public under guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (Feb. 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). DOE has reviewed today's notice 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 today's regulatory action, which sets forth energy conservation standards for three types of heating products, 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. Therefore, DOE has not prepared a Statement of Energy Effects on the proposed rule.

L. Review Under the Information Quality Bulletin for Peer Review

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

In response to OMB's Bulletin, DOE conducted formal in-progress peer reviews of the energy conservation standards development process and analyses, and has prepared a Peer Review Report on the energy conservation standards rulemaking analyses. Generation of this report involved a rigorous, formal, and documented evaluation using objective criteria and qualified and independent reviewers to make a judgment as to the technical/scientific/business merit, the actual or anticipated results, and the productivity and management effectiveness of programs and/or projects. The ''Energy Conservation Standards Rulemaking Peer Review Report'' dated February 2007 has been disseminated and is available at the following Web site: *http://www1.eere.energy.gov/buildings/appliance_standards/peer_review.htm.*

VII. Public Participation

A. Public Meeting

The time, date and location of the public meeting are listed in the **DATES** and **ADDRESSES** sections at the beginning of this document. 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.

B. Procedure for Submitting Requests To Speak

Any person who has an interest in today's notice, or who is a representative of a group or class of persons that has an interest in these issues, may request an opportunity to make an oral presentation. Such persons may hand-deliver requests to speak, along with a computer diskette or CD in WordPerfect, Microsoft Word, PDF, or text (ASCII) file format, to the address shown in the **ADDRESSES** section at the beginning of this NOPR between the hours of 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays. Requests may also be sent by mail, or by e-mail to: *Brenda.Edwards@ee.doe.gov*.

Persons requesting an opportunity to speak should briefly describe the nature of their interest in this rulemaking and provide a telephone number for contact. 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. At its discretion, DOE may permit any person who cannot supply an advance copy of their statement to participate, if that person has made advance alternative arrangements with the Building Technologies Program. The request to give an oral presentation should ask for such alternative arrangements.

C. Conduct of 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 to prepare a transcript. DOE reserves the right to schedule the order of presentations and to establish the procedures governing the conduct of the public meeting. After the public meeting, interested parties may submit further comments on the proceedings as well as on any aspect of the rulemaking until the end of the comment period.

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

DOE will make the entire record of this proposed rulemaking, including the transcript from the public meeting, available for inspection at the U.S. Department of Energy, Resource Room of the Building Technologies Program, 950 L'Enfant Plaza, SW., Washington, DC 20024, (202) 586–2945, between 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays.

D. Submission of Comments

DOE will accept comments, data, and other information on the proposed rule before or after the public meeting, but no later than the date provided at the beginning of this NOPR. Comments, data, and other information submitted to DOE's e-mail address for this rulemaking should be provided in WordPerfect, Microsoft Word, PDF, or text (ASCII) file format. Interested parties should avoid the use of special characters or any form of encryption and, wherever possible, comments should carry the electronic signature of the author. Comments, data, and information submitted to DOE via mail or hand delivery/courier should include one signed original paper copy. No telefacsimiles (faxes) will be accepted.

According to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit two copies: one copy of the document including all the information believed to be confidential, and one copy of the document with the information believed to be confidential deleted. 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.

E. Issues on Which DOE Seeks Comment

DOE is particularly interested in receiving comments and views of interested parties concerning the following issues:

1. The max-tech efficiency levels identified for the analyses, including whether the efficiency levels identified by DOE can be achieved using the technologies screened-in during the screening analysis (see section IV.B), and whether higher efficiencies are achievable using technologies that were screened-in during the screening analysis.
2. The potential burdens to manufacturers of hearth-type DHE as a result of the testing, certification, reporting, and enforcement provisions.
3. EPCA's efficiency descriptor requirements in any potential test procedure revisions for electric pool heaters.
4. DOE's proposed definition for vented hearth heaters.
5. DOE's product classes for water heaters. In particular, DOE is seeking comment about the need for a separate product class for low-boy water heaters.
6. DOE's approach for analyzing ultra-low NO_X gas-fired storage water heaters and the need for a separate product class.
7. DOE's approach to developing the energy efficiency equations, the appropriate slope of energy efficiency equations at each efficiency level analyzed, and the appropriate storage volumes for changing the slope of the line. DOE is also interested in any alternatives to the energy efficiency equations that DOE should consider for the final rule.
8. The need for a separate product class for heat pump water heaters. Specifically, DOE is interested in receiving comments on whether a heat pump water heater can be used as a direct replacement for an electric resistance water heater, and the types and frequency of instances a heat pump water heater cannot be used as a direct

replacement for an electric resistance water heater.

9. DOE's proposed product classes for the four existing types of DHE.

10. DOE's proposed product class divisions for gas hearth DHE.

11. The manufacturability of heat pump water heaters and the capability of manufacturers to ramp up production of heat pump water heaters. Specifically, DOE is seeking comment on how long it would take and the magnitude of the costs for manufacturers to convert all product lines to heat pump water heaters if it were required by an amended energy conservation standard. In addition, DOE is seeking comment about the length of time required to retrain installers and servicers of water heaters for the installation and servicing of heat pump water heaters.

12. DOE's estimated manufacturer production costs for storage water heaters at storage volumes outside of the representative volume.

13. DOE's analysis of installation costs for water heaters. DOE is particularly interested in comments on its analysis of installation costs for heat pump water heaters.

14. DOE's analysis of repair and maintenance costs for heat pump water heaters.

15. DOE's approach for analyzing fuel switching that may result from the proposed standards on water heaters and the other heating products. In particular, DOE requests comments on its general approach, which does not involve price elasticities; its analysis of switching to gas-fired storage water heaters in the case of a standard that effectively requires an electric heat pump water heater; its conclusion that the proposed standards would not induce switching from a gas storage water heater to an electric storage water heater; and its conclusion that the proposed standards would not induce switching for gas-fired instantaneous water heaters, DHE, and pool heaters.

16. DOE's consideration of TSL 6 in the final rule for residential water heaters and the associated issues DOE has identified surrounding heat pump water heaters.

17. DOE's consideration of TSL 5 in the final rule for residential water heaters and the associated issues DOE has identified surrounding standards that effectively require different technologies for different subsets of products.

18. The appropriateness of TSL 4 for residential pool heaters in light of the negative life cycle costs for a majority of consumers. In addition, DOE's consideration of other TSLs, including TSL 3, as an alternative for the final standard level.

19. The impacts of the proposed amended energy conservation standards on small manufacturers of residential water heaters.

20. The impacts of the proposed amended energy conservation standards on small manufacturers of gas-fired residential pool heaters.

21. The impacts of the proposed amended energy conservation standards on small manufacturers of traditional DHE. DOE is interested in specific information regarding the potential for small manufacturers of traditional DHE to discontinue particular product lines as a result of the proposed standard, as well as the potential economic effect discontinuing those particular product lines would have on small manufacturers of traditional DHE.

22. Alternatives to the proposed amended energy conservation standards for traditional DHE. Specifically, DOE is interested in information regarding alternatives that could provide significant cost-savings for small manufacturers while meeting DOE's energy conservation goals.

23. DOE's characterization of typical small and large gas hearth DHE manufacturers.

24. The impacts of the proposed amended energy conservation standards on small manufacturers of gas hearth DHE.

VIII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of today's proposed rule.

List of Subjects in 10 CFR Part 430

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

Issued in Washington, DC, on November 23, 2009.

Cathy Zoi,

Assistant Secretary, Energy Efficiency and Renewable Energy.

For the reasons set forth in the preamble, DOE proposes to amend 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 for part 430 continues to read as follows:

Authority: 42 U.S.C. 6291–6309; 28 U.S.C. 2461 note.

2. In § 430.2, add the definitions ''Direct heating equipment'' and ''Vented hearth heater,'' in alphabetical order to read as follows:

§ 430.2 Definitions.

* * * * *

Direct heating equipment means vented home heating equipment and unvented home heating equipment.

* * * * *

Vented hearth heater means a vented, freestanding, recessed, zero clearance fireplace heater, a gas fireplace insert or a gas-stove, which simulates a solid fuel fireplace and is designed to furnish warm air, without ducts to the space in which it is installed.

* * * * *

3. In § 430.32 revised paragraphs (d), (i), (k) to read as follows:

§ 430.32 Energy and water conservation standards and their effective dates.

* * * * *

(d) *Water heaters.* The energy factor of water heaters shall not be less than the following for products manufactured on or after the indicated dates.

Product class	Energy factor as of January 20, 2004	Energy factor as of [INSERT DATE 5 YEARS AFTER DATE OF PUBLICATION OF THE FINAL RULE]
Gas-fired Water Heater	0.67 − (0.0019 × Rated Storage Volume in gallons).	For tanks with Rated Storage Volume at or below 60 gallons: 0.675 − (0.0012 × Rated Storage Volume in gallons); For tanks with Rated Storage Volume above 60 gallons: 0.717 − (0.0019 × Rated Storage Volume in gallons).
Oil-fired Water Heater	0.59 − (0.0019 × Rated Storage Volume in gallons).	0.68 − (0.0019 × Rated Storage Volume in gallons).
Electric Water Heater	0.97 − (0.00132 × Rated Storage Volume in gallons).	For tanks with Rated Storage Volume at or below 80 gallons: 0.96 − (0.0003 × Rated Storage Volume in gallons);

Product class	Energy factor as of (percent)January 20, 2004	Energy factor as of [INSERT DATE 5 YEARS AFTER DATE OF PUBLICATION OF THE FINAL RULE]
		For tanks with Rated Storage Volume above 80 gallons: 1.088 − (0.0019 × Rated Storage Volume in gallons).
Tabletop Water Heater	0.93 − (0.00132 × Rated Storage Volume in gallons).	0.93 − (0.00132 × Rated Storage Volume in gallons).
Instantaneous Gas-fired Water Heater.	0.62 − (0.0019 × Rated Storage Volume in gallons).	0.82 − (0.0019 × Rated Storage Volume in gallons).
Instantaneous Electric Water Heater.	0.93 − (0.00132 × Rated Storage Volume in gallons).	0.93 − (0.00132 × Rated Storage Volume in gallons).

Note: The Rated Storage Volume equals the water storage capacity of a water heater, in gallons, as specified by the manufacturer.

* * * * *

(i) *Direct heating equipment.* (1) Direct heating equipment manufactured on or after January 1, 1990 and before [INSERT DATE 3 YEARS AFTER DATE OF PUBLICATION OF THE FINAL RULE], shall have an annual fuel utilization efficiency no less than:

Product class	Annual fuel utilization efficiency, Jan. 1, 1990 (percent)
1. Gas wall fan type up to 42,000 Btu/h	73
2. Gas wall fan type over 42,000 Btu/h	74
3. Gas wall gravity type up to 10,000 Btu/h	59
4. Gas wall gravity type over 10,000 Btu/h up to 12, 000 Btu/h	60
5. Gas wall gravity type over 12,000 Btu/h up to 15,000 Btu/h	61
6. Gas wall gravity type over 15,000 Btu/h up to 19,000 Btu/h	62
7. Gas wall gravity type over 19,000 Btu/h and up to 27,000 Btu/h	63
8. Gas wall gravity type over 27,000 Btu/h and up to 46,000 Btu/h	64
9. Gas wall gravity type over 46,000 Btu/h	65
10. Gas floor up to 37,000 Btu/h	56
11. Gas floor over 37,000 Btu/h	57
12. Gas room up to 18,000 Btu/h	57
13. Gas room over 18,000 Btu/h up to 20,000 Btu/h	58
14. Gas room over 20,000 Btu/h up to 27,000 Btu/h	63
15. Gas room over 27,000 Btu/h up to 46,000 Btu/h	64
16. Gas room over 46,000 Btu/h	65

(2) Direct heating equipment manufactured on or after [INSERT DATE 3 YEARS AFTER DATE OF PUBLICATION OF THE FINAL RULE], shall have an annual fuel utilization efficiency no less than:

Product class	Annual fuel utilization efficiency, [INSERT DATE 3 YEARS AFTER DATE OF PUBLICATION OF THE FINAL RULE] (percent)
1. Gas wall fan type up to 42,000 Btu/h	76
2. Gas wall fan type over 42,000 Btu/h	77
3. Gas wall gravity type up to 27,000 Btu/h	70
4. Gas wall gravity type over 27,000 Btu/h up to 46,000 Btu/h	71
5. Gas wall gravity type over 46,000 Btu/h	72
6. Gas floor up to 37,000 Btu/h	57
7. Gas floor over 37,000 Btu/h	58
8. Gas room up to 20,000 Btu/h	62
9. Gas room over 20,000 Btu/h up to 27,000 Btu/h	67
10. Gas room over 27,000 Btu/h up to 46,000 Btu/h	68
11. Gas room over 46,000 Btu/h	69
12. Gas hearth up to 20,000 Btu/h	61
13. Gas hearth over 20,000 Btu/h and up to 27,000 Btu/h	66
14. Gas hearth over 27,000 Btu/h and up to 46,000 Btu/h	67
15. Gas hearth over 46,000 Btu/h	68

* * * * *

(k) *Pool heaters.* (1) Gas-fired pool heaters manufactured on or after January 1, 1990 and before [INSERT DATE 3 YEARS AFTER DATE OF PUBLICATION OF THE FINAL RULE], shall have a thermal efficiency not less than 78%.

(2) Gas-fired pool heaters manufactured on or after [INSERT DATE 3 YEARS AFTER DATE OF PUBLCIATION OF THE FINAL RULE], shall have a thermal efficiency not less than 84%.

* * * * *

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