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: Final rule.

SUMMARY: The U.S. Department of Energy (DOE) is amending the existing energy conservation standards for residential water heaters (other than tabletop and electric instantaneous models), gas-fired direct heating equipment, and gas-fired pool heaters. It has determined that the amended energy conservation standards for these products would result in significant conservation of energy, and are technologically feasible and economically justified.

DATES: The effective date of this rule is June 15, 2010. Compliance with the amended standards established for residential water heaters in today's final rule is required starting on April 16, 2015, and compliance with the standards established for DHE and pool heaters is required starting on April 16, 2013.

ADDRESSES: For access to the docket to read background documents, the technical support document, transcripts of the public meetings in this proceeding, or comments received, visit the U.S. Department of Energy, Resource Room of the Building Technologies Program, 950 L'Enfant Plaza, SW., 6th Floor, Washington, DC 20024, (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. You may also obtain copies of certain previous rulemaking documents in this proceeding (*i.e.,* framework document, notice of public meeting and announcement of a preliminary technical support document (TSD), notice of proposed rulemaking), draft analyses, public meeting materials, and related test procedure documents from the Office of Energy Efficiency and Renewable Energy's Web site at: *http://www1.eere.energy.gov/buildings/appliance_standards/residential/waterheaters.html.*

FOR FURTHER INFORMATION CONTACT: Mr. Mohammed Khan, U.S. Department of Energy, 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, U.S. Department of Energy, Office of the General Counsel, GC–71, 1000 Independence Avenue, SW., Washington, DC 20585–0121. *Telephone:* (202) 586–9507. E-mail: *Eric.Stas@hq.doe.gov*.

SUPPLEMENTARY INFORMATION:

Table of Contents

I. Summary of the Final Rule and Its Benefits

A. The Energy Conservation Standard Levels

The Energy Policy and Conservation Act, as amended (42 U.S.C. 6291 *et seq.;* EPCA or the Act), provides that any new or amended energy conservation standard the Department of Energy (DOE) prescribes for covered consumer products, including residential water heaters, direct heating equipment (DHE), and pool heaters (collectively referred to in this document as the "three heating products") must be designed to "achieve the maximum improvement in energy efficiency * * * which the Secretary [of Energy] 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)) The standards in today's final rule, which apply to certain types of the three heating products, satisfy these requirements.

Table I.1 shows the standard levels DOE is adopting today. These standards will apply to the types of the three heating products listed in the table and manufactured for sale in the United States, or imported into the United States, on or after April 16, 2015 in the case of water heaters, or on or after April 15, 2013 in the case of direct heating equipment and pool heaters.

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

Product class	Standard level	
Residential water heaters*		
Gas-fired Storage	For tanks with a Rated Storage Volume at or below 55 gallons: EF = 0.675 − (0.0015 × Rated Storage Volume in gallons).	For tanks with a Rated Storage Volume above 55 gallons: EF = 0.8012 − (0.00078 × Rated Storage Volume in gallons).
Electric Storage	For tanks with a Rated Storage Volume at or below 55 gallons: EF = 0.960 − (0.0003 × Rated Storage Volume in gallons).	For tanks with a Rated Storage Volume above 55 gallons: EF = 2.057 − (0.00113 × 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	Standard level
Direct heating equipment**	
Gas wall fan type up to 42,000 Btu/h	AFUE = 75%
Gas wall fan type over 42,000 Btu/h	AFUE = 76%
Gas wall gravity type up to 27,000 Btu/h	AFUE = 65%
Gas wall gravity type over 27,000 Btu/h up to 46,000 Btu/h	AFUE = 66%
Gas wall gravity type over 46,000 Btu/h	AFUE = 67%
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 = 61%
Gas room over 20,000 Btu/h up to 27,000 Btu/h	AFUE = 66%
Gas room over 27,000 Btu/h up to 46,000 Btu/h	AFUE = 67%
Gas room over 46,000 Btu/h	AFUE = 68%
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%

Product class	Standard level
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 = 82%

* 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."

B. Benefits and Costs to Purchasers of the Three Heating Products

1. Water Heaters

Table I.2 presents the implications of today's standards for consumers of residential water heaters. The economic impacts of the standards on consumers, as measured by the average life-cycle cost (LCC) savings, are positive, even though the standards may increase some initial costs. For example, a typical gas storage water heater has an average installed price of $1,079 and average lifetime operating costs (discounted) of $2,473. To meet the amended standards, DOE estimates that the average installed price of such equipment will increase by $120, which will be offset by savings of $143 in average lifetime operating costs (discounted).

TABLE I.2—IMPLICATIONS OF STANDARDS FOR PURCHASERS OF RESIDENTIAL WATER HEATERS

Product class	Energy conservation standard *EF**	Average baseline installed price** *$*	Average installed price increase *$*	Average life-cycle cost savings*** *$*	Median payback period *years*
Gas-Fired Storage Water Heater	0.62 (40 gallons)	$1,072	$92	$6	2.0
	0.76 (56 gallons)	1,261	805	77	9.8
	Weighted	1,079	120	18	2.3
Electric Storage Water Heater	0.95 (50 gallons)	554	140	10	6.9
	2.0 (56 gallons)	729	974	626	6.0
	Weighted	569	213	64	6.8
Oil-Fired Storage Water Heater	0.62 (32 gallons)	1,974	67	295	0.5
Gas-Fired Instantaneous Water Heater.	0.82 (0 gallons)	1,779	601	6	14.8

* The values are for the representative storage volumes (40 gallons for gas-fired storage water heaters, 50 gallons for electric storage water heaters, 32 gallons for oil-fired storage water heaters, and 0 gallons for gas-fired instantaneous water heaters). The standard level is represented by an energy-efficiency equation, which specifies an EF level over the entire storage volume range.
** For a baseline model.
*** The average life-cycle cost savings refers to the average savings in the discounted life-cycle costs of owning and operating the product due to the standard. This value represents the net benefit (or cost) of a more-efficient product after considering both the increased installed price and the lifetime operating cost savings.

2. Direct Heating Equipment

Table I.3 presents the implications of today's standards for consumers of direct heating equipment. The economic impacts of the standards on consumers, as measured by the average LCC savings, are positive, even though the standards may increase some initial costs. For example, a typical gas wall fan DHE has an average installed price of $1,832 and average lifetime operating costs (discounted) of $5,544. To meet the amended standards, DOE estimates that the average installed price of such equipment will increase by $81, which will be more than offset by savings of $249 in average lifetime operating costs (discounted).

TABLE I.3—IMPLICATIONS OF STANDARDS FOR PURCHASERS OF DIRECT HEATING EQUIPMENT AT THE REPRESENTATIVE RATED INPUT CAPACITY RANGE

Product class	Energy conservation standard* *AFUE (%)*	Average baseline installed price** *$*	Average installed price increase *$*	Average life-cycle cost savings*** *$*	Median payback period *Years*
Gas Wall Fan	76	$1,832	$81	$102	3.2
Gas Wall Gravity	66	1,433	61	21	7.5
Gas Floor	58	2,209	54	13	10.7
Gas Room	67	1,208	83	60	4.5
Gas Hearth	67	1,603	82	112	0.0

* The values are for the representative input capacity ranges (>42,000 Btu/h for wall fan, >27,000 Btu/h and ≤46,000 Btu/h for wall gravity, >37,000 Btu/h for floor, >27,000 Btu/h and ≤46,000 Btu/h for room, and >27,000 Btu/h and ≤46,000 Btu/h for hearth). The standard levels vary by input capacity range.
** For a baseline model.
*** The average life-cycle cost savings refers to the average savings in the discounted life-cycle costs of owning and operating the product due to the standard. This value represents the net benefit (or cost) of a more-efficient product after considering both the increased installed price and the lifetime operating cost savings.

3. Pool Heaters

Table I.4 presents the implications of today's standards for consumers of pool heaters. The economic impacts of the standards on consumers, as measured by the average LCC savings, are positive, even though the standards may increase some initial costs. For example, a typical pool heater has an average installed price of $3,240 and average lifetime operating costs (discounted) of $5,099. To meet the amended standards, DOE estimates that the average installed price of such equipment will increase by $103, which will be offset by savings of $226 in average lifetime operating costs (discounted).

TABLE I.4—IMPLICATIONS OF STANDARDS FOR PURCHASERS OF POOL HEATERS AT 250,000 Btu/h

Product class	Energy conservation standard* *Thermal Efficiency (%)*	Average baseline installed price** *$*	Average installed price increase *$*	Average life-cycle cost savings*** *$*	Median payback period *Years*
Gas-fired	82	$3,240	$103	$22	8.6

* The values are for the representative input capacity of 250,000 Btu/h.
** For a baseline model.
*** The average life-cycle cost savings refers to the average savings in the discounted life-cycle costs of owning and operating the product due to the standard. This value represents the net benefit (or cost) of a more-efficient product after considering both the increased installed price and the lifetime operating cost savings.

C. Impact on Manufacturers

1. Water Heaters

Using a real corporate discount rate of 8.9 percent for gas-fired and electric storage water heaters, 7.6 percent for oil-fired storage water heaters, and 9.5 percent for gas-fired instantaneous water heaters, which DOE calculated by examining the financial statements of residential water heater manufacturers, DOE estimates the industry net present value (INPV) of the manufacturing industry to be $880 million for gas-fired and electric storage water heaters, $9 million for oil-fired storage water heaters, and $648 million for gas-fired instantaneous water heaters (all figures in 2009$). DOE expects the impact of the standards on the INPV of manufacturers of gas-fired and electric storage water heaters to range from a loss of 2.9 percent to a loss of 13.9 percent (a loss of $25.9 million to a loss of $122.6 million). DOE expects the impact of the standards on the INPV of manufacturers of oil-fired storage water heaters to range from a loss of 2.0 percent to a loss of 4.2 percent (a loss of $0.2 million to a loss of $0.4 million). DOE expects the impact of the standards on the INPV of manufacturers of gas-fired instantaneous water heaters to range from an increase of 0.4 percent to a loss of 0.2 percent (an increase of $2.3 million to a loss of $1.2 million). Based on DOE's interviews with the major manufacturers of residential water heaters, DOE expects minimal plant closings or loss of employment as a result of the standards. At the amended standard level, DOE does not expect significant impacts on competition in the overall water heater market. For gas-fired and electric storage water heaters, DOE believes there are primarily three major manufacturers who have established market positions. In addition, DOE believes there is another major appliance manufacturer with significant resources that has recently announced intentions to scale its efforts in the water heating market. For oil-fired storage water heaters and gas-fired instantaneous water heaters, DOE believes the standards-case market can at least sustain the base-case level of competition.

2. Direct Heating Equipment

Using a real corporate discount rate of 8.5 percent, which DOE calculated by examining the financial statements of direct heating equipment manufacturers, DOE estimates the INPV of the manufacturing industry to be $17 million for traditional direct heating equipment and $77 million for hearth direct heating equipment (both figures in 2009$). DOE expects the impact of the standards on the INPV of manufacturers of traditional direct heating equipment to range from a loss of 7.2 percent to a loss of 23.6 percent (a loss of $1.2 million to a loss of $3.9 million). DOE expects the impact of the standards on the INPV of manufacturers of hearth direct heating equipment to range from a loss of 0.3 percent to a loss of 1.2 percent (a loss of $0.2 million to a loss of $0.9 million). Based on DOE's interviews with the major manufacturers of both traditional and hearth direct heating equipment, DOE expects minimal plant closings or loss of employment as a result of the standards. DOE believes the impact of the amended standards on competition in the traditional and hearth DHE market will not be significant because small manufacturers will be able to upgrade enough product lines to meet the standard, which in combination with product lines that currently meet the standard, will enable them to remain viable competitors.

3. Pool Heaters

Using a real corporate discount rate of 7.4 percent, which DOE calculated by examining the financial statements of pool heater manufacturers, DOE estimates the INPV of the manufacturing industry to be $49 million for gas-fired pool heaters (figures in 2009$). DOE expects the impact of the standards on the INPV of manufacturers of gas-fired pool heaters to range from an increase of 0.5 percent to a loss of 1.7 percent (an increase of $0.3 million to a loss of $0.8 million). Based on DOE's interviews with the major manufacturers of pool heaters, DOE expects minimal plant closings or loss of employment as a result of the standards. DOE does not believe there will be any lessening of competition in the pool heater market as a result of the standards established by today's final rule, because all of the manufacturers already offer at least one product line that meets or exceeds the standard level promulgated by today's final rule.

D. National Benefits

DOE estimates the standards will save approximately 2.81 quads (quadrillion or 10^{15}) British thermal units (Btu) of energy over a 30-year period: 2.58 quads for residential water heaters during 2015–2045, and 0.21 and 0.02 quads for DHE and pool heaters, respectively, during 2013–2043. The total of 2.81 quads is equivalent to all the energy consumed by nearly 15 million American households in a single year. By 2045, DOE expects the energy savings from today's standards to eliminate the need for approximately three new 250 MW power plants.

These energy savings will result in cumulative greenhouse gas emission reductions of approximately 164 million tons (Mt) of carbon dioxide (CO_2), or an amount equal to that produced by approximately 46 million cars every year. Additionally, the standards will help alleviate air pollution by resulting in cumulative emissions reductions of approximately 125 kilotons (kt) for nitrogen oxides (NO_X) and 0.54 tons for power plant mercury (Hg).

The estimated monetary value of the cumulative CO_2 emissions reductions, based on a range of values from a recent interagency process, is $560 to $8,725 million. The estimated monetary value of the cumulative CO_2 emissions reductions, based on the central value from the interagency process, is $2,861 million. The estimated net present monetary value of the other emissions reductions (discounted to 2010 using a 7-percent discount rate and expressed in 2009$) is $12.2 to 125 million for NO_X. At a 3-percent discount rate, the estimated net present value of these emissions reductions is $27.2 to 284 million for NO_X.

The national NPV of consumer benefit of today's standards is $1.98 billion using a 7-percent discount rate and $10.11 billion using a 3-percent discount rate, cumulative from 2013 to 2043 for DHE and pool heaters, and from 2015 to 2045 for water heaters, in 2009$. This is the estimated present value of future operating cost savings minus the estimated increased costs of purchasing and installing the three types of heating products, discounted to 2010.

The benefits and costs of today's rule can also be expressed in terms of annualized values from 2013 to 2043 for DHE and pool heaters, and from 2015 to 2045 for water heaters. Estimates of annualized values for the three types of heating products are shown in Table I.5, Table I.6, and Table I.7. The annualized monetary benefits are the sum of the annualized national economic value of operating cost savings (energy, maintenance, and repair), expressed in 2009$, plus the monetary value of the benefits of CO_2 and NO_X emission reductions. For the value of CO_2 emission reductions, DOE uses the global Social Cost of Carbon (SCC) calculated using the average value derived using a 3-percent discount rate (equivalent to $21.40 per metric ton of CO_2 emitted in 2010, in 2007$). This value is a central value from a recent interagency process. The derivation of this value is discussed in section IV.M. The monetary benefits of cumulative emissions reductions are reported in 2009$ so that they can be compared with the other costs and benefits in the same dollar units.

Although the above consideration of benefits provides a valuable perspective, please note the following: (1) The national operating cost savings are domestic U.S. consumer monetary savings found in market transactions, while the value of CO_2 reductions is based on a global value. Also, note that the central value is only one of four SCC developed by the interagency workgroup. Other marginal SCC values for 2010 are $4.70, $35.10, and $64.90 per metric ton (2007$ for emissions in 2010), which reflect different discount rates and, for the highest value, the possibility of higher-than-expected impacts further out in the tails of the SCC distribution. (2) The assessments of operating cost savings and CO_2 savings are performed with different computer models, leading to different time frames for analysis. The national operating cost savings is measured for the lifetime of heating products shipped in the period 2013–2043 (for DHE and pool heaters) or 2015–2045 (for water heaters). The value of CO_2, on the other hand, reflects the present value of all future climate-related impacts (out to 2300) due to emitting a ton of carbon dioxide in each year of the forecast period.

Using a 7-percent discount rate and the central SCC value, the combined cost of the standards adopted in today's final rule for heating products is $1,285 million per year in increased equipment and installation costs, while the annualized benefits are $1,500 million per year in reduced equipment operating costs, $169 million in CO_2 reductions, and $7.7 million in reduced NO_X emissions. At a 7-percent discount rate, the net benefit amounts to $391 million per year. Using a 3-percent discount rate and the central SCC value, the cost of the standards adopted in today's rule is $1,249 million per year in increased equipment and installation costs, while the benefits of today's standards are $1,843 million per year in reduced operating costs, $169 million in CO_2 reductions, and $9.2 million in reduced NO_X emissions. At a 3-percent discount rate, the net benefit amounts to $771 million per year.

TABLE I.5—ANNUALIZED BENEFITS AND COSTS FOR WATER HEATERS (TSL 5)

Category	Primary estimate (AEO reference case)	Low estimate (low energy price case)	High estimate (high energy price case)	Units		
				Year dollars	Disc. rate	Period covered (2015–2045)
Benefits						
Energy Annualized Monetized (millions$/year).	1407.0	1275.5	1537.5	2009	7%	30
	1729.6	1556.1	1902.9	2009	3%	30
CO_2 Monetized Value (at $4.7/Metric Ton, millions$/year)*.	43.5	43.5	43.5	2009	5%	30
CO_2 Monetized Value (at $21.4/Metric Ton, millions$/year)*.	158.6	158.6	158.6	2009	3%	30
CO_2 Monetized Value (at $35.1/Metric Ton, millions$/year)*.	245.7	245.7	245.7	2009	2.5%	30
CO_2 Monetized Value (at $64.9/Metric Ton, millions$/year)*.	483.8	483.8	483.8	2009	3%	30
NO_x Monetized Value (at $2,437/Metric Ton, millions$/year).	7.0	7.0	7.0	2009	7%	30
	8.5	8.5	8.5	2009	3%	30
Total Monetary Benefits (millions$/year)**.	1457.5–1897.8	1326–1766.3	1588–2028.3	2009	7% range	30
	1572.7	1441.1	1703.2	2009	7%	....
	1896.7	1723.2	2070.0	2009	3%	....

TABLE I.5—ANNUALIZED BENEFITS AND COSTS FOR WATER HEATERS (TSL 5)—Continued

Category	Primary estimate (AEO reference case)	Low estimate (low energy price case)	High estimate (high energy price case)	Units		
				Year dollars	Disc. rate	Period covered (2015–2045)
	1781.5–2221.8	1608–2048.3	1954.9–2395.2	2009	3% range	30
Costs						
Annualized Monetized (millions$/year).	1250.3	1184.5	1321.6	2009	7%	30
	1216.6	1145.7	1295.6	2009	3%	30
Net Benefits/Costs						
Annualized Monetized, including CO_2 Benefits (million$/year)**.	207.2–647.5	141.5–581.8	266.4–706.7	2009	7% range	30
	322.4	256.6	381.5	2009	7%	30
	680.1	577.5	774.4	2009	3%	30
	565–1005.3	462.3–902.6	659.3–1099.6	2009	3% range	30

* These values represent global values (in 2009$) of the social cost of CO_2 emissions in 2010 under several scenarios. The values of $4.7, $21.4, and $35.1 per ton are the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The value of $64.9 per ton represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. *See* section IV.M for details.

** Total Monetary Benefits for both the 3% and 7% cases utilize the central estimate of social cost of CO_2 emissions calculated at a 3% discount rate (averaged across three Integrated Assessment Models (IAMs)), which is equal to $21.4/ton in 2010 (in 2009$). The rows labeled as "7% Range" and "3% Range" calculate consumer and NO_X cases with the labeled discount rate but add these values to the full range of CO_2 values with the $4.7/ton value at the low end, and the $64.9/ton value at the high end.

TABLE I.6—ANNUALIZED BENEFITS AND COSTS FOR DIRECT HEATING EQUIPMENT

[TSL 2]

Category	Primary estimate (AEO reference case)	Low estimate (low energy price case)	High estimate (high energy price case)	Units		
				Year dollars	Disc. rate	Period covered (2013–2043)
Benefits						
Energy Annualized Monetized (millions$/year).	82.2	78.8	84.6	2009	7%	30
	100.6	96.3	103.6	2009	3%	30
CO_2 Monetized Value (at $4.7/Metric Ton, millions$/year)*.	2.5	2.5	2.5	2009	5%	30
CO_2 Monetized Value (at $21.4/Metric Ton, millions$/year)*.	9.2	9.2	9.2	2009	3%	30
CO_2 Monetized Value (at $35.1/Metric Ton, millions$/year)*.	14.3	14.3	14.3	2009	2.5%	30
CO_2 Monetized Value (at $64.9/Metric Ton, millions$/year)*.	28.1	28.1	28.1	2009	3%	30
NO_X Monetized Value (at $2,437/Metric Ton, millions$/year).	0.6	0.6	0.6	2009	7%	30
	0.6	0.6	0.6	2009	3%	30
Total Monetary Benefits (millions$/year)**.	85.2–110.8	81.8–107.4	87.7–113.2	2009	7% range	30
	91.9	88.5	94.4	2009	7%	....
	110.4	106.2	113.4	2009	3%	....
	103.7–129.3	99.5–125	106.7–132.3	2009	3% range	30
Costs						
Annualized Monetized (millions$/year).	27.7	27.7	27.7	2009	7%	30
	26.0	26.0	26.0	2009	3%	30
Net Benefits/Costs						
Annualized Monetized, including CO_2 Benefits (millions$/year)**.	57.6–83.1	54.1–79.7	60–85.6	2009	7% range	30
	64.3	60.8	66.7	2009	7%	30
	84.4	80.1	87.4	2009	3%	30

TABLE I.6—ANNUALIZED BENEFITS AND COSTS FOR DIRECT HEATING EQUIPMENT—Continued

[TSL 2]

Category	Primary estimate (AEO reference case)	Low estimate (low energy price case)	High estimate (high energy price case)	Units		
				Year dollars	Disc. rate	Period covered (2013–2043)
	77.7–103.2	73.4–99	80.7–106.3	2009	3% range	30

* These values represent global values (in 2009$) of the social cost of CO_2 emissions in 2010 under several scenarios. The values of $4.7, $21.4, and $35.1 per ton are the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The value of $64.9 per ton represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. *See* section IV.M for details.

** Total Monetary Benefits for both the 3% and 7% cases utilize the central estimate of social cost of CO_2 emissions calculated at a 3% discount rate (averaged across three IAMs), which is equal to $21.4/ton in 2010 (in 2009$). The rows labeled as "7% Range" and "3% Range" calculate consumer and NO_X cases with the labeled discount rate but add these values to the full range of CO_2 values with the $4.7/ton value at the low end, and the $64.9/ton value at the high end.

TABLE I.7—ANNUALIZED BENEFITS AND COSTS FOR POOL HEATERS

[TSL 2]

Category	Primary estimate (AEO reference case)	Low estimate (low energy price case)	High estimate (high energy price case)	Units		
				Year dollars	Disc. rate	Period covered (2013–2043)
Benefits						
Energy Annualized Monetized (millions$/year).	10.6	10.1	10.9	2009	7%	30
	12.5	12.0	12.9	2009	3%	30
CO_2 Monetized Value (at $4.7/Metric Ton, millions$/year)*.	0.2	0.2	0.2	2009	5%	30
CO_2 Monetized Value (at $21.4/Metric Ton, millions$/year)*.	0.8	0.8	0.8	2009	3%	30
CO_2 Monetized Value (at $35.1/Metric Ton, millions$/year)*.	1.3	1.3	1.3	2009	2.5%	30
CO_2 Monetized Value (at $64.9/Metric Ton, millions$/year)*.	2.4	2.4	2.4	2009	3%	30
NO_X Monetized Value (at $2,437/Metric Ton, millions$/year).	0.1	0.1	0.1	2009	7%	30
	0.1	0.1	0.1	2009	3%	30
Total Monetary Benefits (millions$/year)**.	10.8–13	10.4–12.6	11.1–13.3	2009	7% range	30
	11.4	11.0	11.7	2009	7%	....
	13.4	12.8	13.7	2009	3%	....
	12.8–15	12.3–14.4	13.2–15.3	2009	3% range	30
Costs						
Annualized Monetized (millions$/year).	6.9	6.9	6.9	2009	7%	30
	6.7	6.7	6.7	2009	3%	30
Net Benefits/Costs						
Annualized Monetized, including CO_2 Benefits (millions$/year)**.	3.9–6.1	3.4–5.6	4.2–6.4	2009	7% range	30
	4.5	4.0	4.8	2009	7%	30
	6.7	6.2	7.1	2009	3%	30
	6.1–8.3	5.6–7.8	6.5–8.7	2009	3% range	30

* These values represent global values (in 2009$) of the social cost of CO_2 emissions in 2010 under several scenarios. The values of $4.7, $21.4, and $35.1 per ton are the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The value of $64.9 per ton represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. *See* section IV.M for details.

** Total Monetary Benefits for both the 3% and 7% cases utilize the central estimate of social cost of CO_2 emissions calculated at a 3% discount rate (averaged across three IAMs), which is equal to $21.4/ton in 2010 (in 2009$). The rows labeled as "7% Range" and "3% Range" calculate consumer and NO_X cases with the labeled discount rate but add these values to the full range of CO_2 values with the $4.7/ton value at the low end, and the $64.9/ton value at the high end.

TABLE I.8—SUM OF ANNUALIZED BENEFITS AND COSTS FOR HEATING PRODUCTS STANDARDS

Category	Primary estimate (AEO reference case)	Low estimate (low energy price case)	High estimate (high energy price case)	Units		
				Year dollars	Disc. rate	Period covered
Benefits						
Energy Annualized Monetized (millions$/year).	1499.8	1364.4	1633.0	2009	7%	30
	1842.7	1664.4	2019.4	2009	3%	30
CO_2 Monetized Value (at $4.7/Metric Ton, millions$/year)*.	46.2	46.2	46.2	2009	5%	30
CO_2 Monetized Value (at $21.4/Metric Ton, millions$/year)*.	168.6	168.6	168.6	2009	3%	30
CO_2 Monetized Value (at $35.1/Metric Ton, millions$/year)*.	261.3	261.3	261.3	2009	2.5%	30
CO_2 Monetized Value (at $64.9/Metric Ton, millions$/year)*.	514.2	514.2	514.2	2009	3%	30
NO_X Monetized Value (at $2,437/Metric Ton, millions$/year).	7.6	7.6	7.6	2009	7%	30
	9.2	9.2	9.2	2009	3%	30
Total Monetary Benefits (millions$/year)**.	1553.5–2021.6	1418.2–1886.3	1686.8–2154.8	2009	7% range	30
	1676.0	1540.6	1809.2	2009	7%	....
	2020.5	1842.2	2197.2	2009	3%	....
	1898–2366.1	1719.8–2187.7	2074.8–2542.8	2009	3% range	30
Costs						
Annualized Monetized .... (millions$/year)	1284.9	1219.1	1356.3	2009	7%	30
	1249.3	1178.4	1328.3	2009	3%	30
Annualized Monetized, including CO_2 Benefits (millions$/year)**.	268.7–736.7	199–667.1	330.6–798.7	2009	7% range	30
	391.1	321.5	453.0	2009	7%	30
	771.2	663.8	868.9	2009	3%	30
	648.8–1116.8	541.3–1009.4	746.5–1214.6	2009	3% range	30

* These values represent global values (in 2009$) of the social cost of CO_2 emissions in 2010 under several scenarios. The values of $4.7, $21.4, and $35.1 per ton are the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The value of $64.9 per ton represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. *See* section IV.M for details.

** Total Monetary Benefits for both the 3% and 7% cases utilize the central estimate of social cost of CO_2 emissions calculated at a 3% discount rate (averaged across three IAMs), which is equal to $21.4/ton in 2010 (in 2009$). The rows labeled as "7% Range" and "3% Range" calculate consumer and NO_X cases with the labeled discount rate but add these values to the full range of CO_2 values with the $4.7/ton value at the low end, and the $64.9/ton value at the high end.

E. Conclusion

Based upon the analysis culminating in this final rule, DOE has concluded that the benefits (energy savings, consumer LCC savings, positive national NPV, and emissions reductions) to the Nation of today's amended standards outweigh their costs (a potential loss of manufacturer INPV and consumer LCC increases for some users of the three heating products). Table 1.9 below summarizes total annualized monetized benefits and costs for these energy conservation standards. Today's standards also represent the maximum improvement in energy efficiency that is technologically feasible and economically justified, and will result in significant energy savings for all three types of the heating products. At present, residential water heaters, DHE, and pool heaters that meet the new standard levels are either commercially available or available as prototypes.

TABLE I.9—SUMMARY ANNUALIZED MONETIZED BENEFITS AND COSTS

Category	($million/year)	Discount rate
Benefits*		
	1676.0	7%
	2020.5	3%
Costs		
	1284.9	7%
	1249.3	3%
Net Benefits/Costs*		
	391.1	7%
	771.2	3%

*Annualized Monetized, including monetized CO_2 and NO_X benefits.

II. Introduction

A. 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) provides for the Energy Conservation Program for Consumer Products Other Than Automobiles. The program covers consumer products and certain commercial products (all of which are referred to hereafter as "covered products"), including the three heating products that are the subject of this rulemaking. (42 U.S.C. 6292(a)(4), (9), (11)) DOE publishes today's final rule pursuant to Part A of Title III, which also provides for test procedures, labeling, and energy conservation standards for the three heating products and certain other types of products, and authorizes DOE to require information and reports from manufacturers. The test procedures for water heaters, vented DHE, and pool heaters appear at Title 10 of the Code of Federal Regulations (CFR) part 430, subpart B, appendices E, O, and P, respectively.

EPCA prescribes specific 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)) 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. The notice of proposed rulemaking (NOPR) in this proceeding (the December 2009 NOPR; 74 FR 65852, 65858–59, 65866 (Dec. 11, 2009), and section II.B.2 below, provide additional detail on the nature and statutory history of the requirements for the three types of heating products.

EPCA also provides criteria for prescribing amended standards for covered products generally, including the three heating products. As indicated above, any such amended standard must be designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) Additionally, EPCA provides specific prohibitions on prescribing such standards. DOE may not prescribe an amended standard for any of the three heating products for which it has not established a test procedure. (42 U.S.C. 6295(o)(3)(A)) Further, DOE may not prescribe a standard if DOE determines by rule that such standard would not result in "significant conservation of energy," or "is not technologically feasible or economically justified." (42 U.S.C. 6295(o)(3)(B))

EPCA also provides that in deciding whether a standard is economically justified for covered products, 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, 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 of Energy (Secretary) considers relevant. (42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII))

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

EPCA also contains what is commonly known as an "anti-backsliding" provision. (42 U.S.C. 6295(o)(1)) This provision mandates that the Secretary not prescribe any amended standard that either increases the maximum allowable energy use or decreases the minimum required energy efficiency of a covered product. EPCA further provides that the Secretary may not prescribe an 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 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 at the time of the Secretary's finding. (42 U.S.C. 6295(o)(4))

Under 42 U.S.C. 6295(q)(1), EPCA specifies requirements applicable to promulgating standards for any type or class of covered product that has two or more subcategories. Under this provision, DOE must specify a different standard level than that which applies generally to such type or class of product for any group of 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 such 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 DOE established such higher or lower level. (42 U.S.C. 6295(q)(2))

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 DOE is adopting today's final rule before July 2010, this requirement does not apply in this rulemaking, and DOE has not specifically addressed standby mode or off mode energy use here. DOE is currently working on a test procedure rulemaking to address the measurement of standby mode and off

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

mode energy consumption for the three types of heating products that are the subject of this rulemaking.

Finally, Federal energy conservation requirements for covered products generally supersede State laws or regulations concerning energy conservation testing, labeling, and standards. (42 U.S.C. 6297(a)–(c)) DOE can, however, 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))

B. Background

1. Current Standards

On January 17, 2001, DOE published a final rule prescribing the current Federal energy conservation standards for residential water heaters manufactured on or after January 20, 2004, which set minimum energy factors (EFs) 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. 66 FR 4474; 10 CFR 430.32(d). EPCA prescribes the Federal energy conservation standards for DHE and pool heaters. For DHE, these consist of minimum annual fuel utilization efficiency (AFUE) levels, each of which applies to a type of unit (*i.e.,* wall fan, wall gravity, floor, or room) and heating capacity range. (42 U.S.C. 6295(e)(3)); 10 CFR 430.32(i). For pool heaters, the Federal energy conservation standard prescribed by EPCA includes a single minimum thermal efficiency level. (42 U.S.C. 6295(e)(2)); 10 CFR 430.32(k).

Table II.1, Table II.2, and Table II.3 present the current Federal energy conservation standards for residential water heaters, DHE, and pool heaters, respectively. The water heater standards, set forth in 10 CFR 430.32(d), consist of minimum energy factors (EF) that vary based on the rated 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. The DHE standards, set forth in 42 U.S.C. 6295(e)(3) and 10 CFR 430.32(i), consist of minimum annual fuel utilization efficiency (AFUE) levels, each of which applies to a particular type of gas-fired product (*i.e.,* wall fan, wall gravity, floor, room) and input heating capacity range. (Although electric DHE are available, no Federal energy conservation standards exist for these products, and today's final rule contains no such standards. For a more detailed discussion of DHE coverage under EPCA, *see* 74 FR 65852, 65866 (Dec. 11, 2009) (the December 2009 NOPR)). The pool heater standards, set forth at 42 U.S.C. 6295(e)(2) and 10 CFR 430.32(k), consist of a thermal efficiency level. (Similar to the situation with DHE, this standard applies only to gas-fired products. Although electric pool heaters are available, no Federal energy conservation standards currently exist for other pool heaters, and today's final rule contains no such standard. For a more detailed discussion of pool heater coverage, *see* 74 FR 65852, 65866–67 (Dec. 11, 2009).)

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

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

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

TABLE II.3—CURRENT FEDERAL ENERGY CONSERVATION STANDARDS FOR POOL HEATERS

Product class	Thermal efficiency as of January 1, 1990
Gas-Fired Pool Heater	Thermal Efficiency = 78%

2. History of Standards Rulemaking for the Three Heating Products

Prior to being amended in 1987, EPCA included water heaters and home heating equipment as covered products. The amendments to EPCA effected by the National Appliance Energy Conservation Act of 1987 (NAECA; Pub. L. 100–12) included replacing the term "home heating equipment" with "direct heating equipment," adding pool heaters as a covered product, establishing standards for the three heating products, 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 commenced 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 framework document public meeting on January 16, 2009.

On January 5, 2009, having considered these comments, gathered additional information, and performed preliminary analyses as to standards for the three heating products, DOE announced an informal public meeting and the availability on its Web site of a preliminary technical support document (preliminary TSD). 74 FR 1643 (Jan. 13, 2009). The preliminary TSD is available at: *http://www1.eere.energy.gov/buildings/appliance_standards/residential/water_pool_heaters_prelim_tsd.html.* The preliminary TSD discussed the comments DOE had received at the framework stage of this rulemaking and described the actions DOE had taken, the analytical framework DOE was using, and the content and results of DOE's preliminary analyses. *Id.* at 1644, 1645. DOE convened the public meeting to discuss and receive comments on: (1) These subjects, (2) DOE's proposed product classes, (3) potential standard levels that DOE might consider, and (4) other issues participants believed were relevant to the rulemaking. *Id.* at 1643, 1646. DOE also invited written comments on these matters. The public meeting took place on February 9, 2009. Many interested parties participated, and submitted written comments during the comment period.

On December 11, 2009, DOE published a NOPR to consider amending the existing residential water heater, direct heating equipment, and pool heater energy conservation standards. 74 FR 65852. Shortly after, DOE also published on its Web site the complete TSD for the proposed rule, which incorporated the completed analyses DOE conducted and technical documentation for each analysis. The TSD included the LCC spreadsheet, the national impact analysis spreadsheet, and the manufacturer impact analysis (MIA) spreadsheet—all of which are available at: *http://www1.eere.energy.gov/buildings/appliance_standards/residential/water_pool_heaters_nopr.html.* In the December 2009 NOPR, DOE proposed amended energy conservation standards for the three heating products as follows:

TABLE II.4—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).	

Direct Heating Equipment**

Product Class	Proposed Standard Level
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

Product Class	Proposed Standard Level
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."

In the December 2009 NOPR, DOE identified 24 specific issues on which it was particularly interested in receiving the comments and views of interested parties. 74 FR 65852, 65994–95 (Dec. 11, 2009). In addition, DOE also specifically requested comments and data that would allow DOE to further bring clarity to the issues surrounding heat pump water heaters and condensing water heaters, and determine how the issues discussed in the December 2009 NOPR 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. 74 FR 65852, 65966–67 (Dec. 11, 2009). DOE also held a public meeting in Washington, DC, on January 7, 2010, to hear oral comments on and solicit information on the issues just mentioned and any other matters relevant to the proposed rule. Finally, DOE received many written comments on these and other issues in response to the December 2009 NOPR, which are further presented and addressed throughout today's notice. The December 2009 NOPR included additional, detailed background information on the history of this rulemaking. *See* 74 FR at 65852, 65859–60 (Dec. 11, 2009).

III. General Discussion

A. Test Procedures

As noted above, DOE's test procedures for residential water heaters, vented DHE, and pool heaters are set forth at 10 CFR part 430, subpart B, appendices E, O, and P, respectively. These test procedures are currently used to determine whether the three heating products comply with applicable energy conservation standards and as a basis for manufacturers' representations as to the energy efficiency of these products.

During this rulemaking, interested parties have asserted that the residential water heater test procedure does not: (1) Reflect actual use of these water heaters by consumers; (2) permit accurate (*i.e.,* consistent and repeatable) measurement of the efficiencies of electric resistance water heaters that have an EF of 0.95 EF and above; or (3) include all of the cost-effective efficiency measures available for water heaters. 74 FR 65852, 65860–61 (Dec. 11, 2009).

As to the first point, DOE believes the test procedure does reflect actual use of water heaters. It employs a hot water draw model, and data that incorporate correction factors that account for actual use of water heaters in U.S. homes. 74 FR 65852, 65860 (Dec. 11, 2009). As to the second point, concerning accuracy of the test procedure, DOE explains in the December 2009 NOPR that manufacturer certification of several electric resistance water heaters with EFs of 0.95, as well as DOE testing of such models, demonstrate that the DOE test procedure can accurately measure the efficiencies of units at that level that use conventional, electric resistance technologies. 74 FR 65852, 65680–81 (Dec. 11, 2009). As the December 2009 NOPR also indicates, units with efficiencies significantly above that level must use advanced technologies, for which the test procedure also permits accurate measurement of EF levels. 74 FR 65852, 65681 (Dec. 11, 2009). Thus, because today's standards for electric water heaters have two substantially different tiers—for capacities at or below 55 gallons, minimum EF levels equivalent to 0.95 at the representative storage capacity, and for larger capacities substantially higher minimum EF levels—DOE confirms that the existing test procedure will accurately determine the efficiencies of both models using conventional technologies to meet the lower tier and models that will have to use advanced technologies to meet the higher tier. Finally, the only specific cost-effective efficiency measure that commenters cited as being absent from DOE's water heater test procedure is insulation on the tank bottom. 74 FR 65852, 65861 (Dec. 11, 2009). To the contrary, however, the test procedure addresses and gives credit for inclusion of such insulation in water heaters. 10 CFR part 430, subpart B, appendix E, section 5. Although DOE recognizes that the test procedure does not reflect certain recent advances in energy saving technology, it is aware of no evidence that such technologies actually do or would result in significant, cost-effective energy savings under normal operating conditions for water heaters. Hence, omission of these technologies from the test procedure does not affect the efficiency levels considered in this rulemaking. DOE received no comments on this issue at the NOPR stage. Thus, DOE continues to believe, as stated in the December 2009 NOPR, that the appropriate time to address such omission is during the next revision of the test procedure.

As to the DHE and pool heater test procedures, in the December 2009 NOPR, DOE proposed that its test procedures for vented DHE be applied to establish the efficiencies of vented gas hearth DHE. 74 FR 65852, 65861 (Dec. 11, 2009). DOE received no comments from interested parties raising any concern in this rulemaking about application of the DOE test procedures for vented DHE to other types of this product. In addition, DOE received no comments regarding application of its test procedures for pool heaters.

EPCA, as amended by EISA 2007, requires DOE to amend the test procedures for the three types of heating products to include provisions for measurement of the products' standby mode and off mode energy consumption. (42 U.S.C. 6295(gg)(2)(B)(v)) DOE is actively working on a separate rulemaking to amend its test procedures for the three types of heating products to incorporate these measurements of standby mode and off mode energy consumption in the future.

B. Technological Feasibility

1. General

As stated above, any standard that DOE establishes for any of the three heating products must be technologically feasible. (42 U.S.C. 6295(o)(2)(A) and (3)(B)) DOE considers a design or technology option to be technologically feasible if it is in use by the respective 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 part 430, subpart C, appendix A, section 4(a)(4)(i). Once DOE has determined that particular technology options are technologically feasible, it evaluates each technology 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.

This final rule considers the same technology options as those evaluated in the December 2009 NOPR. (*See* chapter 3 and 4 of the TSD accompanying this notice.) All of these technologies have been used or are in use in commercially-available products, or exist in working prototypes. Also, these technologies all incorporate materials and components that are commercially available in today's supply markets for the products covered by this final rule. DOE received several comments on the technology options considered in the rulemaking and the preliminary conclusions drawn by applying the four screening criteria to them. A detailed discussion of the comment and response can be found in section IV.B. Therefore, DOE determined that all of the efficiency levels evaluated in this notice are technologically feasible.

2. Maximum Technologically Feasible Levels

As required by 42 U.S.C. 6295(p)(1), in developing the December 2009 NOPR, DOE identified the efficiency levels that would achieve the maximum improvements in energy efficiency that are technologically feasible (max-tech levels) for the three heating products. 74 FR 65852, 65861–62 (Dec. 11, 2009). (*See* chapter 5 of the TSD.) Except for the levels for electric and gas-fired storage water heaters and gas wall gravity DHE, DOE received no comments on the December 2009 proposed rule to lead DOE to consider changes to these levels. Therefore, for today's final rule, the max-tech levels for all classes of the three heating products, except for the electric and gas-fired water heaters and gas wall gravity DHE, are the max-tech levels identified in the December 2009 NOPR.

The max-tech levels considered for today's rule are provided in Table III.1. *See* section IV.C.2 for additional details of the max-tech efficiency levels and discussion of related comments from interested parties on the December 2009 NOPR.

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

Product class	Representative product	Max-Tech efficiency level
Residential Water Heaters		
Gas-Fired Storage Water Heater	Rated Storage Volume = 40 Gallons	EF = 0.77.
Electric Storage Water Heater	Rated Storage Volume = 50 Gallons	EF = 2.35.
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 = 70%.
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%.

C. Energy Savings

DOE forecasted energy savings over a 30-year analysis period in its national impact analysis (NIA) through the use of an NIA spreadsheet tool, as discussed in the December 2009 NOPR. 74 FR 65862, 65908–14, 65954 (Dec. 11, 2009).

One of the criteria that governs DOE's adoption of standards for covered products is that the standard must result in "significant conservation of energy." (42 U.S.C. 6295(o)(3)(B)) While EPCA does not define the term "significant," the U.S. Court of Appeals for the District of Columbia Circuit, in *Natural Resources Defense Council* v. *Herrington,* 768 F.2d 1355, 1373 (DC Cir. 1985), indicated that Congress intended "significant" energy savings in this context to be savings that were not "genuinely trivial." DOE's estimates of the energy savings for energy conservation standards at each of the TSLs considered for today's rule indicate that the energy savings each would achieve are nontrivial. Therefore, DOE considers these savings "significant" within the meaning of Section 325 of EPCA.

D. Economic Justification

The following section discusses how DOE has addressed each of the seven factors that it uses to determine if energy conservation standards are economically justified. The comments DOE received on specific analyses and DOE's response to those comments are summarized and presented throughout section IV.

1. Specific Criteria

As noted earlier, EPCA provides seven factors to evaluate in determining whether an energy conservation standard for covered products is economically justified. (42 U.S.C. 6295(o)(2)(B)(i)) The following sections summarize how DOE has addressed each of those seven factors in evaluating efficiency standards for the three heating products.

a. Economic Impact on Consumers and Manufacturers

As required by EPCA, DOE considered the economic impact of potential standards on consumers and manufacturers of the three heating products. (42 U.S.C. 6295(o)(2)(B)(i)(I)) For consumers, DOE measured the economic impact as the change in installed cost and life-cycle operating costs (*i.e.,* the change in LCC). (*See* section IV.F and VI.C.1.a, and chapter 8 of the final rule TSD.) DOE investigated the impacts on manufacturers through the manufacturer impact analysis (MIA). (*See* sections IV.I and VI.C.2 of today's final rule, and chapter 12 of the final rule TSD.) The economic impact on consumers and manufacturers is discussed in detail in the December 2009 NOPR. 74 FR 65852, 65862–63, 65897–908, 65915–22, 65932–54, 65984–92 (Dec. 11, 2009).

b. Life-Cycle Costs

As required by EPCA, DOE considered the life-cycle costs of the three heating products. (42 U.S.C. 6295(o)(2)(B)(i)(II)) LCC is discussed at length in the December 2009 NOPR. 74 FR 65852, 65863, 65897–908, 65915, 65932–35 (Dec. 11, 2009). DOE calculated the sum of the purchase price (including associated installation costs) and the operating expense (including energy, maintenance, and repair expenditures), discounted over the lifetime of the equipment, to estimate the range in LCC benefits that consumers would expect to achieve due to standards.

c. Energy Savings

Although significant conservation of energy is a separate statutory requirement for imposing an energy conservation standard, EPCA also requires DOE, in determining the economic justification of a proposed standard, to consider the total projected energy savings that are expected to result directly from the standard. (42 U.S.C. 6295(o)(2)(B)(i)(III)) As in the December 2009 NOPR, for today's final rule, DOE used the NIA spreadsheet results in its consideration of total projected savings that are directly attributable to the standard levels DOE considered. 74 FR 65852, 65862, 65908–14, 65954 (Dec. 11, 2009).

d. Lessening of Utility or Performance of Products

In selecting today's standard levels, DOE did not consider trial standard levels for the three heating products that would lessen the utility or performance of such products. (42 U.S.C. 6295(o)(2)(B)(i)(IV)). As explained in the December 2009 NOPR, DOE determined that none of the trial standard levels under considerations would reduce the utility or performance of the products subject to this rulemaking. 74 FR 65852, 65863, 65956 (Dec. 11, 2009).

e. Impact of Any Lessening of Competition

DOE considers any lessening of competition that is likely to result from standards. Accordingly, as discussed in the December 2009 NOPR (74 FR 65852, 65863, 65956 (Dec. 11, 2009)), DOE requested that the Attorney General transmit to the Secretary, not later than 60 days after publication of the proposed rule, a written determination of the impact, if any, of any lessening of competition likely to result from the standards proposed in the December 2009 NOPR, 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))

To assist the Attorney General in making such a determination, DOE provided the U.S. Department of Justice (DOJ) with copies of the December 2009 proposed rule and the NOPR TSD for review. The Attorney General's determination is discussed in section VI.C.5 below, and is reprinted at the end of this rule. DOJ did not believe the standards proposed in the December 2009 NOPR for water heaters and pool heaters would likely lead to a lessening of competition. However, DOJ was concerned about the potential of the proposed standards to impact competition in the traditional DHE categories if no more than one or two DHE manufacturers chose to continue to produce products in any one of the categories. DOJ requested that DOE consider the potential impact on competition in determining the final standards for these categories. (DOJ, No. 99 at pp. 1–2) [2] DOJ's comment and DOE's response are further described in section VI.C.5.

f. Need of the Nation To Conserve Energy

In considering standards for the three heating products, the Secretary must consider the need of the Nation to conserve energy. (42 U.S.C. 6295(o)(2)(B)(i)(VI)) The Secretary recognizes that energy conservation benefits the Nation in several important ways. The non-monetary benefits of standards are likely to be reflected in improvements to the security and reliability of the Nation's energy system. Today's standards will also result in environmental benefits. As discussed in detail in the December 2009 NOPR (74 FR 65852, 65863, 65923–29, 65956–61 (Dec. 11, 2009)) and in sections IV.K, IV.L, and IV.M, DOE has considered these factors in considering whether to adopt standards for the three heating products, primarily through its utility impact analysis, environmental assessment, and monetization of anticipated emissions reductions.

g. Other Factors

EPCA directs 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)) In adopting today's standards, the Secretary considered the potential impact of standards on certain identifiable groups of consumers who might be disproportionately impacted by any national energy conservation standard level. For certain water heaters and DHE, DOE considered the impacts of standards on low-income households and senior-only households, and of these water heaters, DOE also considered the impacts of standards on households in multi-family housing and in manufactured homes. 74 FR 65852, 65863, 65934–35, 65961–62 (Dec. 11, 2009).

In addition, DOE considered the uncertainties associated with whether, in order to adequately serve the water heater market: (1) Manufacturers could ramp up production of heat pump water heaters; (2) heat pump component manufacturers could increase production; and (3) enough servicers and installers of water heaters could be retrained. 74 FR 65852, 65863–64, 65877–78, 65962, 65965–66 (Dec. 11, 2009). Lastly, DOE considered the issues identified in the December 2009 NOPR 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, as well as the condensing water heater market. 74 FR 65852, 65966–67 (Dec. 11, 2009). These issues are addressed as presented below in section VI.D.2.

2. Rebuttable Presumption

As set forth in 42 U.S.C. 6295(o)(2)(B)(iii), EPCA states that there is a rebuttable presumption that an energy conservation standard is economically justified if the increased

[2] "DOJ, No. 99 at pp. 1–2" refers to: (1) To a statement that was submitted by the U.S. Department of Justice. 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 99; and (2) a passage that appears on pages 1 through 2 of that statement.

installed cost for a product that meets the standard 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. DOE's LCC and payback period (PBP) analyses generate values that calculate the payback period for consumers of potential energy conservation standards, which include, but are not limited to, the payback period contemplated under the rebuttable presumption test described 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 results of DOE's PBP analysis can be found in sections VI.C.1.a and VI.C.1.c.

IV. Methodology and Discussion of Comments on Methodology

DOE used several analytical tools that it developed previously and adapted for use in this rulemaking. One is a spreadsheet that calculates LCC and PBP. Another tool calculates national energy savings and national NPV that would result from the adoption of energy conservation standards. DOE also used the Government Regulatory Impact Model (GRIM), along with other methods, in its MIA to determine the impacts on manufacturers of standards for the three heating products. Finally, DOE developed an approach using the Energy Information Administration's (EIA) National Energy Modeling System [3] (NEMS) to estimate the impacts of such standards on utilities and the environment. Chapters 3 through 16 of the TSD and the December 2009 NOPR discuss each of these analytical tools in detail. 74 FR 65852, 65897–919, 65923–29 (Dec. 11, 2009).

As a basis for this final rule, DOE has continued to use the spreadsheets and approaches explained in the December 2009 NOPR. DOE used the same general methodology as applied in the December 2009 NOPR, but revised some of the assumptions and inputs for the final rule in response to stakeholder comments. The following sections discuss these comments and revisions.

A. Market and Technology Assessment

When beginning an energy conservation standards rulemaking, DOE develops information that provides an overall picture of the market for the products concerned, including the purpose of the products, the industry structure, and market characteristics. This activity includes both quantitative and qualitative assessments based primarily on publicly-available information. DOE presented its market and technology assessment for this rulemaking in the December 2009 NOPR and chapter 3 of the NOPR TSD. 74 FR 65852, 65864–72 (Dec. 11, 2009). The assessment included product definitions, delineation of the products included in the rulemaking, product classes, manufacturers, quantities and types of products offered for sale, retail market trends, and regulatory and non-regulatory initiative programs. As discussed below, commenters raised a variety of issues related to the market and technology assessment, to which DOE responds in the following sections.

1. DOE's Determinations as to the Inclusion of Products in This Rulemaking

a. Whether Certain Products Are Covered Under the Act

i. Solar-Powered Water Heaters and Pool Heaters

As fully explained in the December 2009 NOPR, DOE has concluded that it presently lacks authority to prescribe standards for these products 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. 74 FR 65852, 65864 (Dec. 11, 2009). In addition, DOE currently lacks authority to adopt standards for solar-powered water heaters because EPCA's definition of "water heater" includes only products that use "oil, gas, or electricity to heat potable water." (42 U.S.C. 6291(27); 10 CFR 430.2) Because DOE did not receive additional feedback from interested parties, DOE did not change its position on solar-powered water heaters and pool heaters as presented in the December 2009 NOPR and summarized above.

ii. Add-On Heat Pump Water Heaters

DOE did not propose in the December 2009 NOPR to adopt standards for a residential product that 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 electric storage water heater. 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. DOE has concluded, therefore, that the device does not meet EPCA's definition of a "water heater" and currently is not a covered product. 74 FR 65852, 65865 (Dec. 11, 2009).

In response to DOE's preliminary conclusions set forth in the December 2009 NOPR regarding add-on heat pump water heaters, the American Council for an Energy Efficient Economy (ACEEE) stated that add-on heat pump water heaters should not have been excluded from the rulemaking. (ACEEE, No. 79 at p. 5) According to the commenter, the December 2009 NOPR language used to exclude them could as readily be used to exclude split system air conditioners as add-ins to furnace systems, since they are not fully functional without the furnace's air handler. ACEEE argued that add-on heat pump water heaters could provide an important opportunity for cost-effective resistive unit retrofits, and standards are required to help exclude low-performance units that will not meet consumer needs. Otherwise, ACEEE asserted that there is danger that failures of low-performance add-on units will damage the reputation of the integral heat pump water heater product class, as it is not clear that consumers will easily differentiate the two product subclasses.

In response, DOE does not agree with ACEEE's comparison of add-on heat pump water heaters to central air conditioning and heating systems. Unlike components in a split air-conditioning system, add-on heat pump water heaters are paired to an electric storage water heater which is fully functional when it leaves the manufacturing facility. Components in a split air-conditioning system do not work independently until paired

[3] 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.

together in the field. As DOE previously stated, 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. DOE is not swayed by the commenter's speculative assertions regarding the future performance of add-on heat pump water heaters. Accordingly, DOE has concluded that an add-on heat pump water heater does not meet EPCA's definition of a "water heater" and currently is not a covered product.

iii. Gas-Fired Instantaneous Water Heaters With Inputs Above and Below Certain Levels

During this rulemaking, DOE considered whether to evaluate for standards gas-fired instantaneous water heaters with inputs greater than 200,000 Btu/h or less than 50,000 Btu/h. DOE determined that the former do not meet EPCA's definition of a "water heater," given the specific portions of the definition pertaining to "instantaneous type units." (42 U.S.C. 6291(27)(B)) As to the latter, DOE determined that manufacturers are not currently producing any gas-fired instantaneous water heaters with an input capacity less than 50,000 Btu/h. Therefore, DOE did not propose standards for products with an input capacity above 200,000 Btu/h or below 50,000 Btu/h. 74 FR 65852, 65865 (Dec. 11, 2009). DOE did not receive any comments on this issue at the NOPR stage, so the above approach has been retained for this final rule, and accordingly, no standards are being adopted for gas-fired instantaneous water heaters with inputs greater than 200,000 Btu/h or less than 50,000 Btu/h.

iv. Residential Pool Heaters With Input Capacities Above Certain Levels and Coverage of Spa Heaters

At the framework stage of this rulemaking, DOE considered excluding pool heaters with an input capacity greater than 1 million Btu/h, and commenters suggested that DOE should exclude products with an input capacity greater than 400,000 Btu/h. The rulemaking covers pool heaters that meet EPCA's definitions of "pool heater" (which provides no capacity limitation) and of "consumer product." (42 U.S.C. 6291(25); 42 U.S.C. 6291(1)). DOE tentatively concluded that these provisions, and standards adopted under them, would apply to any pool heater distributed to any significant extent as a consumer product for residential use, regardless of input capacity. In addition, DOE tentatively concluded that pool heaters marketed as commercial equipment, which contain additional design modifications related to safety requirements for commercial installation, would not be covered by such standards. Therefore, DOE did not propose to limit application of the standards developed in this rulemaking to pool heaters with an input capacity below a specified level. 74 FR 65852, 65865 (Dec. 11, 2009).

In response to this position in the December 2009 NOPR, DOE received three comments urging DOE to establish an input capacity limit for residential pool heaters.

Zodiac Pool Systems (Zodiac) asserted that DOE should consider setting different minimum efficiency levels for pool heaters with input ratings of up to 400,000 British thermal units per hour (Btu/h) and for those with input ratings above 400,000 Btu/h. Zodiac stated its belief that there may be some benefits to be gained if what Zodiac referred to as "commercial" pool heaters (*i.e.,* those units rated above 400,000 Btu/h input) required a higher minimum efficiency level than that for "residential" pool heaters (*i.e.,* those units rated up to 400,000 Btu/h input). According to the commenter, commercial-type units are operated longer and in general, continuously, thereby increasing the potential payback in efficiency and energy savings over the life of the product. (Zodiac, No. 68 at p. 2)

Lochinvar asserted that DOE should limit the input capacity for residential pool heaters to 400,000 Btu/h and that DOE should add an additional classification for commercial pool heaters above 400,000 Btu/h. According to the commenter, practically all of the residential pool heaters sold today have pool heater inputs of 400,000 Btu/h and below. Lochinvar stated that residential pool heater sales by pool heater manufacturers do not include pumps. Residential pool heaters are designed to accept a wide range of water flows to meet the customers' demands because the residential market is mature with a wide variety of pool distribution accessories (*e.g.,* pumps that mate with water filtration systems, water temperature controls, and valving components). Therefore, pumps are not supplied because this is a variable that cannot be anticipated by the pool heater manufacturer. Thus, for efficiency rating purposes, pool heater thermal efficiency, as calculated by DOE's test procedure, does not include the pump energy. In contrast, Lochinvar pointed out that commercial pool heater applications require much higher volumes of water to be circulated in a primary pool loop that incorporates large filtration systems and pool water conditioning and monitoring equipment. Commercial pool heaters are designed to tap off of the primary pool loop and, via means of a separate pump, circulate pool water through the commercial pool heater to be heated and then delivered back to the pool loop. The ratio of water flow through commercial pool loop systems to that flowing through the pool heater is anywhere from 5 to 15 times. In these applications, commercial pool heater sales always provide or specify matching pumps to ensure sufficient water flow through the heat exchanger. Accordingly, the contribution of pump energy is included in the industry commercial pool heater test procedure and combustion efficiency metric. (Lochinvar, No. 56.6 at p. 2)

AHRI recommended that consideration be given in the future to creating separate subclasses to distinguish between commercial and residential pool heaters from a market perspective. Comments have previously been provided noting the major differences between pool heaters for commercial applications versus residential applications, specifically in terms of construction, control schemes, and how they go to market. (AHRI, No. 91 at p. 10)

As DOE discussed in the December 2009 NOPR, EPCA places no capacity limit on the pool heaters it covers in terms of its definition of "pool heater." (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. In light of the above and based upon the distinct differences articulated by commenters between the residential and commercial pool heater markets and products, DOE has concluded that further delineation by adding an input capacity limit is not necessary. Specifically, 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. This would include pool heating systems that are designed to meet a high volume flow and are matched with a pump from the point of manufacture to accommodate the needs of commercial facilities. DOE believes manufacturers can distinguish those units from pool heaters distributed to any significant extent as a consumer product for residential use, regardless of input capacity.

As to spa heaters, the EPCA definition for "pool heater" clearly encompasses them. (42 U.S.C. 6291(25)) Therefore, in the December 2009 NOPR, DOE tentatively concluded that they are covered by EPCA, and included them in this rulemaking. Furthermore, DOE tentatively concluded that because spa heaters and pool heaters perform similar functions, include similar features, and lack performance or operating features that would cause them to have inherently different energy efficiencies, a separate product class for such units is not warranted. 74 FR 65852, 65865–66 (Dec. 11, 2009). DOE did not receive any comments in response to its proposed treatment of spa heaters in the December 2009 NOPR. Consequently, DOE has concluded that spa heaters are included within EPCA under the definition of "pool heater" and do not warrant a separate product class.

v. Vented Hearth Products

The following two paragraphs summarize DOE's reasons, explained in greater detail in the December 2009 NOPR for concluding that EPCA covers vented hearth products and for including them in this rulemaking. 74 FR 65852, 65866 (Dec. 11, 2009).

When EPCA was amended to include energy conservation standards for "direct heating equipment," that term replaced the term "home heating equipment" in the Act. However, EPCA has never defined either of these terms. Instead, DOE regulations define "home heating equipment," stating that the term includes "vented home heating equipment." 10 CFR 430.2. These definitions inform the meaning of "direct heating equipment," but, to provide clarity in the future, in today's rule DOE is incorporating into its regulations a definition of this term that is identical to the existing definition of "home heating equipment."

Vented hearth products include gas-fired products such as fireplaces, fireplace inserts, stoves, and log sets that typically include aesthetic features and that provide space heating. DOE has concluded that such products meet its definition of "vented home heating equipment," because they are designed to furnish warmed air to the living space of a residence. DOE has also concluded, therefore, that they are covered products under EPCA and are properly classified as DHE. Accordingly, DOE proposed and today is adopting standards for vented hearth products.

In the December 2009 NOPR, DOE also pointed out that vented hearth products would be subject to the same product testing and certification requirements that currently apply to DHE. 74 FR 65852, 65866 (Dec. 11, 2009). In order to help manufacturers determine more easily whether their vented hearth direct heating equipment is covered under DOE's regulations, DOE proposed to adopt the following definition of "vented hearth heater":

> *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.

74 FR 65852, 65867–68 (Dec. 11, 2009).

The Air-Conditioning, Heating, and Refrigerating Institute (AHRI), the Hearth, Patio, and Barbeque Association (HPBA), and Empire Comfort Systems (Empire) do not support DOE's proposed definition "vented hearth heater" as presented above and in the December 2009 NOPR. However, these three interested parties do support DOE's decision to establish vented gas fireplace heaters as a separate type of direct heating equipment. AHRI, HPBA, and Empire urged DOE to use the definition of "vented gas fireplace heater" as presented in the American National Standards Institute (ANSI) Standard Z21.88, *Vented Gas Fireplace Heaters,* so as to directly connect it to this safety standard. By law, manufacturers are required to list and label these types of appliances to approved safety standards such as ANSI Z21.88. By using this safety standard reference, the interested parties argued that DOE and others would be able to distinguish vented gas fireplace heaters from decorative gas appliances certified to ANSI Z21.50, *Vented Gas Fireplaces,* and ANSI Z21.60, *Decorative Gas Appliances for Installation in Solid-Fuel Burning Fireplaces,* thereby eliminating a significant opportunity for confusion in the marketplace after the new energy conservation standards take effect. The interested parties argued that when the National Appliance Energy Conservation Act was being developed, it was recognized that there were decorative gas appliances that were marketed based on the aesthetic appeal of a simulated solid fuel fireplace or stove. The interested parties asserted that those same products are available in the marketplace today and need to be excluded from inclusion in this rulemaking in a proactive manner, preferably by using the consensus safety standard designation in the definition and adding an explanatory note to the definition stating that ANSI Z21.50 and ANSI Z21.60 appliances are not vented gas fireplace heaters. The interested parties suggested the following definition of "vented gas fireplace heater":

> *Vented Gas Fireplace Heater.* A vented appliance which simulates a solid fuel fireplace and furnishes warm air, with or 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 heated 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.

(AHRI, No. 91 at pp. 13–14; HPBA, No. 75 at p. 1; Empire, No. 100 at p. 3; AHRI, Public Meeting Transcript, No. 57.4 at pp. 48–49; HPBA, Public Meeting Transcript, No. 57.4 at pp. 42 and 51; and Empire, Public Meeting Transcript, No. 57.4 at pp. 50)

ACEEE also suggested that it would be reasonable for DOE to not set efficiency regulations for purely decorative products with an output capacity less than or equal to 6,000 Btu/h. However, ACEEE asserted that an upper limit is necessary to prevent subterfuge and confusion with actual heating appliances. (ACEEE, No. 79 at p. 6)

DOE agrees with the interested parties that further modification to the definition of "vented hearth heater" is necessary to provide clear guidance to the industry regarding which products are covered under DOE's regulations. DOE's definition of "vented home heating equipment" limits the coverage of vented home heating equipment to include only those units "designed to furnish warmed air to the living space of a residence." 10 CFR 430.2. DOE notes that it is often difficult to determine the intended purpose of fireplace product currently sold. Units designed to furnish warmed air to the living space and purely decorative units often share very similar external appearances, unit construction, and input capacities. Some interested parties suggested DOE use the ANSI safety standards to distinguish coverage in the marketplace. DOE does not believe that using ANSI safety standards would be a suitable solution to this problem since many of those products classified as "decorative fireplaces" under the ANSI safety standards are very similar in construction to fireplace heaters and provide warm air to the residence.

DOE notes that the primary difference between the two types of hearth products is that decorative units are intended only to provide the ambiance and aesthetic utility associated with a solid fuel (*e.g.,* wood-burning) fireplace with little or no heat output to the living space, while heating hearth products are intended to provide heat to the living space along with the aesthetic utility. Heating-type products are often shipped with additional accessories that decorative products do not have, such as thermostats to control the heat output and blowers that distribute hot air to the room. DOE research suggests that this additional equipment is typically optional and hence not very useful to distinguish between heaters and decorative units.

After carefully considering the public comments and conducting additional research, DOE believes implementing a maximum input capacity limit will likely result in a clear distinguishable way for DOE, manufacturers, and consumers to identify which products provide "warmed air to the residence," as compared with those designed purely for aesthetic purposes. Because of the nature of hearth products (*i.e.,* the presence of a flame), all hearth products create heat and nearly all of the hearth products provide some amount of that heat, however small that may be, to the surrounding living space.

Unlike fireplace heaters, decorative hearth products provide a unique utility, specifically offering the ambiance and aesthetic appeal provided by the flame without adding significant heat to the conditioned space. By way of explanation, some consumers that wish to purchase purely decorative hearth products live in warmer climates where any additional heat provided to the residence would be undesirable. However, these consumers still want the aesthetic appeal provided by the flame. As the efficiency of the vented hearth product is increased, the more useful heat is provided to the space. So in response to comments, DOE is adopting an approach that would maintain the utility and availability of decorative hearth products.

In order to determine whether a maximum input capacity limit is a good indicator of intended use, DOE reviewed the market for vented hearth products, including those products marketed as heaters and decorative appliances. DOE research identified products marketed for heating and decorative purposes offered across the entire range of input capacities. Many of the units produced solely for decorative purposes come with the capability to vary the input capacity in order to change the magnitude of the flame. Since manufacturers provide consumers, installers, and contractor with a means to change the input capacity of the unit to better match consumers' aesthetic desires and heating needs, DOE believes input capacity is indicative of the type of intended use of the vented hearth heater.

DOE believes that consumers desiring a purely decorative unit will chose to buy units which minimize the heat furnished to their living space, thereby reducing the impacts on the cooling loads of their house for those living in warmer climates. DOE contacted several contractors in warmer climates, where decorative appeal is presumably the consumers' top priority. From these discussions and further review of the product literature, DOE found that many hearth products allow the input capacity to be modulated via the gas valve. In warmer climates, contractors frequently suggest to their customer to turn down the gas supply to minimize the amount of heat radiated and convected to the air within the residence. Some installation companies even offer optional venting products and dampers, which attempt to direct the heat to other parts of the residence or outdoors. Even though decorative hearth products are offered with a large range of input capacities, DOE research hence suggests that the input rating is typically significantly reduced for applications in conditions in which the flames are purely ornamental to minimize heat provided to the residence. This is shown by the variability in the input ratings offered for a given model as described in manufacturer catalog data, which can be field-adjusted based on the amount of heat desired within the residence.

DOE believes that hearth products intended for decorative purposes provide a specific aesthetic utility that consumers value. In its analysis, DOE considered the value of this aesthetic quality and the additional heat load that such systems produce. DOE believes that a maximum input capacity of 9,000 Btu/h is an appropriate cut-off for decorative appliances since existing hearth-type DHE units featuring adjustable input capacities operate at or below this input capacity limit. DOE chose 9,000 Btu/h because other gas appliances found in a house, which may have unintended heating loads, such as a burner on a gas-cook top, are also found at this input capacity. By allowing manufacturers the option of producing vented hearth heaters that are excluded from the standards amended in today's final rule, DOE is preserving the ability of manufacturers to continue selling decorative units, consumers can continue to enjoy them, and unintended heat loads are limited to no more than ½ of a ton of heating capacity per decorative unit. DOE research suggests that manufacturers can comply relatively inexpensively with the coverage established by the "vented hearth heater" definition by reducing the maximum input capacity of the gas delivery system through the use of a restrictor plate, modifying the gas valve, or altering the flame orifice. All of these options are currently available or utilized within the industry today. DOE believes the most likely solution that will be used by hearth manufacturers to meet DOE's restriction on input capacity would be to use a restrictor plate because it is the most inexpensive. A restrictor plate would ensure that limitations were placed upon the gas line such that the maximum input capacity of the fireplace is less than 9,000 Btu/h. DOE notes that all vented hearth heaters which manufacturers produce to be purely decorative units must be designed so that the consumer cannot override this 9,000 Btu/h maximum input capacity limit in the field.

DOE chose to include a maximum input capacity limitation, instead of an output capacity limit as ACEEE suggested, because a very inefficient unit could have a very high input capacity and use a lot of energy, while meeting DOE's limitation on output capacity.

DOE realizes its amended definition of "vented hearth heater" will include all types of hearth units with maximum input capacities above the specified limit, including all products that are currently referred to as fireplace heaters and some products that are currently deemed as decorative within the marketplace. DOE also notes that this maximum input capacity corresponds to the output capacity suggested by ACEEE, assuming the unit is about two-thirds efficient, which is an efficiency that is comparable to the standard level being adopted today for vented gas hearth heaters. Therefore, DOE is modifying the "vented hearth heater" definition to include a maximum input capacity limit of 9,000 Btu/h for purely decorative units.

AHRI, HBPA, and Empire asserted that DOE should amend its definition of "vented hearth heater" to include duct connections. While duct connections were excluded from the original "direct heating equipment" definition, the interested parties stated that this exclusion is unnecessary for vented gas fireplace heaters because they are allowed to have duct connections by design. The interested parties argued that there is no reason for DOE to exclude these currently-available appliances merely based upon the presence of ducting, particularly given that the limiting definition of "vented home heating equipment" was written before the products were introduced. (AHRI, No. 91 at pp. 13–14; HPBA, No. 75 at pp. 1–2; Empire, No. 100 at p. 3)

DOE agrees with these interested parties and is extending coverage to both ducted and ductless vented hearth heater products. DOE believes this modification will provide equal treatment to similar products offered on the market today. DOE's research confirmed that some vented hearth heater models have the ability to connect to ducts and distribute the heat furnished to the space throughout the house. In order to include both ducted and ductless vented hearth products, DOE is amending the definitions of "vented hearth heater" and "vented home heating equipment" for inclusion at 10 CFR 430.2. Lastly, DOE is making a number of editorial changes to the definition of "vented hearth heater" proposed in the December 2009 NOPR, in order to make the definition easier to read. As adopted, these definitions read as follows:

Vented hearth heater means a vented appliance which simulates a solid fuel fireplace and is designed to furnish warm air, with or without duct connections, to the space in which it is installed. The circulation of heated room air may be by gravity or mechanical means. A vented hearth heater may be freestanding, recessed, zero clearance, or a gas fireplace insert or stove. Those heaters with a maximum input capacity less than or equal to 9,000 British thermal units per hour (Btu/h), as measured using DOE's test procedure for vented home heating equipment (10 CFR part 430, subpart B, appendix O), are considered purely decorative and are excluded from DOE's regulations.

DOE is also amending its definition of "*vented home heating equipment* or *vented heater*" in 10 CFR 430.2 to include vented hearth heaters with duct connections. This modification is necessary in order for the definition of "vented home heating equipment or vented heater" to be consistent with the definition of "vented hearth heater." DOE is also amending this definition to add "vented hearth heater" to the list of products—"vented wall furnace, vented floor furnace, and vented room heater"—that the definition currently states are included as vented home heating equipment. As stated in the December 2009 NOPR and above, vented hearth products already meet DOE's definition for "vented home heating equipment." This is true regardless of whether the term "vented hearth heater" is added to that definition. Thus, the addition of that term merely clarifies the existing definition, and is a technical correction that does not alter the substance of the definition. As amended, the definition reads as follows:

Vented home heating equipment or *vented heater* means 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 except for vented hearth heaters, which may be with or without duct connections) and includes: vented wall furnace, vented floor furnace, vented room heater, and vented hearth heater.

b. Covered Products Not Included in This Rulemaking

As the December 2009 NOPR explains in detail, unvented direct heating equipment, electric pool heaters, and combination water heating/space heating products all are covered products under EPCA, but no Federal energy conservation standards exist for them. 74 FR 65852, 65866–76 (Dec. 11, 2009). DOE did not propose standards for them in this rulemaking, because, in the case of unvented DHE, a standard could produce little energy savings (largely due to the fact that any heat losses are dissipated directly into the conditioned space) and because of limitations in the applicable DOE test procedure, and in the case of the other two products, because of the lack of an appropriate DOE test procedure. *Id.*

By contrast, standards currently apply to tabletop and electric instantaneous water heaters. (10 CFR 430.32(d)) But, as explained in the December 2009 NOPR, an increase in the current standard levels for tabletop products is not feasible, and would force them off the market, and an increase in the levels for electric instantaneous products would, at best, save little energy. 74 FR 65852, 65867 (Dec. 11, 2009). Therefore, DOE also did not propose amended standards for these products.

With regard to these five covered products, DOE sees no reason to change the conclusions expressed in the December 2009 NOPR, and takes no further action in today's final rule. DOE did not receive any comments in response to its proposed treatment of these five covered products in the December 2009 NOPR. Consequently, DOE is not adopting standards for these products in today's final rule.

2. 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 and a discussion of comments relating to the product classes for the three heating products in response to the December 2009 NOPR proposals.

TABLE IV.1—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.

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

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

As presented in the December 2009 NOPR, 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. 74 FR 65852, 65868–71 (Dec. 11, 2009). 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. 74 FR 65852, 65868 (Dec. 11, 2009).

In response to the December 2009 NOPR analysis and the issues for which DOE specifically sought comment, DOE received several comments from interested parties about DOE's proposed product classes and their organization for residential water heaters. These comments are summarized and addressed immediately below.

i. Low-Boy Water Heaters

General Electric (GE), A.O. Smith Corporation (A.O. Smith), Bradford White Corporation (BWC), and AHRI supported the need for a separate product class for low-boy water heaters, which are electric storage water heaters that are shorter in height and wider in diameter than traditional water heaters. (GE, No. 84 at p. 1; A.O. Smith, No. 76 at p. 2; BWC, No. 61 at p. 3; AHRI, No. 91 at p. 3; Rheem, No. 89 at p. 11; and A. O. Smith, Public Meeting Transcript, No. 57.4 at pp. 55–56) ACEEE, EarthJustice, and ASAP disagreed and supported DOE's position in the December 2009 NOPR, which did not establish a separate product class for low-boy electric storage water heaters. (ACEEE, No. 79 at p. 8; EarthJustice, No. 83 at p. 1; and ASAP, Public Meeting Transcript, No. 57.4 at p. 60) The individual commenters' rationales and further justification are presented below.

GE asserted the low-boy water heaters should be separated into their own product class, because in some categories, the benefits of unique size, configuration, and functionality are very important to consumers. In this product category, the unique functionality of a low-boy water heater happens to focus on the physical dimensions of the product. GE asserted that some consumers prefer or require the lower overall product height, as they do not have the space available for a standard-sized water heater. (GE, No. 84 at p. 1)

A.O. Smith strongly asserted that a separate class for low-boy water heaters is justified, for many of the same reasons that a separate class is already established for table-top water heaters. According to the commenter, low-boy water heaters are predominately used in installations where height is a constraint, such as where a furnace or air-handler is mounted on a rack above the low-boy water heater in an equipment closet. Because low-boy water heaters are already a larger diameter unit than the baseline design, increasing the diameter even more by requiring additional insulation thickness would make the heater too large to fit into the space available in most replacement situations (again, such as the closet/rack example above). A.O. Smith stated its belief that there will be a loss of utility for low-boy heaters if they are not put into a separate class with an EF less than proposed for the "standard" heater. (A.O. Smith, No. 76 at p. 2)

BWC supports a separate product class for low-boy water heaters because they have very specific applications. Low-boy water heaters are frequently used in condominiums where additional space is unavailable and a gas water heater cannot be used due to venting limitations. When used in these applications, BWC claimed that low-boys use less water than typical standard electric water heaters. Therefore, BWC asserted low-boy water heaters have a different utility than standard electric water heaters. (BWC, No. 61 at p. 3)

AHRI asserted that low-boy water heaters use electricity, but are not offered in the same range of volumes as standard electric storage water heaters. Most low-boys are offered in 30-gallon and 40-gallon sizes. AHRI asserted that the December 2009 NOPR mischaracterizes the functionality or utility of these products. Low-boy models have the unique feature of being able to be installed in short, confined spaces in a dwelling. But, as is the case with countertop electric water heaters, the constraints dictated by the spaces in which these products are installed affect the options for increasing the efficiency of low-boy electric models. Many low-boy models today may have efficiencies comparable to standard size electric water heaters, but they do not have the same potential for further increasing their efficiency. Accordingly, AHRI argued that this separate product class should have a minimum EF standard that is 0.01 less than that proposed for electric storage water heaters. (AHRI, No. 91 at p. 3)

Rheem asserted that low-boy electric water heaters (*i.e.,* electric storage water heaters ranging from 20 to 50 gallons) are typically installed under a counter or stacked (air handler) in high-density housing, such as apartment and condominium communities. According to Rheem, any size increase driven by a significant change in the EF requirements would affect the product geometry (diameter and height) and drive the potential use of multiple, smaller, point-of-use electric or instantaneous electric water heaters. (Rheem, No. 89 at p. 11)

ACEEE asserted that low-boy water heaters designed to fit beneath conventional cabinets are similar to "table-top" units, with similar trade-offs in terms of capacity and improved efficiency (through thicker insulation). ACEEE agrees with DOE's reasoning in the December 2009 NOPR that low-boys can be designed to meet the proposed standards by using thicker insulation, higher set-point settings, and a tempering valve, and, therefore, ACEEE opined that, in general, no special product class is needed. However, as a compromise, ACEEE stated that it could support a special class for low-boys designed for small living units, but with an upper capacity limit of 30 gallons, in order to prevent "leakage" of lower-efficiency units into the general water heater applications. If larger units are also included, ACEEE expressed concern that significant growth in low-boy sales would be expected, leading to a significant loss in energy savings relative to use of higher-efficiency conventional units. (ACEEE, No. 79 at pp. 8–9)

EarthJustice stated that a separate product class for low-boy water heaters is not justified. According to the commenter, DOE's analyses demonstrate that water heaters in these configurations can meet the efficiency standards under consideration for electric-storage and gas-storage water heaters, respectively (*see* 74 FR 65852, 65869 (Dec. 11, 2009)). (EarthJustice, No. 83 at p. 1)

NRDC also stated that "low-boy" water heaters do not warrant a separate product class, because these products could become a low-cost loophole to the standard if allowed to be less efficient than traditional tank-type water heaters. (NRDC, No. 85 at p. 6)

ASAP agreed with DOE's position not to establish a separate product class for low-boy water heaters, as presented in the December 2009 NOPR. ASAP warned DOE to keep a close eye on lower standards for particular product classes, which can result in market shares for those products increasing and reduction of the overall energy savings associated with the energy conservation standards. (ASAP, Public Meeting Transcript, No. 57.4 at p. 60)

After careful consideration, DOE does not agree with certain commenters that a separate product class needs to be established for low-boy 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 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 as other water heaters (*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. DOE acknowledges that low-boy water heaters are only offered in certain volume sizes, which tend to be at the lower end of the range (*i.e.,* below 50 gallons). While many of the commenters pointed to specific size-constrained applications where low-boy water heaters are installed, DOE reviewed the market and found that low-boy water heaters are generally classified as water heaters that have a shorter height and wider diameter. However, unlike tabletop water heaters, low-boy water heaters did not seem to have a uniform or common platform size. Instead, the physical dimensions of low-boy water heaters varied by manufacturer, model, and efficiency, but this is also true of the entire electric storage water heating market. Water heater manufacturers offer a range of options to consumers, including various physical dimensions that are not unique to low-boy units. (*See* chapter 3 of the TSD.) Furthermore, DOE does not believe each different combination of physical dimensions currently available on the market warrants a separate product class. DOE reaffirmed its position in the December 2009 NOPR that 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's research suggests that there are currently multiple low-boy units offered that will meet the standards being adopted in today's final rule for electric storage water heater less than 55 gallons. Specifically, DOE found multiple low-boy models at 0.95 EF with a rated storage volume of 50 gallons. Consequently, for the reasons above, DOE is not establishing a separate product class for low-boy water heaters.

ii. Ultra-Low NO_X Water Heaters

In the December 2009 NOPR analysis, DOE did not propose to establish a separate product class for ultra-low NO_X gas-fired storage water heaters. 74 FR 65852, 65869–70 (Dec. 11, 2009). However, DOE did specifically analyze these water heaters as compared to traditional gas-fired storage water heaters with standard burners. 74 FR 65852, 65882–83 (Dec. 11, 2009). In response to the treatment of ultra-low NO_X gas-fired storage water heaters in the December 2009 NOPR, DOE received a number of different comments. A.O. Smith, BWC, AHRI, and Rheem urged DOE to establish a separate product class for ultra-low NO_X gas-fired water heaters. (A.O. Smith, No. 76 at p. 2; BWC, 61 at p. 3; AHRI, No. 91 at p. 3; A.O. Smith, Public Meeting Transcript, No. 57.4 at pp. 56–57; and AHRI, Public Meeting Transcript, No. 57.4 at pp. 57–58) On the other hand, ACEEE, EarthJustice, and NRDC agreed with DOE's position in the December 2009 NOPR that ultra-low NO_X gas-fired water heaters should not have their own product class. Further details provided by each commenter are presented below.

A.O. Smith asserted that the burner technology needed to comply with the South Coast Air Quality Management District's (SCAQMD) ultra-low NO_X requirements and the changes to the water heater technology that are needed to meet increased efficiency requirement are "operationally contradictory" with each other. The types of burners currently used to comply with the ultra-low NO_X requirement in atmospheric heaters are much more restrictive (higher pressure drop) than conventional burners. Since these ultra-low NO_X heaters also must comply with the flammable vapor ignition resistance requirements, they also have flame arrestors on the air inlet, which add more restriction (pressure drop) to the system. In order to boost the efficiency, the flue baffle must be made more effective, which means making it more restrictive. The increased pressure drops due to all three components taken together is enough to offset the thermal buoyancy of the atmospheric venting design, and cause the heater to no longer work. The only way to overcome the additional restriction would be to add a blower and/or power-burner to the heater, which would greatly increase the manufacturing and installation costs of the heater. (A.O. Smith, No. 76 at p. 2)

BWC asserted that ultra-low NO_X gas-fired water heaters should be a separate product class because they have distinct design differences compared to standard atmospheric gas water heaters. The unique design requirements for ultra-low NO_X gas-fired water heaters greatly limit their capacity to increase the efficiency while maintaining a lower level of emissions. (BWC, 61 at p. 3)

AHRI challenged the December 2009 NOPR's tentative conclusions that ultra-low NO_X gas-fired models provide the same utility as standard gas-fired storage water heaters, while simply using a distinct burner to achieve the ultra-low NO_X emissions. AHRI argued that standard gas-fired water heaters do not offer the same utility as the ultra-low NO_X models because the standard gas-fired water heater cannot heat water efficiently while also emitting NO_X at a very low rate. Regardless of its efficiency, a standard residential gas-fired water heater cannot be sold or installed in many areas in California. According to AHRI, the feature of ultra-low NO_X emissions is a unique performance characteristic that imposes different conditions on how, and at what expense, the efficiency of these models can be increased. As is the case with low-boy electric models, AHRI asserted that ultra-low NO_X water heaters should have a separate product class with a minimum EF standard that is 0.01 less than that proposed for gas-fired storage water heaters. (AHRI, No. 91 at p. 4)

ACEEE stated that there is no reason for a separate product class with separate standards for ultra-low NO_X water heaters. According to ACEEE, these units can meet the same standards as conventional equipment, if they incorporate induced draft (power vent) to compensate for the combined pressure drop of the better baffle, FVIR, and ultra-low NO_X burner. If stakeholders want an exception, the commenter suggested that this should be dealt with by the waiver process rather than by establishing another dead-end class of atmospherically vented equipment. (ACEEE, No. 79 at p. 9)

EarthJustice stated that a separate product class for ultra-low NO_X gas-fired water heaters is not justified. The commenter pointed to DOE's own analysis, which arguably demonstrates that water heaters in these configurations can meet the efficiency standards under consideration for electric storage and gas storage water heaters, respectively (*see* 74 FR 65852, 65869, 65881 (Dec. 11, 2009)). (EarthJustice, No. 83 at p. 1)

NRDC likewise argued that there should not be a separate product class for ultra-low NO_X gas-fired water heaters. NRDC stated that the efficiency requirements considered in the rulemaking can be met in ultra-low NO_X gas-fired units by moving to power vent technology and probably with other routes. Therefore, the commenter concluded that there is no need to allow a less-stringent standard for these products when the proposed requirements can be met. (NRDC, No. 85 at p. 6)

After considering public comments on this issue, DOE has decided not to change its position from the December 2009 NOPR and continues to believe that a separate product class does not need 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. Some of the commenters pointed out that the increased pressure drops could adversely impact the efficiency levels. DOE agreed with this assertion and maintained its methodology for handling ultra-low NO_X gas-fired storage water heaters, which included development of a separate analysis for these products, as detailed in the December 2009 NOPR. 74 FR 65852, 65881–82 (Dec. 11, 2009). *See* section IV.C.2.a for additional details. This analysis showed that implementing power venting and the same insulation increases as those for standard gas-fired water heaters would result in slightly lower efficiencies due to the additional pressure restrictions resulting from the addition of the ultra-low NO_X burner. Therefore, DOE implemented technologies at lower efficiency levels for ultra-low NO_X gas-fired storage water heaters in order to achieve the same efficiencies as those identified for standard gas-fired storage water heaters. Based on the teardown analysis of ultra-low NO_X water heaters, DOE believes that ultra-low NO_X gas-fired storage water heaters will be able to meet the standards that are being adopted in today's final rule using available technologies currently on the market. Therefore, for the above reasons, DOE has decided not to establish a separate product class for ultra-low NO_X gas-fired storage water heaters in this final rule.

iii. Heat Pump Water Heaters

Throughout the rulemaking, DOE has treated heat pump water heaters as a design option for electric storage water heaters rather than a separate product class, as further explained and detailed in the preliminary analysis. (*See* Chapter 2 of the preliminary analysis TSD and the discussion in the December 2009 NOPR (74 FR 65852, 65870–81 (Dec. 11, 2009).) A heat pump water heater represents a merging of two technologies: (1) An electric resistance storage water heater with tank and controls; and (2) a refrigeration circuit similar to that found in a residential air-conditioner. Heat pump water heaters use existing heat pump technology to extract heat from the surrounding air (typically at room temperature) for heating stored water. For electric water heaters, this is an alternative to resistive heating, which transfers heat from the electric resistance element to the water. DOE received several comments from interested parties in response to its treatment of heat pump water heaters and its request for comment on some of the issues identified surrounding heat pump water heaters. Some commenters urged DOE to establish separate product classes for traditional electric resistance storage water heaters and heat pump water heaters, while others agreed with DOE's classification of heat pump water heaters. Their specific comments and DOE's response are presented below.

General Electric stated support for DOE's proposal to not create a separate product class for heat pump water heaters, as they are designed to replace traditional electric water heaters in most residences, and have similar consumer functionalities. (GE, No. 84 at p. 1)

Daikin asserted that electric resistance water heaters should be placed in the same product class as heat pump water heaters. Anecdotally, Daikin stated that in the European Union, the European Parliament has classified both of these products in the same category for energy efficiency regulatory purposes, and the commenter further stated that in Japan, electric resistance water heaters have practically disappeared from the market as of 2010. In addition, Daikin stated that heat pump water heaters usually have a back-up electric heater. If heat pump water heaters are classified separately, there will be a difficult question about whether the back-up electric heater requires heat pump water heating systems to remain in the other category for some purposes. However, Daikin suggested that if DOE decides to establish a heat pump water heater product class, then it should be subdivided based on the following three criteria: (1) Refrigerant type; (2) heat source (*i.e.,* air to water heat pump); and (3) add-on or integrated type system (*i.e.,* heat pump system and a tank). (Daikin, No. 82 at pp. 1–2)

Northwest Energy Efficiency Alliance (NEEA) stated there is not a need for a separate class of water heaters based on heat pump versus resistance elements. According to NEEA, all of the current product offerings have a first-hour rating that is equivalent to an electric resistance heated product of the same size. From a consumer utility standpoint, the products are equivalent in terms of delivery of hot water for an equivalent tank size. These products are all designed as integrated, "drop-in" replacement units according to product literature that NEAA has reviewed from A.O. Smith, Rheem, and General Electric. (NEEA, No. 88 at p. 2)

In its comments, EarthJustice opposed establishing a separate product class for heat pump water heaters, based on the following rationale. EarthJustice asserted that EPCA provides both mandatory and permissive authority for DOE to establish new product classes for covered products. (*See* 42 U.S.C. 6295(o)(4) and (q)(1)) However, aside from the unique situation of a covered product capable of consuming different kinds of energy (42 U.S.C. 6295(q)(1)(A)), EarthJustice argued that EPCA only mandates the creation of multiple product classes when the failure to do so would eliminate certain truly unique product attributes from the market. (42 U.S.C. 6295(o)(4)) In contrast, while DOE does have discretion to create separate classes for products based on the presence of "a capacity or other performance-related feature," the Department may exercise this authority only if "such feature justifies a [different] standard." 42 U.S.C. 6295(q)(1)(B)) For the reasons explained below, EarthJustice argued that the plain language of EPCA forecloses an interpretation that the establishment of separate product classes for electric resistance and heat pump water heaters is warranted or required. First, EarthJustice stated that as DOE notes in the December 2009 NOPR, there is no distinction between heat pump and electric resistance water heaters with regard to operational utility. Accordingly, EarthJustice argued that because heat pump and electric resistance water heaters provide identical service, there is no basis for DOE to conclude that separate product classes for these technologies are necessary to preserve the availability in the market of a distinct "feature" with utility to the user of the product (*see* 42 U.S.C. 6295(o)(4)).

At the public hearing on the December 2009 NOPR, representatives from some manufacturers asserted that a separate product class for heat pump water heaters was needed to address the fraction of households that would otherwise experience higher-than-normal installation costs to replace a water heater using electric resistance heating with one using a heat pump. However, EarthJustice stated that even if DOE's analysis confirms that there is a cost penalty to install a heat pump water heater in some applications, this fact, standing alone, would not support the creation of separate product classes for heat pump and electric resistance water heaters. In all standards rulemakings, EarthJustice reasoned that some households will face higher incremental costs to install products meeting revised standards, but the proper approach under EPCA is to consider these impacts in calculating consumers' average lifecycle cost and payback period for the standard levels under consideration (*see* 42 U.S.C. 6295(o)(2)(B)(i)(II)). According to EarthJustice, to use an increase in the installed cost for a portion of shipments as the basis for a separate product class would be an end-run around the other factors Congress required DOE to consider in assessing the economic justification for a standard (*see* 42 U.S.C. 6295(o)(2)(B)(i)). The commenter suggested that DOE's recent statements in the commercial clothes washers rulemaking reinforce this point. There, an industry commenter argued that a particular product design merited a separate product class on the basis of its low installed cost. 75 FR 1122, 1130 (Jan. 8, 2010). In response, DOE explained that it "does not consider first cost a 'feature' that provides consumer utility for purposes of EPCA. DOE acknowledges that price is an important consideration to consumers, but DOE accounts for such consumer impacts in the [lifecycle cost] and [payback period] analyses conducted in support of this rulemaking." *Id.* at 1134. EarthJustice stated that DOE's refusal to use installed costs as the basis for a separate product class for commercial clothes washers is faithful to EPCA's text, and there is no justification for adopting a contrary approach for water heaters. (EarthJustice, No. 73 at pp. 1–3)

NRDC also stated that heat pump water heaters do not warrant a separate product class since heat pump water heater and an electric tank type water heater provide the same consumer utility. (NRDC, No. 85 at p. 5)

On the other hand, Southern Company (Southern) stated its belief that there is more of a functional difference between heat pump water heaters and electric resistance water heaters than with other products for which DOE has established separate product classes, including refrigerators (top freezer versus side-by-side), window air conditioners (for location of louvers), and transformers (a multitude of different phases and sizes). Southern Company argued that heat pump water heaters should be treated as a separate product class because the heat pump water heater transfers cold air from the heat pump to the surrounding space and are noisier than electric resistance water heaters. (Southern, No. 90 at p. 5)

BWC recommended a separate product class be established for heat pump water heaters because the primary fuel source is air instead of electricity. Heat pump water heaters can attain greater efficiencies, because while electricity is being converted to heat the water like a typical electric resistance water heaters, heat is also being moved from the surrounding environment to the stored water via the heat pump. In order for heat pump water heaters to maximize efficiency, they must recover slowly, which changes the utility of the water heater. According to BWC, the same size heat pump water heater is not providing the same performance as the equivalent size electric resistance heater. (BWC, No. 61 at p. 4)

AHRI reaffirmed its position that heat pump water heaters should be a separate product class. AHRI argued that DOE's tentative conclusion that heat pump water heaters do not require a separate product class because they provide hot water just like a traditional electric storage water heater is invalid because it fails to recognize how the heat pump water heater produces that hot water and how the heat pump water heater's performance is effected by the environment in which it is installed. AHRI asserted that the following characteristics make heat pump water heaters unique: (1) Water is heated by energy extracted from the air; (2) the heating capacity is variable depending on the temperature of the air provided to the heat pump; (3) the unit cannot heat water above approximately 135 degrees Fahrenheit; (4) the unit must be installed in a space large enough to provide the necessary volume of air for the unit to adequately heat water; (5) the unit cools the air in the household; (6) the unit requires a condensate drain as part of the installation; (7) the unit cannot be adjusted to meet increases in demand without relying on the electric resistance elements; (8) the unit can heat water as long as there is adequate airflow through the heat pump, and thus, a heat pump with electrical power but with a clogged air filter will not heat water; and (9) the unit needs a back up water heating means that can operate when the heat pump cannot meet the load. (AHRI, No. 91 at pp. 4–6)

In response to these NOPR comments, DOE does not agree that heat pump water heaters meet the requirements for establishing 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 does. While AHRI noted that heat pump water heaters utilize heat extracted from the air to heat the water, both heat pump water heaters and traditional electric resistance storage water heaters use electricity as the primary fuel source. AHRI's recitation of operational differences associated with water heaters that utilize heat pump technology does not establish that the mode of heating water is performance-related feature or provides a unique utility. As pointed out by GE, current manufacturers of heat pump water heaters are marketing these products as direct replacements for traditional electric resistance water heaters. The rated storage volumes and first hour ratings of the heat pump water heaters currently on the market are comparable to the traditional electric resistance water heaters. Some of the commenters pointed out that heat pump water heaters require special installation considerations, but to account for this, DOE applied in its analysis specific installation costs, where applicable, to heat pump water heaters. (*See* section IV.F.2 of today's notice for more details on treatment of the installation costs.) Consequently, DOE has concluded that heat pump water heaters can replace traditional electric resistance storage water heaters in most residences, although the installation requirements may be quite costly. For these reasons, DOE has decided not to establish a separate product class for heat pump water heaters.

iv. Unpowered Gas-Fired Water Heaters

The American Gas Association (AGA) asserted that unpowered gas-fired storage water heaters should be an independent product class. An unpowered gas-fired storage water heater is one that does not utilize line electricity in order to provide hot water to the residence. For many customers during a power outage, unpowered gas-fired water heaters are the only utility system that provides a source of heat. AGA believes that this occurrence is sufficiently frequent to justify the treatment of unpowered gas-fired storage water heaters as an independent product class, consistent with DOE's charge to establish product classes based on type of energy used, capacity, and in this case, "other performance-related feature" such as those that provide utility to consumers. (AGA, No. 78 at pp. 6–7)

DOE does not agree with AGA's assertion that unpowered gas-fired storage water heaters meet the criteria for the establishment of a separate product class. Both powered and unpowered gas-fired storage water heaters use gas as the primary fuel source, and both provide the same basic utility to consumers, which is to supply hot water to the residence. DOE does not believe that having the ability to maintain hot water during power outages when the electricity is not working provides enough additional utility to consumers to warrant a separate product class. DOE believes that power outages are infrequent events that can be handled by a number of different market solutions such as back-up power systems.

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 (*e.g.,* fan wall units contain circulation blowers), intended installation (*e.g.,* floor furnaces are installed with the majority of the unit outside of the conditioned space), and input capacity.

In the December 2009 NOPR, DOE proposed consolidating the product classes for four types of DHE and adding product classes for one type of DHE. DOE discusses the full details of its proposals in the December 2009 NOPR. 74 FR 65852, 65871–72 (Dec. 11, 2009). In response to the proposed product class consolidation, AHRI took the position that the Federal energy conservation standards should not change for direct heating equipment, which would include not consolidating any of the existing BTU range categories or range levels. (AHRI, Public Meeting Transcript, No. 57.4 at p. 85)

Empire Comfort Products (Empire) stated that if DOE condenses the product classes for direct heating equipment, it will reduce the manufacturers' flexibility to increase efficiency. (Empire, Public Meeting Transcript, No. 57.4 at p. 86)

Neither AHRI nor Empire provided any additional insight to explain why the proposed reduction in product classes would limit a manufacturer's ability to increase the efficiency of direct heating equipment. DOE believes the consolidation of product classes reflects the current models offered by manufacturers. As discussed in the December 2009 NOPR, DOE carefully reviewed product catalogs and performance directories to determine the relationship between AFUE and input rating found among products listed in the AHRI Directory. For each of the five types of DHE, DOE found that manufacturers do not produce products in some of the input capacity ranges or that some of the efficiency characteristics of these products are similar. DOE explained each of these changes in the NOPR along with its proposal to further consolidate the product classes, where applicable. 74 FR 65852, 65871–72 (Dec. 11, 2009). For each product class, DOE characterized this relationship, and the commenters have provided no data or rationale as to why DOE's characterization was incorrect. Consequently, DOE is adopting the consolidated product classes as proposed in the December 2009 NOPR. Table IV.2 presents the product classes for DHE being adopted by this rulemaking.

TABLE IV.2—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.

TABLE IV.2—PRODUCT CLASSES FOR DIRECT HEATING EQUIPMENT—Continued

Direct heating equipment type	Input heating capacity *Btu/h*
	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 in the December 2009 NOPR, 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). 74 FR 65852, 65872 (Dec. 11, 2009).

B. Screening Analysis

The purpose of the screening analysis is to evaluate the technology options identified in the market and technology assessment as having the potential to improve the efficiency of products and to determine which technologies to consider further and which to screen out based on the four screening criteria. DOE consulted with industry, technical experts, and other interested parties to develop a list of technologies for consideration. DOE then applied the following four screening criteria to determine which design options are suitable for further consideration in the standards rulemaking:

1. *Technological feasibility.* DOE considers 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 considers 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.

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

As presented in the December 2009 NOPR, DOE identified a number of technology options that might be used to improve the efficiency of residential heating products during the market and technology assessment. 74 FR 65852, 65872–79 (Dec. 11, 2009). *See* chapter 3 of the December 2009 NOPR and final rule TSDs for more information and the complete list of technologies identified by DOE. DOE then applied the screening criteria listed above to determine which technologies would be carried through the analysis. Table IV.3 through Table IV.5 show the technology options that were screened-in during the December 2009 NOPR screening analysis.

TABLE IV.3—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.4—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.5—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.

1. Comments on the Screening Analysis

In response to the screening analysis presented in the December 2009 NOPR, DOE received several comments from interested parties.

In the December 2009 NOPR, CO_2 heat pump water heaters were a technology option screened out by DOE for electric storage 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. 74 FR 65852, 65873 (Dec. 11, 2009). In general, ACEEE stated that it strongly objected to the screening analysis because DOE considered only technologies available in U.S.-manufactured water heaters and screened out technologies used in other domestic products, as well as ones used in the global market. (ACEEE, No. 79 at p. 2) ACEEE stated that DOE's screening out of CO_2 as a heat pump water heater refrigerant is absurd, given the fact that 1.7 million of them had been sold worldwide through the end of 2008, and that there is a 5-year lead time before the standards compliance date in which manufacturers could design a CO_2 heat pump water heater. (ACEEE, No. 79 at p. 2)

Conversely, Rheem commented that CO_2 refrigerants were appropriately screened out. (Rheem, No. 89 at p. 8) AHRI noted that there is a huge heat pump business in the U.S. for air conditioning and space heating, and no significant percentage of those products use CO_2 as the refrigerant. DOE believes AHRI is using the air conditioning and space heating industry as an example of an industry with significant expertise in working refrigerants, but that still does not use CO_2 refrigerants in its heating and cooling products. Even though DOE is investigating the use of CO_2 as a refrigerant in water heating applications, AHRI's example demonstrates that U.S. manufacturers and service industries do not have the expertise in using or handling CO_2 as a typical refrigerant in cooling applications. Therefore, AHRI stated its belief that CO_2 heat pumps have been properly screened out because it is not the prevailing technology in North America. Further, AHRI stated that for standards that will apply to U.S. industry, DOE should not unnecessarily expand this rulemaking by looking at what might be happening in other parts of the world. (AHRI, Public Meeting Transcript, No. 57.4 at pp. 133–134) A.O. Smith stated that CO_2 heat pump water heaters sold and installed in Japan are certified to different levels of standards requirements than those that exist in the U.S., and those heat pump water heaters would not be certifiable in the U.S. (A.O. Smith, Public Meeting Transcript, No. 57.4 at pp. 134–135)

In response, DOE believes that CO_2 heat pump water heaters were properly screened out during the December 2009 NOPR analysis. DOE notes that technologies are not screened out solely because they are not yet available in the U.S. market. Technologies, such as CO_2 heat pump water heaters, which are available overseas, are screened out if the U.S. does not have the necessary infrastructure to support such a technology on the scale necessary by the compliance date of the standard. As described in chapter 4 of the final rule TSD (Screening Analysis), CO_2 heat pump water heaters were screened out because the necessary infrastructure to support manufacturing, installation, and service of CO_2 heat pump water heaters is not available in the United States, and will not be available on the scale necessary to serve the relevant market at the time of the compliance date of the standard. ACEEE did not provide any new evidence that would cause DOE to change its position on this issue, and, therefore, DOE continued to screen out CO_2 heat pump water heaters for the final rule analysis. DOE notes that pursuant to Section 612 of the Clean Air Act, the U.S. EPA has found CO_2 an acceptable refrigerant for use in the U.S. in certain applications (*e.g.,* retail food refrigeration), but has not made such a ruling on the use of CO_2 in water heating heat pumps. EPA indicates that to date it has not received any submission under the SNAP program for the use of CO_2 in such devices. For additional information on EPA's Significant New Alternative Policy (SNAP) program (*see http://www.epa.gov/ozone/snap/*.)

ACEEE asserted that DOE fails to differentiate between low-voltage (*i.e.,* 24 volt) and line-voltage (*i.e.,* 120 volt) power requirements for gas-fired equipment auxiliaries such as igniters, controls, and fans. The commenter stated that line voltage requires a power outlet reachable by a 6 foot power cord on the water heater, which would require a new outlet in some retrofits, while a remote low-voltage plug-in power supply can use much longer supply lines that could support electronic ignition and electro-mechanical flue dampers. ACEEE stated that a recent study of standby losses of atmospheric water heaters shows losses large enough that ACEEE infers that these features would be quite cost-effective, and that such products have been demonstrated in the past (for the SCAQMD) and in gas stoves. (ACEEE, No. 79 at p. 3) ACEEE stated that requiring gas-fired appliances to have an electrical connection does not diminish utility because it is not an issue in the minds of the public, and if the capability of gas-fired products to operate during power outages was important, then local building codes would require backup non-electric heating capabilities for houses with electric water heaters. (ACEEE, Public Meeting Transcript, No. 57.4 at pp. 38–39)

In response, DOE agrees with ACEEE that requiring gas-fired appliances to have an electrical connection does not diminish utility, and DOE notes that this rationale was not provided for screening out any of the technologies that DOE did not consider in the analysis. Further, DOE notes that many of the design options for gas-fired appliances included electronic components, such as electronic ignitions and power venting.

Louisville Tin & Stove (LTS) commented that the proposed standards for DHE would reduce consumer utility because they would lose the ability to heat without electricity and/or lose the ability to retrofit. (LTS, No. 56.7 at p. 2) Empire stated adding components that require electricity would cause the elimination of the gas wall gravity, gas room, gas floor, and gas hearth categories because their main purpose is to provide efficient heating and be able to provide heat during a power outage or for consumers who do not have electricity. (Empire, No. 100 at p. 2)

Although DOE recognizes the consumer utility of direct heating equipment that can be operated in the event of a power outage, DOE also notes that there are direct heating equipment available on the market equipped with an electronic ignition that utilize battery backup systems to allow for operation during power outages. As a result, DOE does not believe the use of an electronic ignition would reduce the consumer utility of direct heating equipment. DOE also does not believe that adding electrical components would reduce the ability to retrofit these products, thereby causing the elimination of product classes. The addition of certain electrical components (*e.g.,* an electronic ignition) does not require products to be any larger than products currently available that have no electric components, and thus, DOE does not believe this will prevent products from being retrofitted. DOE also does not believe adding larger electrical components (*e.g.,* blower fans) would cause the elimination of any products, because DOE only considers the addition of blower fans for certain product classes which have products that have demonstrated that the technology is possible (*i.e.,* gas wall fan DHE, gas room DHE, and gas hearth DHE). For gas wall gravity DHE, where the inclusion of a fan would shift products into the gas wall fan DHE product class, DOE does not consider a fan as a design option.

However, DOE does recognize that in certain instances, consumers will have to install electrical power outlets near the heating equipment, thereby increasing the cost of retrofitting the product. These costs are addressed during DOE's analysis of installation costs and are described in section IV.F.2 of this document. Accordingly, DOE continued to screen-in electronic ignition and other electronic components for the final rule analysis of direct heating equipment.

2. Heat Pump Water Heater and Condensing Gas-Fired Storage Water Heater Discussion

In the December 2009 NOPR, DOE specifically requested comment regarding the screening process for the advanced technologies used as the basis for the max-tech levels for gas-fired storage and electric storage water heater (*i.e.,* heat pump water heaters and condensing gas-fired storage water heaters). 74 FR 65852, 65878 (Dec. 11, 2009). DOE received a multitude of comments on this topic, which are summarized below.

a. Condensing Gas-Fired Water Heaters

DOE received several comments specifically related to condensing gas-fired water heater technology. ACEEE noted that all three of the full-line water heater manufacturers in the U.S. currently manufacture commercial condensing products. (ACEEE, Public Meeting Transcript, No. 57.4 at p. 127) Further, ACEEE stated that at least one condensing gas-fired storage water heater is actively marketed for residential applications and is shipped with a residential thermostat. ACEEE recognized that this product is easy to install, with height, diameter, and installation requirements similar to standard power-vent units. ACEEE asserted that the only skills required for installing condensing gas-fired water heaters, beyond those already required for installing conventional gas-fired water heaters, are those common to the installation of condensing furnaces and air conditioners—cutting and gluing PVC pipe, and hooking up a condensate pump, if required. (ACEEE, No. 79 at p. 11)

ASAP stated that the manufacturing capacity required for condensing gas-fired storage water heaters at TSL 5 (*i.e.,* approximately 4 percent, as estimated in the December 2009 NOPR) would be well within the capacity of manufacturers to serve the market. (ASAP, Public Meeting Transcript, No. 57.4 at p. 126) AHRI stated that manufacturers could probably convert their production of 75-gallon gas-fired water heaters to make only condensing 75-gallon gas-fired storage water heaters within five years. (AHRI, Public Meeting Transcript, No. 57.4 at p. 119)

In addition, A.O. Smith stated that they manufacture commercial condensing gas-fired water heaters that are ultra-low NO_X, and, therefore, it is technologically feasible to have an ultra-low NO_X condensing water heater. (A.O. Smith, Public Meeting Transcript, No. 57.4 at p. 123)

In light of the comments above from interested parties supporting the technologically feasibility and the practicability of manufacturing, installing, and servicing condensing gas-fired water heaters, DOE has concluded that this technology option was appropriately screened-in and considered during the December 2009 NOPR analysis, and DOE continued to consider condensing gas-fired water heaters in the final rule analysis.

b. Heat Pump Water Heaters

DOE received several comments specifically related to the screening analysis for heat pump water heater technology. These comments related to adverse impacts on product utility, as well as the practicability to manufacture, install, and service heat pump water heaters.

Regarding adverse impacts on product utility, the American Public Power Association (APPA) commented that for electric storage water heaters at TSL 5 and TSL 6 (*i.e.,* levels requiring heat pump water heater technology), the utility of the product would be lessened, although no further explanation was provided. (APPA, No. 92 at p. 3) Rheem stated that the utility of heat pump water heaters is not equivalent to electric storage water heaters because of the reduced delivery performance of heat pump water heaters. As evidence of the reduced delivery performance, Rheem cited ENERGY STAR's requirement of a minimum first hour rating of 50 gallons for heat pump water heaters, which is below the 67 gallons that Rheem claimed is typical for conventional technologies at that capacity. (Rheem, No. 89 at p. 8) The first hour rating is the amount of hot water in gallons the heater can supply per hour (starting with a tank full of hot water). If the first hour rating were reduced for heat pump water heaters, this would impact consumer utility because the water heater would not provide the consumer with the same amount of hot water as with a traditional electric resistance water heater.

In response, DOE does not believe that any lessening of utility will occur for electric storage water heaters that use heat pump water heater technology, as asserted by APPA and Rheem. In response to APPA's comment (as explained in the December 2009 NOPR), DOE does not believe the use of heat pump technology will diminish the utility of electric storage water heaters, and DOE believes that these products will provide the same utility to the consumer as electric storage water heaters using traditional electric resistance technology. 72 FR 65852, 65876–77 (Dec. 11, 2009). In response to Rheem's assertion that heat pump water heaters provide a reduced first hour rating, and thereby reduce consumer utility, DOE examined the first hour ratings of heat pump water heaters available on the market. DOE identified heat pump water heaters currently available on the market that have first hour ratings of up to 67 gallons, which Rheem states is typical for an electric resistance water heater. DOE also notes that electric storage water heater models in the AHRI Directory of certified equipment at the representative 50-gallon storage volume have first hour ratings ranging from 48 to 68 gallons, and for 50-gallon heat pump water heaters currently available on the market, the first hour ratings range from 63 to 67 gallons. Thus, DOE has concluded that the integrated heat pump water heater technology does not cause any lessening of utility since it provides similar first hour ratings as water heaters that utilize electric resistance technology.

Regarding practicability to manufacture, install, and service heat pump water heaters, DOE received numerous comments from interested parties. The views of interested parties are summarized below, along with DOE's conclusions based on the results of the comments received.

AHRI stated that to convert the U.S. water heater industry from producing four million electric resistance units per year to all heat pump water heaters is an unreasonable expectation. (AHRI, Public Meeting Transcript, No. 57.4 at p. 90) AHRI pointed out that converting existing product lines to manufacturing of heat pump water heaters would be difficult, because manufacturers would continue to manufacture electric resistance water heaters in order to meet consumer demand before the compliance date of the standard. (AHRI, Public Meeting Transcript, No. 57.4 at pp. 101–103)

Bock asserted that with heat pump water heaters, there is no infrastructure to teach and train technicians to properly install and maintain those units. Bock asserted that training technicians of electric resistance, gas-fired, and oil-fired water heaters to install and maintain heat pump water heaters could not be done quickly. (Bock, Public Meeting Transcript, No. 57.4 at p. 96) Similarly, Bradford White stated that there is no infrastructure to repair and maintain heat pump water heaters. Bradford White stated that water heater service contractors would need to be extensively retrained, and that it would be impossible for them to train plumbers to install and maintain heat pump water heaters in sufficient time. (Bradford White, No. 61 at p. 3)

In support of heat pump water heaters, GE stated that it does believe that heat pump water heaters are manufacturable in a reasonable timeframe. (GE, No. 84 at p. 1) Further, GE commented that it currently has a nationwide network for heat pump water heater product service, and is developing a nationwide installation base to ensure that its consumers can readily purchase, install, and repair their heat pump water heaters. (GE, No. 84 at p. 1) The commenter noted that it is currently working with two national partners and numerous regional distributors to have its heat pump water heater available in most markets and to develop its water heater installation network. GE forecasted that the availability, service, installation, and manufacturability of heat pump water heaters will not present a significant obstacle to the market acceptance of such units. (GE, No. 84 at p. 2) The commenter stated that installation of a heat pump water heater is only slightly more complex than installing an electric resistance water heater, and is easily within the capabilities of any residential plumber. GE did acknowledge that service of the sealed refrigeration system can be more complex, but stated that it believes that this can be adequately handled by the national network of appliance technicians and plumbers. (GE, No. 84 at p. 2)

NPCC commented that several manufacturers already have heat pump water heater products and business plans to sell heat pump water heaters over the next five years, a schedule well before the compliance date of the relevant amended energy conservation standards. Therefore, NPCC believes that it is within the ability of manufacturers to produce heat pump water heater units on the scale necessary to serve the market for large-volume products. (NPCC, Public Meeting Transcript, No. 57.4 at p. 107) NPCC also stated that it believes there is adequate lead time for those manufacturers who still must develop new products, since standards will not take effect for five years. (NPCC, No. 87 at p. 5) Further, NPCC stated that DOE's concern about the manufacturability of heat pump water heaters and the capacity of manufacturers to ramp up production are overstated, because two major manufacturers already appear committed to manufacturing significant quantities of heat pump water heaters and a third manufacturer also appears likely to do the same. NPCC asserted that because new energy conservation standards for water heaters will not go into effect for five years, manufacturers will have ample time to "ramp up" the production of these high-efficiency models to meet the limited market expected at TSL 5. (NPCC, No. 87 at pp. 5–6) Regarding practicability to install heat pump water heaters, the commenter stated that heat pump water heaters currently on the market are drop-in replacements for electric resistance water heaters, and are advertised as such by manufacturer literature. NPCC commented that this fact, along with the fact that a national home improvement chain has agreed to sell Rheem's heat pump water heater unit, are evidence that both manufacturers and retailers believe that the installation of "advanced" water heater technology is not a significant barrier to its adoption. (NPCC, No. 87 at pp.3–4) NPCC stated that DOE's concern regarding whether the service infrastructure's lack of familiarity with advanced technologies would act as a deterrent to their adoption also appears unwarranted, due to the fact that: (1) Manufacturers are already offering these products; (2) manufacturers will have 5 years to train and deploy a service force; (3) major manufacturers with product on the market offer a 10-year warranty; (4) GE has a set up a nationwide network of authorized service technicians who are being trained to both install and service its "advanced technology" water heaters; and (5) Rheem has stated that its heat pump water heater uses a sealed heat pump and that no HVAC experience is needed, so no additional service technician training is required. (NPCC, No. 87 at p. 4)

NEEP stated that based on the documented ENERGY STAR-qualified water heating units on the market, heat pump water heaters and condensing gas water heaters are commercially viable, manufacturable, and have a growing infrastructure of service and maintenance professionals. (NEEP, No. 86 at p.1) NEEP stated that according to a recent advertisement by Rheem and the Home Depot, their ENERGY STAR-qualified heat pump water heater "installs as easily as a standard electric storage water heater," and thus, NEEP commented that installation issues are clearly not as serious as many manufacturers claim. (NEEP, No. 86 at p. 2)

NEEA commented that regarding a potential scale-up in response to a large utility program opportunity that was being considered for heat pump water heaters, major manufacturers assured them that scale-up to large manufacturing numbers is not a limiting factor. (NEEA, No. 88 at pp. 2–3) The commenter stated all of the heat pump water heater units being offered for sale are designed as drop-in integrated units that require no more connections than a conventional electric resistance tank. NEEA asserted that there is nothing in principle about heat pump water heater technology that makes it substantively more difficult than a current replacement with a standard electric tank. NEEA also stated that all heat pump water heaters offered for sale in 2010 have sealed refrigeration components (similar to a refrigerator or a room air-conditioner that do not require service) and have 10-year warranties, an indication of manufacturers' confidence in the long-term reliability of the systems. NEEA commented that a duct to vent cold air to the outdoors is required in some heat pump water heater installations, and that installing such a duct is no more complicated than installing a flue for a gas-fired water heater, which is well within the skill set of existing water heater installers. (NEEA, No. 88 at p. 3)

ACEEE commented that five years from final rule publication to the compliance date is sufficient time to design, test, tool up, manufacture, and certify a brand new product. (ACEEE, No. 79 at pp. 13) ACEEE stated that manufacturing capacity should not be a concern for heat pump water heaters, given the five-year lead time between the standards' effective date and compliance date. The commenter also stated that resistive tank water heaters and refrigeration engines like the ones used in heat pump water heaters are mature technologies that can be integrated to manufacture heat pump water heaters. (ACEEE, No. 79 at p. 4) ACEEE commented that TSL 5 would require new production lines for about 9 percent of the product, which should be manageable and in the scale of expected investments in new production lines. (ACEEE, No. 79 at p. 10) Regarding practicability to install heat pump water heaters, ACEEE stated that the arguments regarding training time for installers and servicers are vastly overblown. The commenter noted further that the Web sites of the leading providers of ENERGY STAR heat pump water heaters do not contain language that would void warrantees if such units are home-owner installed, and such units are now sold by major "big box" retailers and Internet sales outlets. (ACEEE, No. 79 at p. 10) With regard to servicing, ACEEE stated that although a heat pump water heater operates more hours per year than a room air conditioner, it is basically the same kind of technology, and will require no routine service beyond that which can be done by the homeowner (*i.e.,* filter cleaning). Thus, ACEEE argued that at least for heat pump water heaters with appropriate diagnostics, there are no skills required beyond those one would expect from a typical refrigerator repair person. (ACEEE, No. 79 at p. 10) ACEEE stated that in January 2010, the GE Hybrid electric heat pump water heater will be sold at Lowe's, Sears, and other locations, presumably to do-it-yourself installers, and in examining the warranties available on-line, ACEEE found no restrictions as would limit product installation to certified or qualified trades people. From this, the commenter inferred that there are no special skills expected for installation of these heat pump water heater products. (ACEEE, No. 79 at p. 12) ACEEE asserted that the skill set required to service heat pump water heaters is the same as the skill set associated with fixing the refrigeration engines of room air conditioners, refrigerators, and similar light equipment. Similarly, the commenter argued that servicing of condensing gas water heaters uses the same skill sets as condensing boilers. Thus, ACEEE stated that it believes that over the next five years, the emergence and market penetration of incentive programs for both types of products will lead to adequate supplies of servicers with the requisite skills. (ACEEE, No. 79 at p. 12)

The Joint Advocacy comment [4] (submitted by ASAP) stated that the limited scope of the December 2009 NOPR TSL 5 (*i.e.,* the TSL requiring electric storage water heaters larger than 55 gallons to use heat pump water heater technology), combined with the five-year lead time before the compliance date, will make the new standards more manageable for manufacturers, equipment installers, and servicers than standards which effectively require heat pump water heaters and condensing gas products in all sizes. (The Joint Advocacy Comment, No. 102 at p. 2)

ASE stated that for the December 2009 NOPR's TSL 5, the advanced technology requirements are limited to a modest share of total water heater shipments, which is a sensible means of addressing the issue of manufacturers being able to scale up the production of these products to meet the needs of the market. (ASE, No. 77 at p. 2)

A.O. Smith stated that a facility to produce 2 million heat pump water heaters per year (*i.e.,* A.O. Smith's approximate share of the entire electric storage water heater market) would take 2–3 years to implement. (A.O. Smith, No. 76 at p. 3)

Daikin stated that heat pump technology can be easily introduced to existing electric resistance water heater manufacturers from the air conditioning and refrigerator manufacturing sectors. The commenter noted that European and Japanese electric resistance heat pump manufacturers have already obtained the necessary heat pump technology and have heat pump water heater manufacturing lines up and running. Daikin stated its belief that taking into account the significance of the introduction of heat pump technology to unfamiliar manufacturers, at least one to two years would be required for this change to be implemented after publication of the final rule. (Daikin, No. 82 at p. 2)

After reviewing the comments from interested parties above, DOE believes that integrated heat pump water heaters and condensing gas-fired storage water heaters were properly screened in for the December 2009 NOPR analysis, and DOE continued to consider this technology for the final rule analysis. Based on the comments of interested parties, including those from manufacturers, DOE has concluded that given the five-year lead time, the practicability to manufacture, install, and service heat pump water heaters and condensing gas-fired storage water heaters is not a concern that would justify eliminating these technologies from consideration in this analysis. However, DOE further considered the concerns of interested parties regarding heat pump water heaters and condensing gas-fired storage water heaters for the selection of the final standard level.

Because DOE did not change any of its conclusions about the screening analysis for technologies for the December 2009 NOPR analysis, DOE screened in the same technologies for the final rule (shown in Table IV.3 through Table IV.5). For more information about the technologies that were screened out, and the reasoning for those options being screened out, *see* chapter 4 of the final rule TSD.

DOE believes that all of the efficiency levels discussed in today's notice are technologically feasible. The technologies that DOE examined have been used (or are being used) in

[4] The joint advocacy comment was submitted by ASAP on behalf of multiple organizations, including: ACEEE, National Association of State Energy Officers, California Energy Commission, Consumer Federation of America, PG&E, ASE, ASAP, National Consumer Law Foundation, NRDC, National Grid, National Insulation Association, North American Insulation Manufacturers Association, NEEP, NPCC, Sierra Club, Iowa Office of Energy, New Hampshire Office of Energy and Planning, Office of the Ohio Consumers' Council, California Public Utilities Commission, New Mexico Public Regulation Commission, Public Utility Commission of Oregon, New Jersey Board of Public Utilities, Community Environmental Center, Conservation Law Foundation, Environmental Defense Fund, Environment America, Environmental Law and Policy Center, Environmental and Energy Study Institute, Midwest Energy Efficiency Alliance, Southern Alliance for Clean Energy, Southwest Energy Efficiency Project, Urban Green Council (U.S. Green Building Council of New York), Arizona PIRG, Energy Coordinating Agency of Philadelphia, Environment Illinois, Environment Texas, Michigan Environmental Council, NW Energy Coalition, Ohio Environmental Council, Oklahoma Sustainability Network, Texas Ratepayer's Organization to Save Energy, National Community Action Foundation, and Fresh Energy.

commercially-available products or working prototypes. Furthermore, these technologies all incorporate materials and components that are commercially available in today's supply markets for the residential heating products that are the subject of this final rule.

C. Engineering Analysis

The engineering analysis develops cost-efficiency relationships to show the manufacturing costs of achieving increased efficiency. As explained in the December 2009 NOPR, DOE conducted the engineering analysis for heating products using both the efficiency level approach to identify incremental improvements in efficiency for each product and the cost-assessment approach to develop the manufacturer production cost (MPC) at each efficiency level. 74 FR 65852, 65879–96 (Dec. 11, 2009). DOE first identified the most common residential heating products on the market and determined their corresponding efficiencies 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 information about these selected products 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 used information gathered by reverse-engineering multiple manufacturers' products spanning the range of efficiency levels for each of the three product categories to generate bills of materials (BOMs), which describe each product in detail, including all manufacturing steps required to make and/or assemble each part. DOE developed a cost model that converted the raw information BOMs into MPCs. By applying derived manufacturer markups to the MPCs, DOE calculated the manufacturer selling prices (MSPs) and constructed industry cost-efficiency curves.

In response to the December 2009 NOPR, DOE received comments from interested parties on various aspects of the engineering analysis, including: (1) Efficiency levels analyzed and technology options; (2) manufacturer production costs; (3) shipping costs; (4) scaling of storage water heater MPCs to other storage volumes; and (5) the energy efficiency equations. A further discussion of the engineering analysis methodology, a discussion of the comments DOE received, DOE's response to those comments, and any changes 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 final rule TSD for additional details about the engineering analysis.

1. Representative Products for Analysis

As explained in the December 2009 NOPR, DOE reviewed all of the product classes of residential water heaters, DHE, and pool heaters for the engineering analysis. Within each product type, DOE chose units for analysis that represent a cross-section of the residential heating products market. The December 2009 NOPR contains specific details about DOE's selection of representative units for each type of heating product. 74 FR 65852, 65879–81 (Dec. 11, 2009). The analysis of these representative products 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. In response to the December 2009 NOPR, DOE did not receive any comments regarding the representative units analyzed, and as a result, DOE did not change the representative units from the December 2009 NOPR analysis. The representative units for each product class are shown in Table IV.6 below. For more details about the selection of the representative units for each product class, *see* chapter 5 of the final rule TSD.

TABLE IV.6—REPRESENTATIVE PRODUCTS ANALYZED

Residential Water Heaters	
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).
Direct Heating Equipment	
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.
Residential Pool Heaters	
Pool heaters product class	Representative input rating (Btu/h)
Gas-fired Pool Heaters	250,000.

2. Efficiency Levels Analyzed

For each of the representative products, DOE analyzed multiple efficiency levels and estimated manufacturer production costs at each efficiency level. These efficiency levels were presented in detail in the December 2009 NOPR. 74 FR 65852, 65881–89 (Dec. 11, 2009). DOE analyzed from the baseline efficiency level to the maximum technologically feasible (max-tech) efficiency level for each product class. The baseline units in each product class were used as reference points against which DOE measured changes resulting from potential amended energy conservation standards. These units generally represent the basic characteristics of equipment in that product class, just meet current Federal energy conservation standards, and provide basic consumer utility. DOE established intermediate energy efficiency levels for each of the product classes that are representative of efficiencies that are typically available on the market through a complete review of AHRI's product certification directory, manufacturer catalogs, and other publicly-available literature. 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.

a. Water Heaters

Table IV.7 through Table IV.11 in this section show the efficiency levels analyzed at the representative rated storage volume for each of the water heater product classes for the final rule. These tables also show the technology pathways identified by DOE which could be used to reach the identified efficiency levels. DOE received several comments (discussed below) in response to the efficiency levels and possible technology pathways presented in the December 2009 NOPR for gas-fired storage water heater.

Rheem stated that for 40-gallon gas-fired storage water heaters at TSL 4 (*i.e.,* 0.63 EF), DOE underestimates the insulation thickness that would be required. Rheem asserted that 3 inches of insulation would be required to reach this efficiency level, instead of the 2 inches that DOE estimated in the December 2009 NOPR. In addition, Rheem stated that for 50-gallon electric storage water heaters, DOE estimates 4 inches of foam insulation are needed to achieve TSL 4 (*i.e.,* 0.95 EF) but that DOE should recognize there are diminishing returns for added foam insulation. Further, Rheem asserted that the increased insulation requirements will result in increased product cost, shipping cost, life-cycle cost, space constraint frequency, and reduce consumer payback. (Rheem, No. 89 at p. 10) Similarly, Bradford White stated that when increasing insulation thickness to improve water heater efficiency, there is a diminishing return and a point at which increasing insulation does not result in any further efficiency gain. Bradford White asserted that to attain the efficiencies in the December 2009 NOPR, additional changes would be required besides increasing insulation thickness. (Bradford White, No. 61 at p. 1)

As described in the December 2009 NOPR, DOE performed extensive research regarding the technologies required to reach each efficiency level for the representative rated storage volumes analyzed. 74 FR 65852, 65884 (December 11, 2009). DOE research suggested that the insulation thicknesses listed at various efficiency levels identified are consistent with products available on the market. DOE reviewed manufacturer literature (which typically includes information on energy factor and insulation thicknesses) and then reverse-engineered several gas-fired water heaters to verify the technologies used to improve energy efficiency, including insulation thicknesses. For the December 2009 NOPR analysis, DOE also hired an independent testing facility to determine the EF of a representative sample of water heaters across multiple efficiency levels. (*See* chapter 5 of the December 2009 NOPR TSD for additional details.) These water heaters were subsequently disassembled to verify the technologies used to increase energy efficiency. DOE was able to measure the insulation thicknesses on the sides, top, and bottom of each water heater unit disassembled. For these reasons, DOE believes the results of its assessment of insulation thicknesses at various efficiency levels are accurate and maintained the same insulation thicknesses for the final rule analysis.

AGA stated that efficiency level 2 for gas-fired storage water heaters should include power venting, because according to industry testing and research, the prevailing technology at that level will be a power-vented design, not an atmospheric design. (AGA, Public Meeting Transcript, No. 57.4 at pp. 35–36) Further, AGA stated that the majority of the models on the market rated at this efficiency level are not atmospherically vented, and contended that atmospherically-vented models at 0.63 EF would have recovery efficiencies high enough such that they require venting modifications because of the possibility for corrosive condensate to occur. (AGA, No. 78 at p. 8) If proper venting is not installed, corrosion from condensate can cause leaks in the venting system, which in turn can allow combustion by-products (*e.g.,* carbon monoxide) to infiltrate into areas where such by-products are not desirable, possibly leading to serious injury or death. Thus, AGA recommended that DOE should consider only power-venting technology as the design option at efficiency level 2 for reasons of installation safety and practicality, and asserted that continuing to rely upon atmospheric technology for the efficiency level 2 design would violate statutory requirements for DOE to avoid implementing efficiency standards that would pose an increased safety risk to consumers. (AGA, No. 78 at p. 10)

In response, DOE notes that there are products currently available on the market at efficiency level 2 that do not use a power-venting design. The manufacturer literature for these products does not indicate that there are certain instances in which the installation of these products would be unsafe. Therefore, DOE did not change its technology options at efficiency level 2. However, DOE does recognize the venting concerns of gas-fired storage water heaters at efficiency level 2 with high recovery efficiencies. DOE addresses this issue in section IV.F.2 (Installation Cost).

A.O. Smith strongly recommended that DOE lower the max-tech level for gas-fired storage water heaters from the 0.80 EF level identified in the December 2009 NOPR for the representative 40-gallon storage volume. A.O. Smith stated that the 0.80 EF level identified as the max-tech for gas-fired storage water heaters by the Super Efficient Gas Water Heating Appliance Initiative (SEGWHAI) program and in a presentation by A.O. Smith at the 2009 ACEEE Hot Water Forum were based on theoretical modeling, and not operational prototypes. A.O. Smith also commented that the ENERGY STAR level of 0.80 EF is based on similar modeling, and stated that discussions are underway with DOE regarding the need to lower the Energy Star level to 0.77 EF. A.O. Smith stated they have recently built and tested a number of condensing gas-fired water heater prototypes that result in actual performance that is somewhat lower than predicted by the models. Consequently, A.O. Smith expressed support for 0.77 EF as the max-tech level for 40 gallon gas-fired storage water heaters. (A.O. Smith, No. 76 at pp. 1–2)

In the preliminary analysis, DOE proposed to use 0.77 EF as the max-tech level for gas-fired storage water heaters at the representative rated storage volume (*see* chapter 5 of the preliminary analysis TSD for more details). In response to this proposal in the preliminary analysis, DOE received comments from interested parties stating that the max-tech efficiency level considered for gas-fired storage water heaters in this rulemaking should be harmonized with the ENERGY STAR level for residential condensing gas-fired storage water heaters, and DOE subsequently revised the max-tech level to 0.80 EF for the December 2009 NOPR analysis. 74 FR 65852, 65883 (Dec. 11, 2009). DOE believes there is some uncertainty regarding the efficiencies that can be achieved by gas-fired storage water heaters because there are no products currently available on the market and to date only prototypes have been developed for residential applications. For the final rule, DOE has reviewed confidential data characterizing the performance of residential gas-fired storage water heater prototypes and has concluded that 0.77 EF is more representative of the condensing water heaters likely to enter the market. As such, DOE has revised its max-tech efficiency level for the final rule so that at the 40-gallon representative capacity, the efficiency level is 0.77 EF, as shown in Table IV.7.

TABLE IV.7—FORTY-GALLON GAS-FIRED STORAGE WATER HEATER (STANDARD BURNER) EFFICIENCY LEVELS

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 = 0.77)	Condensing, Power Vent, 2” Insulation.

Regarding the technology options for ultra-low NO_X gas-fired storage water heaters, ACEEE stated that once an inducer fan is added to an ultra-low NO_X product, the ultra-low NO_X design factor is not a prohibitive feature. (ACEEE, Public Meeting Transcript, No. 57.4 at pp. 127) A.O. Smith stated that the only way for ultra-low NO_X water heaters to overcome the additional restriction added by increased flue baffling (needed to promote heat exchange and increase efficiency) would be to add a blower and/or power-burner to the heater, which would greatly increase the manufacturing and installation costs of the heater. (A.O. Smith, No. 76 at p. 2)

DOE tentatively concluded in the December 2009 NOPR that ultra-low NO_X gas-fired water heaters require the introduction of additional technologies to achieve the same efficiency as standard gas-fired water heaters. For the December 2009 NOPR, DOE performed a teardown analysis of ultra-low NO_X gas-fired storage water heaters. 74 FR 65852, 65881 (Dec. 11, 2009). (Details about DOE's December 2009 NOPR analysis of ultra-low NO_X storage water heaters are available in chapter 5 of the December 2009 NOPR TSD.) DOE research showed that implementing power venting and the same insulation increases as those for standard gas-fired water heaters would result in slightly lower efficiencies due to the additional pressure restrictions resulting from the addition of the ultra-low NO_X burner. Therefore, DOE implemented technologies at lower efficiency levels for ultra-low NO_X gas-fired storage water heaters in order to achieve the same efficiencies as those identified for standard gas-fired storage water heaters. Based on the teardown analysis of ultra-low NO_X water heaters, DOE believes that the levels identified for ultra-low NO_X gas-fired storage water heaters are achievable using the technologies identified in Table IV.8. In its comments, ACEEE does not present any new data or evidence to support its assertion that once a power venting design is implemented, ultra-low NO_X gas-fired storage water heaters can achieve the same efficiencies as gas-fired water heaters with standard burners. As a result, DOE maintained the technologies and efficiency levels identified in the December 2009 NOPR for the final rule, with the exception of the max-tech level, which was reduced to 0.77 EF for the reasons described above.

TABLE IV.8—FORTY-GALLON GAS-FIRED STORAGE WATER HEATER (ULTRA-LOW NO_X BURNER) EFFICIENCY LEVELS

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 = 0.77)	Condensing, Power Vent, 2″ Insulation.

DOE also received several comments relating to the max-tech efficiency levels for electric storage water heaters, which was identified as 2.2 EF at the 50-gallon representative rated storage volume in the December 2009 NOPR. 74 FR 65852, 65884 (Dec. 11, 2009). GE stated that the heat pump water heater it has in production has an EF of 2.35 at standard DOE test conditions, which is higher than the max-tech level identified in the December 2009 NOPR for electric storage water heaters. (GE, No. 84 at p. 1) A.O. Smith also stated that the 2.2 EF max-tech in the December 2009 NOPR is too low, citing the GE heat pump water heater that is rated at 2.3 EF as evidence. A.O. Smith stated that the heat pump water heater max-tech level should be increased to 2.3 EF or higher if there is data available showing higher levels are feasible. (A.O. Smith, No. 76 at p. 2) Further, A.O. Smith stated that because of heat pumps using CO_2 as a refrigerant and because other heat pump technologies exist, the max-tech possibly is higher than 2.2 EF. (A.O. Smith, Public Meeting Transcript, No. 57.4 at p. 131) ACEEE stated that DOE does not have an appropriate max-tech for electric storage water heaters because it inappropriately screened out CO_2 heat pump water heaters, which are commercially available in other countries. (ACEEE, Public Meeting Transcript, No. 57.4 at p. 130) Additionally, ACEEE stated that the GE product with an EF of 2.35 exceeds DOE's December 2009 NOPR max-tech level of 2.2 EF (ACEEE, No. 79 at p. 8)

Daikin stated that DOE's proposed max-tech for heat pump water heaters of 2.2 EF is reasonable and appropriate, and is an achievable standard for heat pump water heaters. (Daikin, No. 82 at p. 1)

In response, DOE estimated the max-tech efficiency for electric storage water heaters for the December 2009 NOPR before any integrated heat pump water heaters were commercially available on the market. In the time since the December 2009 NOPR's publication, several heat pump water heater models have become available to consumers. The highest EF of the heat pump water heater models currently available on the market is 2.35 EF at 50 gallons. While DOE does acknowledge A.O. Smith's and ACEEE's point that a CO_2 heat pump water heater could provide an even higher EF, that technology was screened out during the screening process (*see* section IV.B.1), and DOE is not considering that technology as a viable way of reaching the max-tech level. As a result, DOE has revised the max-tech level for the final rule to be 2.35 EF at the representative 50-gallon rated storage volume, as shown in Table IV.9.

TABLE IV.9—FIFTY-GALLON ELECTRIC STORAGE WATER HEATER EFFICIENCY LEVELS

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 = 2.35)	Heat Pump Water Heater, More-Efficient Compressor.

DOE received only one comment in response to the efficiency levels and technology pathways presented in the December 2009 NOPR for oil-fired storage water heaters. In the December 2009 NOPR, DOE determined that oil-fired storage water heaters would have to use a multi-flue design to achieve efficiency levels 6 and 7 (*i.e.,* 0.66 and 0.68 EF for the 32-gallon representative rated storage volume). 74 FR 65852, 65885–86 (Dec. 11, 2009). Bradford White stated that at the efficiency level proposed in the December 2009 NOPR for oil-fired storage water heaters (*i.e.,* efficiency level 5, or 0.62 EF for the 32-gallon representative rated storage volume), reaching the required efficiency will likely require the use of multi-flue designs, thereby adding tremendous cost to residential designs. (Bradford White, No. 61 at p. 2)

In response, DOE identified the technologies at each efficiency level by examining the designs of products currently available on the market at each efficiency level. Oil-fired storage water heaters are currently available on the market at 0.62 EF, which do not utilize a multi-flue design or other proprietary technology. As a result, DOE believes that the technology options identified in the December 2009 NOPR at efficiency level 5 are appropriate, and has retained the same efficiency levels and technologies for the final rule. Accordingly, DOE did not include a multi-flue design at efficiency level 5 for the final rule analysis.

TABLE IV.10—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.

DOE did not receive any comments in response to the efficiency levels and technology options presented in the December 2009 NOPR analysis for gas-fired instantaneous water heaters. 74 FR 65852, 65886–87 (Dec. 11, 2009). DOE believes that the efficiencies and technology options presented for gas-fired instantaneous water heaters in the December 2009 NOPR are still valid and continued to use the same technologies and efficiency levels in the final rule analysis.

TABLE IV.11—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).

b. Direct Heating Equipment

Table IV.12 through Table IV.16 present the efficiency levels DOE examined for the final rule analysis for DHE. In the December 2009 NOPR analysis, DOE identified various efficiency levels for gas wall fan DHE. 74 FR 65852, 65887 (Dec. 11, 2009). DOE did not receive any comments pertaining to its efficiency levels or technologies identified for the gas wall fan product in the December 2009 NOPR analysis. After reviewing the efficiency levels and technologies, DOE has determined that the same efficiency levels and technologies are still appropriate and continued to use them in the final rule analysis.

TABLE IV.12—GAS WALL FAN-TYPE DHE (OVER 42,000 Btu/h) EFFICIENCY LEVELS

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.

For gas wall gravity DHE, DOE identified efficiency levels and technology options in the December 2009 NOPR analysis, which included a 72-percent AFUE level as the max-tech that could be achieved using electronic ignition. 74 FR 65852, 65887–88 (Dec. 11, 2009). DOE received several comments in response to the efficiency levels and technologies for gas wall gravity DHE presented in the December 2009 NOPR. These comments and DOE's response are discussed below.

Williams stated that due to factors such as interior stud-wall installation, the lack of an electricity requirement, and limited height footprint, gravity wall heaters do not lend themselves to the addition of a fan, and the commenter asserted that the TSD recommendations centered almost exclusively on the incorporation of a fan for improving efficiency of DHE. (Williams, No. 96 at p. 2) Further, Williams stated that a three-percent AFUE difference between a gravity wall and fan wall heater is not plausible. Williams also commented that DOE's assumption that increased efficiencies of three percent to nine percent can be attained by using an electronic ignition is unproven. (Williams, No. 96 at p. 2)

Empire stated that to improve efficiency of DHE, larger heat exchanger surface areas would be needed and, as a result, the overall size of the unit may increase. Furthermore, Empire stated that many of the modifications necessary to improve the efficiency of gas wall gravity DHE would require electricity. (Empire, Public Meeting Transcript, No. 57.4 at p. 166) LTS stated that it is not optimistic that it could manufacture gravity wall furnaces at the proposed level, because meeting that level would require a larger heat exchanger and cabinet and, consequently, the product would lose its retrofit ability. (LTS, No. 56.7 at p. 1)

In consideration of the comments above, DOE reevaluated its efficiency levels and technologies for gas wall gravity DHE for the final rule. After reexamining the current market for gas wall gravity DHE for the final rule, DOE concluded that at the efficiency levels analyzed by DOE in the December 2009 NOPR, some gas wall gravity DHE models are available on the market, but these models are not in the representative rated capacity range. Therefore, DOE revised the efficiency levels analyzed for the final rule to more accurately reflect the current market for products within the representative rated capacity. DOE notes that the revised efficiency levels do not require the use fans, and allow for heat exchangers to be sized so that the units can be easily retrofitted. In addition, although no gas wall gravity products that use an electronic ignition system are available on the market, DOE maintained the assumption from the December 2009 NOPR that an electronic ignition could be added to gas wall gravity products to improve the AFUE by 1 percent. DOE does not believe that a reduction of consumer utility will occur by requiring electrical power for an electronic ignition because these products could incorporate a battery backup to mitigate any concerns about operation during power outages.

Regarding Williams' assertion that the AFUE increases from an electronic ignition have not been proven, DOE agrees that the actual AFUE increase resulting from the addition of an electronic ignition will be highly variable based on the characteristics of each individual product, and the results of this have not been demonstrated in gas wall gravity DHE on the market. Because no products are available on the market in this product class that utilize electronic ignition, it is difficult to determine the exact impact of utilizing an electronic ignition for gas wall gravity DHE. However, consideration under the DOE test procedures for vented home heating equipment (10 CFR part 430, subpart B, appendix O) led DOE to believe it is reasonable to assume that a 1-percent increase in AFUE would be achieved with the addition of an electronic ignition. Section 4.1.17 of DOE's test procedures for vented home heating equipment lists the AFUE equation as:

$$AFUE = 0.968\eta_{ss\text{-}wt} - 1.78D_F - 1.89D_S - 129P_F - 2.8L_J + 1.81$$

Of particular relevance in the AFUE equation above is the P_F term, which is the pilot fraction and accounts for the AFUE reduction caused by the standing pilot. P_F is defined as the ratio of the pilot light input to the total input of the product. If DOE assumes a typical pilot light input of 400 Btu/h, the minimum pilot fraction for the representative input range for gas wall gravity DHE would be 0.009. When multiplied by the 129 coefficient provided in the equation, a pilot fraction of 0.009 would yield slightly over a 1-percent AFUE reduction according to the equation. Therefore, DOE assumes that the elimination of a standing pilot would provide about a 1-percent AFUE increase for the representative capacity range. DOE used gas wall gravity DHE with an electronic ignition to represent the max-tech efficiency level because the incorporation of electronic ignition does not require significant modifications to the installation space that would limit consumers' ability to retrofit the product. Table IV.13 shows the revised efficiency levels for gas wall gravity DHE that were used in the final rule analysis.

TABLE IV.13—GAS WALL GRAVITY DHE (OVER 27,000 Btu/h AND UP TO 46,000 Btu/h) EFFICIENCY LEVELS

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 = 69)	Standing Pilot and Improved Heat Exchanger.
Efficiency Level 4—Max Tech (AFUE = 70)	Electronic Ignition.

For gas floor DHE, gas room DHE, and gas hearth DHE, DOE surveyed the market and identified a number of efficiency levels for these products based on the technologies available for each product class in the December 2009 NOPR analysis. 74 FR 65852, 65888 (Dec. 11, 2009). DOE did not receive any comments about the efficiency levels and technologies identified for these products. After reviewing the efficiency levels and technologies for each of these three product classes, DOE determined that the efficiency levels and technologies examined in the December 2009 NOPR are still appropriate and maintained them for the final rule analysis. Table IV.14 through Table IV.16 show the efficiency levels analyzed for gas floor, gas room, and gas hearth DHE.

TABLE IV.14—GAS FLOOR DHE (OVER 37,000 Btu/h) EFFICIENCY LEVELS

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

TABLE IV.15—GAS ROOM DHE (OVER 27,000 Btu/h AND UP TO 46,000 Btu/h) EFFICIENCY LEVELS

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.

TABLE IV.16—GAS HEARTH DHE (OVER 27,000 Btu/h AND UP TO 46,000 Btu/h) EFFICIENCY LEVELS

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

Table IV.17 shows the efficiency levels analyzed for the final rule analysis for pool heaters. In response to the December 2009 NOPR analysis, DOE received several comments related to the efficiency levels and technologies identified for pool heaters, particularly for efficiency level 5 (*i.e.,* 84-percent thermal efficiency).

AHRI asserted that DOE has incorrectly analyzed the measures required to manufacture gas-fired pool heaters capable of achieving a minimum thermal efficiency of 84 percent. Further, AHRI stated that manufacturers must design products to address the entire range of installation situations that the product could experience, and if a particular replacement installation presents concerns about possible excessive condensation for a heater with 83- or 84-percent thermal efficiency, the option currently exists to install a slightly less efficient pool heater and minimize this concern. However, AHRI asserted that because this option will no longer exist if DOE adopts TSL 4, manufacturers will have to use more corrosion-resistant (and more expensive) stainless steel in the heat exchangers. (AHRI, No. 91 at p. 9)

Similarly, Raypak stated its belief, based on their own testing conducted to evaluate ways to achieve higher efficiency from their products that more-expensive stainless steel materials will be required to properly deal with the increased amount of condensate at higher efficiency levels (*i.e.,* anything greater than TSL 2). Further, Raypak stated that atmospheric products currently on the market do condense (although they are designed to minimize condensation), so increasing the efficiency level will both increase the amount of condensation and reduce the life of the product, unless more-expensive stainless steel materials are used to manage condensate more effectively. (Raypak, No. 67 at p. 3)

Zodiac also stated that 84-percent thermal efficiency for gas-fired pool heaters approaches the point at which condensing occurs, and that condensation as a byproduct of combustion is acidic and can cause corrosion to important components of the heater, including the venting material if the proper type of venting is not installed. Zodiac stated that corrosion from condensate can lead to leaks in the venting system, which in turn can allow combustion by-products to infiltrate into areas where such by-products are not desirable. Zodiac asserted this can subsequently contribute to creating a carbon monoxide hazard in the event that abnormal combustion ever occurs, which can lead to serious injury or death. (Zodiac, No. 68 at pp. 1–2)

In response to these comments, DOE notes that in the engineering analysis, DOE examined pool heaters that are currently available on the market at 84-percent thermal efficiency. DOE determined that these products did not incorporate stainless steel heat exchangers. In addition, manufacturer literature does not specify instances when these products could cause unsafe installations, and where less-efficient products should be used to minimize corrosive condensate. Instead, manufacturer literature advertises safety features that minimize condensate, such as a manual bypass that will raise the incoming water temperature to reduce the formation of corrosive condensate. Because these products currently exist on the market and seem to be capable of safe operation with condensate being mitigated using less expensive methods than incorporating stainless steel materials, DOE did not consider stainless steel heat exchangers at 84-percent thermal efficiency for the final rule. Additionally, DOE notes that typically pool heaters are installed outdoors or outside of the living space, so these products are unlikely to cause safety concerns in most installations. DOE does not believe manufacturers would largely deviate from the designs currently on the market in the event of a standard at this efficiency level, and, thus, DOE based its technologies on products currently available on the market at 84-percent thermal efficiency. As a result, DOE maintained the pool heater efficiency levels analyzed for the December 2009 NOPR in the final rule analysis.

TABLE IV.17—GAS-FIRED POOL HEATER (250,000 Btu/h) EFFICIENCY LEVELS

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.

3. Cost Assessment Methodology

a. Manufacturer Production Cost

As explained in the December 2009 NOPR, DOE's process for developing manufacturer production costs (MPCs) consisted of several steps. First, DOE selected representative models that corresponded to the representative rated storage volumes and input capacities, and that represented the most common designs and characteristics available in products on the market. DOE then performed a teardown analysis of the selected models, which included disassembling the selected products into their base components and characterizing each component according to its weight, dimensions, material, quantity, and the manufacturing processes used to fabricate and assemble it. The teardown analysis for this rulemaking included a total of over 60 physical and virtual teardowns of water heaters, DHE, and pool heaters during the preliminary and NOPR analysis phases. 74 FR 65852, 65889–93 (Dec. 11, 2009).

DOE used the data gathered during the teardown analysis to generate bills of materials (BOMs) that 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. DOE developed a cost model using Microsoft Excel 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, 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 final rule analysis, DOE updated all of the labor rates, tooling costs, raw material prices, and the purchased parts costs. DOE calculated new 5-year average materials prices 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, 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 2009$ using the gross domestic product implicit price deflator. Chapter 5 of the final rule TSD describes DOE's cost model and definitions, assumptions, and estimates.

Additionally, because integrated heat pump water heaters became available on the market before the completion of the final rule analysis, DOE was able to perform teardown analyses and develop detailed BOMs for multiple heat pump water heaters. DOE used the BOMs to develop the MPCs for heat pump water heaters, which DOE found affirmed the MPCs developed for the December 2009 NOPR analysis that were based on a theoretical heat pump water heater design (since no heat pump water heaters were available on the market at the time of the December 2009 NOPR analysis). The teardown analysis of heat pump water heaters allowed DOE to refine its MPCs for these products for the final rule analysis.

DOE received several comments in response to the manufacturer production costs and methodology presented in the December 2009 NOPR. ACEEE stated its disappointment that DOE did not perform retrospective analysis of the costs of products affected by changes in efficiency standards. ACEEE recommended that DOE balance the current approach to developing the cost-efficiency relationship by considering the historical results of rulemakings, arguing that manufacturer production costs for product redesigns almost inevitably result in lower consumer prices for more-efficient goods than DOE has typically estimated in its rulemaking analyses for energy conservation standards. Further, ACEEE stated that DOE's reasoning that it cannot speculate about specific changes manufacturers might adopt, is no reason to reject analysis of the historical pattern of manufacturer responses. ACEEE cited published work by a DOE contractor purportedly showing that most standards yield consumer prices lower than projected by the Department, and ACEEE stated that empirical results are simply more credible than those relied upon in DOE's rulemaking record, particularly for the future costs of products that include technology shifts and very low market shares today, such as heat pump water heaters. (ACEEE, No. 79 at p. 3)

In response, DOE reiterates its tentative conclusion in the December 2009 NOPR that 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. 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 based upon relevant data is particularly important given EPCA's anti-backsliding provision at 42 U.S.C. 6295(o)(1).

At the December 2009 NOPR public meeting, A.O. Smith stated that the cost impact studies for ultra-low NO_X in combination with condensing technology should be reworked extensively because it is significantly more complex to implement an ultra-low NO_X design with a condensing gas-fired water heater than a non-condensing gas-fired water heater. (A.O. Smith, Public Meeting Transcript, No. 57.4 at p. 124) A.O. Smith also commented at the public meeting that for ultra-low NO_X gas-fired storage water heaters, the MPC at efficiency level 6 for an ultra-low NO_X condensing gas water heater is considerably too low (A.O. Smith, Public Meeting Transcript, No. 57.4 at p. 139) However, in its written submission, A.O. Smith stated that they believe DOE's manufacturer production costs in the December 2009 NOPR are all reasonably accurate. (A.O. Smith, No. 76 at p. 3) DOE believes A.O. Smith's written statement clarified A.O. Smith's opinion regarding the manufacturer production costs, and thus, DOE did not change its approach to developing MPCs for ultra-low NO_X condensing water heaters.

Turning to pool heaters, AHRI stated that the manufacturing cost for pool heater models to comply with TSL 4 (*i.e.,* 84-percent thermal efficiency) is underestimated by DOE. (AHRI, No. 91 at p. 8) Similarly, Raypak asserted that DOE does not account for the stainless steel material improvements (a significant cost increase) at any TSL below fully condensing. (Raypak, No. 67 at p. 3)

In response, DOE did not include the cost of a stainless steel heat exchanger design in its analysis of pool heaters at 84-percent thermal efficiency, because DOE's MPC for this product is based on models at 84-percent thermal efficiency that are currently available on the market, as explained in section IV.C.2.c, DOE does not have sufficient reason to believe that in the event of a minimum energy conservation standard at this efficiency level, manufacturers would completely redesign their products at this efficiency. Thus, DOE disagrees with AHRI and Raypak, and does not believe that the pool heater MPC at 84-percent thermal efficiency was underestimated for the December 2009 NOPR and has continued to use that MPC for the final rule analysis.

b. Manufacturer Selling Price

The manufacturer selling price (MSP) is the price at which the manufacturer can recover all production and non-production costs and earn a profit. 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. For heating products, DOE calculates the MSP in one of two ways, depending on the product type. For gas-fired instantaneous water heaters, DHE, and pool heaters, the MSP is the MPC multiplied by a manufacturer markup. For gas-fired, electric, and oil-fired storage water heaters, the size of the unit is largely dependent on the final standard requirement, and as a result, the shipping costs are much different at each efficiency level. Therefore, in the December 2009 NOPR analysis, DOE separated the shipping costs of storage water heaters from the manufacturer markup to more transparently show the impacts of standards on the shipping costs of storage water heaters. The MSP for gas-fired, electric, and oil-fired storage water heaters was calculated as the MPC multiplied by the manufacturer markup (less the percentage of markup usually attributed to shipping cost) plus the shipping cost per unit. *See* chapter 5 of the final rule TSD for more information regarding the manufacturer markup.

i. Manufacturer Markup

The manufacturer markup is a non-production cost multiplier that DOE applies to the full MPC to account for corporate non-production costs and profit. To calculate the manufacturer markups for the preliminary analysis, DOE used 10–K reports from publicly-owned residential heating products companies. DOE presented the calculated markups to manufacturers during interviews conducted for the December 2009 NOPR MIA analysis, and considered the feedback from manufacturers in order to supplement the calculated markup. DOE then refined the markups for each type of residential heating product to better reflect the residential heating products market. DOE used a constant markup to reflect the MSPs of the baseline products as well as more-efficient products. DOE used this approach because amended standards may result in high-efficiency products (which currently are considered premium products) becoming the baselines.

In regard to the manufacturer markups and methodology for determining manufacturer markups in the December 2009 NOPR, DOE did not receive any feedback from interested parties. After reviewing the manufacturer markups used for the December 2009 NOPR, DOE continued to use the same manufacturer markups for the final rule.

ii. Shipping Cost for Storage Water Heaters

The final step in DOE's cost-assessment methodology was to calculate the shipping cost for storage water heaters. Typically, the cost of shipping is fully accounted for in the manufacturer markup, and as noted above, this was DOE's approach for direct heating equipment, pool heaters, and gas-fired instantaneous water heaters. For storage water heaters, however, shipping costs are highly variable because the size of the unit is largely dependent upon the efficiency level being considered. Thus, DOE separated the shipping cost from manufacturer markup for storage water heaters.

For the final rule, DOE used many of the same assumptions used in the December 2009 NOPR to calculate shipping costs. DOE calculated shipping costs based on a typical 53-foot straight-frame trailer with a storage volume of 4,240 cubic feet, and assumed an average cost of $4,000 per trailer load. DOE examined the average sizes of water heaters at each efficiency level and storage volume, and determined the number of units that would fit in each trailer based on assumptions about the arrangement of water heaters in the trailer.

In response to the shipping costs presented in the December 2009 NOPR, Bradford White stated that the increases in shipping costs at higher efficiency levels are far too low. (Bradford White, Public Meeting Transcript, No. 57.4 at pp. 40–41) However, DOE notes that Bradford White did not provide any new data regarding shipping costs in response to the December 2009 NOPR. Further, Bradford White expressed strong disagreement with the shipping costs used for the December 2009 NOPR analysis, arguing that at the increased insulation thicknesses presented in the December 2009 NOPR, DOE's shipping costs are very much underestimated. (Bradford White, No. 61 at p. 1)

In response to these comments, DOE reexamined the shipping costs for the final rule analysis. DOE made several changes to its December 2009 NOPR assumptions for the final rule, including changes to the packaging dimensions of heat pump water heaters and changes to assumptions about the arrangement power vented gas-fired units on the trailer. For example, for the final rule analysis, DOE was able to examine actual heat pump water heaters available on the market, which allowed DOE to refine its estimated shipping dimensions of these units by increasing the dimensions to more accurately reflect the packaging of products that have recently become available to consumers. The increased shipping dimensions led to an increase the shipping cost (as manufacturers would be able to fit fewer units per shipping load). As a result, DOE was able to revise its shipping costs to more accurately reflect the cost to ship products currently available on the market. However, DOE notes that the shipping costs developed for the final rule represent estimates of the cost per unit shipped if the trailer were fully loaded with the same product (*i.e.,* same type of water heater at the same efficiency level and same storage volume). DOE recognizes that in reality, manufacturers will likely mix different products of various storage volumes and efficiencies to try to optimize the use of space within the trailer, which will cause some variation in the actual shipping costs per unit. For a full description of shipping costs for storage water heaters, *see* chapter 5 of the final rule TSD.

4. Engineering Analysis Results

The results of the engineering analysis are reported as cost-efficiency data in the form of MSP (in dollars) versus efficiency (EF for water heaters, AFUE for DHE, and thermal efficiency for pool heaters). The results from the engineering analysis are the basis for the subsequent analyses in the final rule and were used in the LCC analysis to determine consumer prices for residential heating products at the various potential standard levels. Chapter 5 of the final rule TSD provides the full list of MPCs and MSPs at each efficiency level for each analyzed representative product.

5. Scaling to Additional Rated Storage Capacities

As discussed in the December 2009 NOPR, 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 for the representative rated storage volumes to several discrete rated storage volumes higher and lower than the representative storage volume for each storage water heater product class. 74 FR 65852, 65893–94 (Dec. 11, 2009) DOE developed the MPCs for water heaters at each of the rated storage volumes shown in Table IV.18. 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.F).

TABLE IV.18—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.

TABLE IV.18—ADDITIONAL WATER HEATER STORAGE VOLUMES ANALYZED—Continued

Water heater product class	Storage volumes analyzed (gallons, U.S.)
Oil-fired Storage	50.

As described in the December 2009 NOPR, DOE developed the MPCs for the analysis of additional storage volumes by creating a cost model based on teardowns of products at nominal storage volumes outside the representative volume across a range of efficiencies and manufacturers. The cost model accounts for changes in the size of water heater components that would scale with tank volume, while assuming other components (*e.g.,* gas valves, thermostats, controls) remain largely the same across the different storage volume sizes. DOE estimated the changes in material and labor costs that occur at volume sizes higher and lower than the representative volume based on observations made during teardowns, which allowed DOE to accurately model certain characteristics that are not identifiable in manufacturer literature. Additional details and the results of DOE's analysis for the additional storage volumes are presented in chapter 5 of the final rule TSD (engineering analysis).

In response to the scaled MPCs developed for the December 2009 NOPR analysis, DOE received feedback from several interested parties. Southern Company and AHRI commented that DOE's assumption that for heat pump water heaters, the heat pump output capacity would not change as a function of tank size is likely incorrect. Southern Company stated that a heat pump with a higher capacity would be used on a 119-gallon tank than on a 30-gallon tank. As a result, the commenters stated their belief that DOE's scaling of costs for the heat pump water heater efficiency levels may be incorrect. (Public Meeting Transcript, No. 57.4 at pp. 152–155) Further, Southern Company stated that the reason the heating elements in electric resistance heaters have the same output capacity across the full range of gallon sizes is because they max-out the standard circuit. (Southern Company, Public Meeting Transcript, No. 57.4 at p. 155) A.O. Smith also commented that a 119-gallon heat pump water heater would likely have a higher-capacity refrigerant circuit than a 30-gallon heat pump water heater. (A.O. Smith, Public Meeting Transcript, No. 57.4 at p. 157)

DOE's analysis of electric storage water heaters currently available on the market revealed that electric storage water heaters use the same capacity heating elements across the range of storage volumes to provide the same amount of heat input to the water. DOE notes that for heat pump water heaters, the heat pump unit serves essentially the same function as the electric resistance element in electric storage water heaters (*i.e.,* heating the water). Because heat pump modules paired with electric water heaters currently available on the market demonstrate that the same amount of heating capability as compared to the electric elements found in conventional water heaters and both of these types of heaters can be used to satisfy the heating requirements of the full range of water heater storage volumes, DOE believes the same amount of heat input from a heat pump can also be used to satisfy the heating requirements for the full range of storage volumes. Therefore, DOE does not believe an increase in the heat pump capacity would be required at larger tank storage volumes. DOE believes that the same amount of heat pump heating capacity will be adequate to serve the water heating needs across the entire range of storage volumes, and as a result manufacturers would be unlikely to increase the size and capacity of the heat pump unit as the storage volume increases. Therefore, DOE maintained the assumption that the heat pump unit will not scale with storage volume for the final rule analysis.

EEI stated that for large water heaters (66 to 119 gallons), DOE's costs to go from TSL 4 (electric resistance) to TSL 5 (heat pump water heaters) are between $20 and $26, which are vastly understated. (EEI, No. 95 at p. 5)

In response, DOE believes that EEI misinterpreted the scaled MPCs presented in the December 2009 NOPR analysis. EEI appears to have been considering the MPC differences between TSLs, whereas the December 2009 NOPR only lists the cost differences between efficiency levels. Heat pump water heater technology is implemented for larger-storage-volume products at the December 2009 NOPR TSL 5; however, DOE does not consider heat pump water heater technology in the engineering analysis for efficiency level 5, but instead considers it at efficiency level 6 for all product classes. The December 2009 NOPR TSL 5 was a combination of efficiency level 5 for the smaller storage volume sizes (55 gallons or less), and efficiency level 6 for the larger storage volume sizes (greater than 55 gallons). Thus, DOE believes the scaled MPCs at the higher gallon sizes and higher efficiency levels presented in the December 2009 NOPR were correct.

6. Water Heater Energy Efficiency Equations

For this rulemaking, DOE reviewed the energy efficiency equations that define the existing Federal energy conservation standards for residential water heaters. The energy efficiency equations characterize the relationship between rated storage volume and energy factor and 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. The energy efficiency equations allow DOE to account for the increases in standby losses as tank volume increases. The current energy efficiency equations show that for each water heater class, the minimum energy factor decreases as the rated storage volume increases.

As described in the December 2009 NOPR, DOE reviewed market data and product literature for gas-fired and electric storage water heaters and developed two approaches for amending the existing energy efficiency equations for gas-fired and electric storage water heaters in the preliminary analysis. 74 FR 65852, 65894–96 (Dec. 11, 2009). One approach was to maintain the same slope used in the existing equations (found at 10 CFR 430.32(d)), but to incrementally increase the intercepts. The 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 the second approach was to acknowledge the changes in the product efficiencies that have occurred since the previous standards were set, and to account for these changes. DOE examined the efficiencies of models with varying storage volumes, but with the same or similar design features and varied the slope of the line to maximize the number of models in the series that meet the efficiency levels that DOE is considering in the full range of rated storage volumes.

The standard levels proposed in the December 2009 NOPR were based on the results of the second approach for gas-fired and electric storage water heaters. For oil-fired storage water heaters and gas-fired instantaneous water heaters, DOE only used the first approach to develop energy efficiency equations due to the limited number of models available on the market and limited data to justify modifying the equations. In response to the energy efficiency equations presented in the December 2009 NOPR, DOE received feedback from several interested parties.

A.O. Smith stated it supports the energy-efficiency equations as generally being appropriate for the various efficiency levels. A.O. Smith endorsed the equations applicable to TSL 4, and strongly recommended that they not be revised from those proposed in the December 2009 NOPR. (A.O. Smith, No. 76 at p. 2)

Bradford White expressed its disagreement with the energy efficiency equations proposed for electric storage water heaters. In particular, Bradford White commented that the efficiency level 4 equation ($EF = -0.00060(V_R) + 0.965$) should be used for $V_R \leq 65$ gallons and that the efficiency level 3 equation ($EF = -0.00155(V_R) + 1.026$) should be used for $V_R > 65$ gallons. Bradford White asserted that these changes are necessary to prevent the disproportionate EF increase that was proposed on larger volumes that have to combat higher standby losses. (Bradford White, No. 61 at p. 4)

Similarly, AHRI recommended that DOE revise the energy efficiency equation for TSL 4 for electric storage water heaters above 65 gallons, because AHRI believes it represents a disproportionately large increase in the EF requirement for these units. AHRI asserts that because larger electric storage water heaters have a smaller surface-area-to-volume ratio, increased insulation is less effective in achieving energy efficiency gains, and as a result, the projected efficiencies are overstated. AHRI recommended that for electric storage water heaters above 65 gallons, DOE should select the equation for TSL 3 ($EF = 1.051 - (0.00168 * \text{Rated Storage Volume})$) as the standard. (AHRI, No. 91 at p. 2)

Rheem also stated that the energy-efficiency equation for gas-fired storage water heaters at TSL 4 disproportionately imposes higher minimum EF values for large-capacity gas-fired storage water heaters. Rheem expressed concern that the uneven treatment of large-capacity units would encourage work-around solutions and product shifts. In addition, Rheem stated that the energy efficiency equation for electric storage water heaters at TSL 4 disproportionately impacts large-capacity electric storage water heaters. Rheem recommends that the equation read $EF = 1.026 - (0.00155 \times \text{Rated Storage Volume in gallons})$ for capacities above 55 gallons, in order to yield balance for high-capacity units. (Rheem, No. 89 at p. 12)

In light of the comments above, DOE reexamined the energy efficiency equations proposed in the December 2009 NOPR for gas-fired and electric storage water heaters. The energy efficiency equations are intended to represent the relationship between efficiency and storage volume so that the same technology could be used to meet the EF requirement for the entire range of gallon capacities. After examining the characteristics of products on the market at each efficiency level and gallon size, and based on the results of the testing and teardown analysis done prior to the December 2009 NOPR, DOE believes that the energy efficiency equations, as presented in the December 2009 NOPR, accurately represent the relationship between efficiency and storage volume. The equations developed by DOE have two slopes and decline faster for the larger storage volumes than the smaller storage volumes. The slopes developed for the December 2009 NOPR incorporated the results of testing and a physical examination (through teardowns) of the features incorporated into units across various gallon sizes and efficiency levels. Through this process, DOE was able to determine the efficiencies that can be achieved using the same technologies across the range of rated storage volumes. DOE then developed equations based on the results of this analysis to create efficiency levels that allow products to utilize the same technology across the range of storage volumes.

DOE believes that the equations have a proportionate impact on both larger-storage-volume units and smaller-storage-volume units. While DOE acknowledges that the efficiency levels in the proposed TSLs (which are determined based on a variety of factors, *see* section VI.A for more details) may be paired in a way which requires different efficiency levels utilizing different technologies for water heaters at various storage volumes, DOE does not believe this applies for the energy efficiency equations in the engineering analysis, which are based on constant technologies across the full range of storage volumes. The commenters did not provide any new data or evidence to lead DOE to conclude that the outcome of its analysis for the December 2009 NOPR is not valid.

As a result, DOE is maintaining the energy efficiency equations presented in the December 2009 NOPR, with only minor changes to account for the new max-tech levels described in section IV.C.2. For the max-tech energy efficiency equation (*i.e.,* EL 6) for gas-fired storage water heaters, DOE maintained the slope used in the December 2009 NOPR, but shifted the efficiency requirements down so that the EF requirement at the 40-gallon representative rated storage volume is 0.77 EF instead of 0.80 EF. Similarly, for the max-tech equation (*i.e.,* EL 7) for electric storage water heaters, DOE maintained the same slope, but shifted the equation upwards so that the efficiency requirement at the 50-gallon representative rated storage volume is 2.35 EF instead of 2.2 EF. *See* section IV.C.2.a for discussion of the max-tech efficiency levels.

DOE did not receive any comments regarding the proposed approach for oil-fired storage water heater energy efficiency equations presented in the December 2009 NOPR and has used the same approach in the final rule. Similarly, DOE did not receive any comments objecting to the proposed approach for gas-fired instantaneous water heater energy efficiency equations presented in the December 2009 NOPR and has used the same approach in the final rule. Table IV.19 through Table IV.22 show the energy efficiency equations for residential water heaters. For more information on the energy efficiency equations, *see* chapter 5 of the final rule TSD.

TABLE IV.19—ENERGY EFFICIENCY EQUATIONS FOR GAS-FIRED STORAGE WATER HEATERS

Efficiency level	Minimum energy factor (20 to 60 gallons)	Minimum energy factor (Over 60 and up to 100 gallons)
Baseline Energy Efficiency Equation	$EF = -0.00190(V_R) + 0.670$	

TABLE IV.19—ENERGY EFFICIENCY EQUATIONS FOR GAS-FIRED STORAGE WATER HEATERS—Continued

Efficiency level	Minimum energy factor (20 to 60 gallons)	Minimum energy factor (Over 60 and up to 100 gallons)
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	$EF = -0.00078(V_R) + 0.8012$	

TABLE IV.20—ENERGY EFFICIENCY EQUATIONS FOR ELECTRIC STORAGE WATER HEATERS

Efficiency level	Minimum energy factor (20 to 80 gallons)	Minimum energy factor (Over 80 and up to 120 gallons)
Baseline Energy Efficiency Equation	$EF = 0.00132(V_R) + 0.97$.	
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	$EF = -0.00113(V_R) + 2.057$	
EL 7 Energy Efficiency Equation	$EF = -0.00113(V_R) + 2.406$	

TABLE IV.21—ENERGY EFFICIENCY EQUATIONS FOR OIL-FIRED STORAGE WATER HEATERS

Efficiency level	Minimum energy factor
EL 1 Energy Efficiency Equation	$EF = -0.0019(V_R) + 0.60$.
EL 2 Energy Efficiency Equation	$EF = -0.0019(V_R) + 0.62$.
EL 3 Energy Efficiency Equation	$EF = -0.0019(V_R) + 0.64$.
EL 4 Energy Efficiency Equation	$EF = -0.0019(V_R) + 0.66$.
EL 5 Energy Efficiency Equation	$EF = -0.0019(V_R) + 0.68$.
EL 6 Energy Efficiency Equation	$EF = -0.0019(V_R) + 0.72$.
EL 7 Energy Efficiency Equation	$EF = -0.0019(V_R) + 0.74$.

TABLE IV.22—ENERGY EFFICIENCY EQUATIONS FOR GAS-FIRED INSTANTANEOUS WATER HEATERS

Efficiency Level	Minimum energy factor
EL 1 Energy Efficiency Equation	$EF = -0.0019(V_R) + 0.69$.
EL 2 Energy Efficiency Equation	$EF = -0.0019(V_R) + 0.78$.

TABLE IV.22—ENERGY EFFICIENCY EQUATIONS FOR GAS-FIRED INSTANTANEOUS WATER HEATERS—Continued

Efficiency Level	Minimum energy factor
EL 3 Energy Efficiency Equation	$EF = -0.0019(V_R) + 0.80$.
EL 4 Energy Efficiency Equation	$EF = -0.0019(V_R) + 0.82$.
EL 5 Energy Efficiency Equation	$EF = -0.0019(V_R) + 0.84$.
EL 6 Energy Efficiency Equation	$EF = -0.0019(V_R) + 0.85$.
EL 7 Energy Efficiency Equation	$EF = -0.0019(V_R) + 0.92$.
EL 8 Energy Efficiency Equation	$EF = -0.0019(V_R) + 0.95$.

D. Markups To Determine Product Price

DOE used manufacturer-to-consumer markups to convert the manufacturer selling prices estimated in the engineering analysis to customer prices, which then were used in the life-cycle cost (LCC), payback period (PBP), and manufacturer impact analyses. DOE calculates markups for baseline products (baseline markups) and for more-efficient products (incremental markups) based on the markups at each step in the distribution channel. The overall incremental markup relates the change in the manufacturer sales price of higher-efficiency models (the incremental cost increase) to the change in the retailer or distributor sales price.

In order to develop markups, DOE identifies how the products are distributed from the manufacturer to the customer (the distribution channels). DOE estimated manufacturer-to-customer markups for residential heating products based on separate distribution channels for water heaters, direct heating equipment, and pool heaters. After establishing appropriate distribution channels for each of the product classes, DOE relied on economic data from the U.S. Census Bureau and other sources to define how prices are marked up as the products pass from the manufacturer to the customer. A detailed description of the distribution channels and the markup applied at each step in the distribution process can be found in chapter 6 of the December 2009 NOPR TSD. DOE did not receive any comments on development of markups, and it used the same approach for the final rule as it used for the December 2009 NOPR.

E. Energy Use Characterization

The energy use characterization, which assesses the energy savings potential from adopting higher efficiency standards, provides the basis for the energy savings values used in the LCC and subsequent analyses. For each considered efficiency level within each heating product class, DOE calculated the potential energy savings compared to baseline models. As part of the characterization, DOE made certain engineering assumptions regarding product application, including how the products are operated and under what conditions. Those assumptions are documented in chapter 7 of the TSD, which also provides more detail about DOE's approach.

DOE determined the annual energy use in the field by using a nationally-representative set of housing units for each type of product. The housing units were selected from EIA's Residential Energy Consumption Survey (RECS). The December 2009 NOPR analysis and today's final rule used the 2005 RECS, which was the latest data set available. (*See http://www.eia.doe.gov/emeu/recs/.*)

1. Water Heaters

For residential storage-type water heaters, DOE relied on an energy use analysis tool, the water heater analysis model (WHAM), and a hot water draw model. For this rulemaking, DOE modified earlier versions of the tools, which were used to conduct the previous rulemaking that concluded in 2001. Combined with data from the 2005 RECS, these analytical tools enable DOE to establish the variation in water heater energy consumption in the United States.

DOE determined the annual energy consumption of water heaters in actual housing units by considering the primary factors that determine energy use: (1) Hot water use per household; (2) the energy efficiency characteristics of the water heater; and (3) water heater operating conditions other than hot water draws. DOE used a hot water draw model to determine hot water use for each household in the sample. The characteristics of each water heater's energy efficiency were taken from the engineering analysis. DOE developed water heater operating conditions (other than hot water draws) from weather data and other relevant sources. DOE calculated the energy use of water heaters using WHAM, which accounts for a range of operating conditions and energy efficiency characteristics of water heaters.

For heat pump water heaters that would be located indoors, overcooling of the indoor space as a result of the unit's operation is a potential problem. DOE assumed that the majority of 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. To account for this indirect increase in home heating (and the decrease in cooling during summer months), DOE estimated the associated energy consumption by space heating and air conditioning equipment for the appropriate homes in the RECS subsample for electric water heaters, and included this energy use in its analysis.

A.O. Smith stated that to replace an electric resistance water heater with a heat pump water heater, the heat pump water heater will either require a larger tank to effectively utilize the heat pump cycle, or if a larger tank is not provided, the unit will run in the electric resistance mode and diminish the benefits of having a heat pump water heater. (A.O. Smith, No. 76 at pp. 2–3) In the December 2009 NOPR analysis and the final rule analysis, DOE estimated the fraction of heat pump water heater operation that would be in electric resistance mode for each unit in the subsample. The fraction estimated to be in electric resistance mode varies from 10 to 50 percent in the subsample.

Southern stated that heat pump water heaters do not perform well in temperatures outside the 45°–120 °F range, and it pointed out that there are locations where ambient temperatures are outside this range. (Southern, No. 90 at p. 3) DOE accounted for the ambient temperatures likely to be faced in heat pump water heater locations by assuming electric resistance heating operation under extreme temperatures.

For gas-fired instantaneous water heaters, DOE modified the approach used for storage water heaters to account for the absence of a storage tank. DOE applied a performance adjustment factor to account for evidence that the rated energy efficiency of instantaneous water heaters does not accurately portray actual performance.

2. Direct Heating Equipment

The household sample developed for DHE is comprised of 2005 RECS housing units that used a floor/wall furnace, fireplace, or heater as the primary or secondary source of heat. DOE relied on the assumptions in the DOE test procedure (10 CFR part 430, subpart B, appendix O) to establish the typical annual energy consumption of direct heating equipment. However, to better reflect actual operating conditions, DOE used home heating loads derived from RECS instead of the average assumptions in the test procedure.

Williams stated that DHE is used in many applications as a secondary heat source, where the primary heat source is turned down and the DHE provides heat to the occupied zone only. (Williams, No. 96 at p. 1) For the December 2009 NOPR and today's final rule, for those RECS households that used a gas furnace as the primary heating equipment and direct heating equipment as a secondary heat source, DOE adjusted the house heating load to estimate the portion of the load met by only the direct heating equipment.

DOE did not receive any other comments on its approach for estimating energy consumption of direct heating equipment, and it has used essentially the same approach and data for the final rule.

3. Pool Heaters

DOE estimated energy consumption of pool heaters in a representative sample of housing units from the 2005 RECS. DOE relied on the assumptions in the DOE test procedure (10 CFR part 430, subpart B, appendix P) to establish the typical annual energy consumption of pool heaters. However, to better reflect actual operating conditions, DOE used pool heater heating loads derived from RECS instead of the average test procedure assumptions.

The calculation of pool heater energy consumption at each considered efficiency level depends on the assumed fraction of products that use a pilot light. In the December 2009 NOPR analysis, DOE used data based on the number of models in the market to estimate that 26.5 percent of units use a pilot light. Raypak stated that 8 percent of pool heaters are millivolt pool heaters (*i.e.,* use a pilot light). (Raypak, No. 67 at p. 2) Given that Raypak's estimate is based upon actual shipments data, DOE believes that the value it cited likely better reflects the actual market than the NOPR estimate based on the number of models. Therefore, for the final rule analysis, DOE adopted the value cited by Raypak.

F. Life-Cycle Cost and Payback Period Analyses

DOE 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, and 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 the 2005 RECS. The housing units include five types: Single-family (attached), single-family (detached), multi-family (2–5 units), multi-family (more than 4 units), and manufactured homes. For each sample household, DOE determined the energy consumption for the heating product and the energy price faced by the household. 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.

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. For many of the above inputs, DOE created distributions of values to account for uncertainty and variability. Within each distribution, 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.23 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 December 2009 NOPR TSD, as well as the changes made for today's final rule. The following subsections discuss the main inputs and the changes DOE made to them.

TABLE IV.23—SUMMARY OF INPUTS AND KEY ASSUMPTIONS IN THE LCC AND PBP ANALYSES *

Inputs	NOPR	Changes for the final rule
Installed Costs		
Product Price	Derived by multiplying manufacturer cost by manufacturer, retailer, and distributor markups and sales tax, as appropriate.	Updated manufacturer product costs (*see* section IV.C.3.a).
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*	Modified fraction of installations with pilot light.
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 2005. Calculated energy use using the water heater analysis model (WHAM).	No change.
	DHE: Based on sample and data from RECS 2005	No change.
	Pool Heaters: Based on sample and data from RECS 1993 to 2005.	Based on sample and data from RECS 2001 and 2005. Included spa heaters.
Energy Prices	Electricity: Based on EIA's 2007 Form 861 data Natural Gas: Based on EIA's 2007 *Natural Gas Navigator*. Variability: Regional energy prices determined for 13 geographic areas **.	Electricity: Updated using data from EIA's 2008 Form 861 data and EIA's Form 826. Natural Gas: Updated using EIA's 2008 *Natural Gas Navigator.* Variability: No change.
Energy Price Trends	Forecasted using EIA's *AEO2009*	Forecasts updated using EIA's *AEO2010* (Early Release).
Repair and Maintenance Costs.	Water Heaters: Based on *RS Means* and other sources	No change.
	DHE: Based on *RS Means* and other sources	No change.
	Pool Heaters: Based on *RS Means* and other sources	No change.
Present Value of Operating Cost Savings		
Product Lifetime	Water Heaters: Based on data from RECS, AHS, and shipments. Variability and uncertainty: Characterized using Weibull probability distributions.	No change.
	Set lifetime of oil-fired storage water heater equal to that of gas-fired storage water heater.	No change.
	DHE: Based on range of lifetimes from various sources	No change.
	Variability and uncertainty: Characterized using Weibull probability distributions.	
	Pool Heaters: Based on range of lifetimes from various sources. Variability and uncertainty: characterized using Weibull probability distributions..	Average lifetime increased from 8 years to 10 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, 2004, and 2007.	No change in approach; added data for asset classes.
Standard Compliance Date	Water heaters: 2015 DHE and Pool Heaters: 2013.	No change.

* References for the data sources mentioned in this table are provided in the sections following the table or in chapter 8 of the December 2009 NOPR TSD.

** Consisting of the nine U.S. Census Divisions, with four large States (New York, Florida, Texas, and California) treated separately.

*** Survey of Consumer Finances.

1. Product Price

To calculate consumer product prices, DOE multiplied the manufacturer selling prices developed in the engineering analysis by the supply-chain markups described above (along with sales taxes where appropriate). 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. The estimated product prices at the considered efficiency levels are included in Chapter 8 in the TSD.

2. Installation Cost

Installation costs include labor, overhead, and any miscellaneous materials and parts. The following sections discuss DOE's treatment of installation costs for each of the three heating products for the December 2009 NOPR, describe and address significant comments received, and discuss changes that DOE made for today's final rule.

a. Water Heaters

In its preliminary analysis, DOE included several installation costs to address the space constraints that water heaters having thicker insulation may face. DOE assumed that major modifications for replacement installations of electric storage water heaters would occur 40 percent of the time for water heater designs with 3 inches or greater insulation. 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.

Generally, DOE maintained the above approach for the December 2009 NOPR. However, in response to comments on the space constraints for water heaters with increased insulation thickness, for the NOPR analysis, DOE investigated the issue of space constraints for electric and gas-fired storage water heaters with an insulation thickness of 2 inches or more. Based upon the results of this inquiry, DOE expanded the percentage of installations that may have space constraints to also include water heaters with 2–3 inches of insulation. DOE assumed that major modifications for replacement installations of electric and gas storage water heaters would occur 20 percent of the time for water heater designs with 2–3 inches of insulation. DOE also added for all water heaters a cost for extra labor needed to install water heaters in attics, and for installing larger water heaters.

Commenting on the December 2009 NOPR analysis, Rheem and Southern stated that DOE has not adequately considered the space constraints faced by manufactured housing, although no data were provided relevant to this issue. (Rheem, No. 89 at pp. 11–12; Southern, No. 90 at pp. 3–4) In response, DOE reviewed its assumptions regarding space constraints faced by manufactured housing, and based on its assessment of likely water heater locations from 2005 RECS, it approximately doubled the fraction of installations deemed to have space constraints. These installations would incur costs as described above to address the space constraints faced by water heater designs with more insulation.

Regarding installation of gas-fired storage water heaters, A.O. Smith stated that the need (and cost) to add electrical power and condensate disposal to existing installations appears to be understated in the December 2009 NOPR. (A.O. Smith, No. 76 at p. 4) DOE notes that the commenter did not provide any data to support its position. DOE reviewed the available sources, which are based on *RS Means* and consultant reports, concluded that they provide a reasonable basis for its estimates, and therefore it has maintained the NOPR estimates for the final rule.

AHRI stated that replacing larger gas-fired storage water heaters with condensing water heaters would require the added cost of new venting system, electrical connection, and a condensate disposal system, and sometimes an electric supply circuit. (AHRI, No. 91 at p. 7) Rheem stated that external power would be required to operate max-tech gas-fired storage water heaters, that venting would typically change to a positive pressure system with plastic venting, and that condensate lines, pumps, and proper disposal methods would be required. (Rheem, No. 89 at pp. 3–4) For the final rule analysis, DOE included a range of installation costs for the condensing water heater design that include all of the items cited by AHRI and Rheem.

In its preliminary analysis, DOE applied a distribution of costs for heat pump water heater installations in indoor locations, including situations where modifications would be required. In response to comments on the assumed costs, for the December 2009 NOPR analysis, DOE made a number of changes, which are discussed below. Additional comments on these issues at the NOPR stage and DOE's response are likewise presented below.

In 20 percent of replacement installations, DOE assumed that a household facing space constraints would install a smaller water heater and use tempering valves. BWC stated that adjusting the thermostat higher on a smaller-volume heat pump water heater and using a tempering valve cannot be done. It noted that the viable refrigerants available limit the water heater to lower temperatures (typically ~130 °F maximum), and to achieve temperatures above this level, an electric resistance element must be used, which decreases the efficiency of the water heater. (BWC, No. 61 at p. 2) Rheem raised similar concerns. (Rheem, No. 89 at p. 8) DOE finds some merit in the above comments. Therefore, it reduced the fraction of installations that would use a tempering valve to include only those cases where the water heater setpoint would not need to exceed 140 °F, as recommended in manufacturer product literature. DOE assumed that those households for which the tempering valve strategy is not viable would incur significant costs to modify the space to accommodate the heat pump water heater.

For the December 2009 NOPR, DOE assumed that some households that would experience significant indoor cooling due to operation of the heat pump water heater in the heating months would have a venting system installed to exhaust and supply air. DOE estimated that 40 percent of households facing a significant cooling effect would incur this cost, which averages $460. A.O. Smith stated that heat pump water heaters will not be vented due to the exorbitant costs of such a venting system and the fact that the venting will not fit within the existing studs and will need to be installed outside the current wall structure, where it will either be exposed, or have to be covered with additional material. (A.O. Smith, No. 76 at p. 3) DOE agrees that the costs of a venting system could be high in some cases, but its analysis assumes that venting will occur in some cases, and the associated costs are included in its LCC analysis. DOE also agrees that in some cases it would be necessary to install the venting system outside the wall structure, where the exposed vents would likely be covered. Therefore, for the final rule analysis, DOE has assumed that one-fourth of the venting system installations would incur an additional cost (on average $581) for covering the exposed vents.

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. A.O. Smith stated that putting a louvered door on a closet will not provide adequate air volume for a heat pump water heater to function correctly. (A.O. Smith, No. 76 at p. 3) Southern raised similar concerns about closet installations. (Southern, No. 90 at pp. 3–4) AHRI also commented that heat pump water heaters installed in replacement situations may require costly alterations so that the heat pump water heater can perform efficiently. (AHRI, No. 91 at p. 6) DOE agrees that there are legitimate concerns about the extent to which installing a louvered door will provide adequate air flow for closet installations of heat pump water heaters. For the final rule analysis, DOE decreased the fraction of indoor replacement installations that add a louvered door. DOE now assumes that all indoor replacement installations where the household would face a significant cooling effect would use a venting system (costing on average $469), which would provide adequate air flow and also alleviate excessive cooling of the indoor space near the water heater.

GE stated that DOE overstated the installation costs for heat pump water heaters, and claimed that their heat pump water heater has not required more labor, larger drain pans, tempering valves, or closet door redesigns. (GE, No. 84 at p. 1) DOE's estimates of installation costs for heat pump water heaters seek to account for the full range of installation situations that might be faced in all replacements of conventional electric storage water heaters. DOE agrees that in many installations, particularly those not located indoors, the additional costs associated with heat pump water heater installation may be small, and DOE's analysis accounts for those installations as well as those where higher costs may be incurred. Chapter 8 of the final rule TSD provides further details about DOE's analysis of installation costs for heat pump water heaters.

For the December 2009 NOPR, DOE's design for gas-fired storage water heaters at efficiency level 2 (0.63 EF for the representative 40-gallon unit) assumed natural draft (atmospheric venting) operation. DOE's analysis assumed that installations with water heaters with recovery efficiency (RE) of 80 percent or higher (which accounted for a small fraction of models at 0.63 EF) would use stainless steel vent connectors. Without such vent connectors, there is a potential for corrosion of the vent due to condensation of flue gases, which can lead to safety concerns.

AGA expressed concerns about the safety of atmospheric venting at efficiency level 2. AGA referred to analysis by the Gas Technology Institute of vent temperatures from water heaters with high recovery efficiency, and voiced concern for recovery efficiencies of 78 percent and higher regarding condensation and the resulting corrosive environment in vent connectors during water heater cycling. AGA insisted that, for venting integrity and occupant safety, 100 percent of installations of units with recovery efficiency of 78 percent and higher should include the cost of a stainless steel vent connector. It added that the combined concerns of vent connector corrosion and venting system buoyancy suggest that the proper vent connector should be stainless steel Type B. (AGA, No. 78 at p. 9) A.O. Smith also expressed concerns that efficiency level 2 could potentially lead to increased vent corrosion and raise issues that may require revisiting the venting table in the National Fuel Gas Code.[5] (A.O. Smith, No. 76 at p. 1)

In response, DOE appreciates the information provided by AGA regarding the safety of atmospheric venting at efficiency level 2. Although there are several 40-gallon gas-fired water heater models currently available to consumers at 0.63 EF that utilize atmospheric venting and do not have any instructions directing installers to use special venting for these products, DOE believes that the prudent course is to assume that a stainless steel vent connector would be required for all models with RE of 78 percent and higher. Applying this assumption resulted in DOE using a cost for a stainless steel vent connector for 57 percent of installations at efficiency level 2, for 53 percent of installations at efficiency level 1, and for 24 percent of installations at the baseline level. DOE agrees that there remain issues that may require revisiting the venting table in the National Fuel Gas Code, and discusses these issues in section VI.D.2 below.

b. Direct Heating Equipment

DOE used the approach in the 1993 TSD[6] to calculate installation costs for baseline direct heating equipment for its December 2009 NOPR analysis, as it believed 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 included installation costs for designs that require electricity (the average cost is $181). DOE made this adjustment for the replacement market only, because wiring is considered part of the general electrical work in new construction.

LTS commented that the proposed standards for the gravity wall furnace category (71-percent AFUE for furnaces in the input capacity range over 27,000 and up to 46,000 Btu/h) would not allow the product to keep the same characteristics, particularly cabinet size and combustion chamber sizes. The commenter claims that with a bigger cabinet and heat exchanger dimensions, installation would require more carpenter work, possible drywall work, and, in some cases, changing or replacing the vent. According to LTS, these changes would be in addition to providing an electrical port. (LTS, No. 56.7 at pp. 1–2)

In response, DOE found that gravity wall furnaces that have dimensions to fit in replacement applications are currently available on the market with efficiencies ranging from 64-percent to 69-percent AFUE in the representative capacity range. There are currently no 71-percent or 72-percent AFUE models within the representative capacity range offered by any of the manufacturers. DOE agrees that models at 71-percent or 72-percent AFUE are likely to have larger dimensions and/or include electronic ignition, either of which would require an additional installation cost. As discussed in section IV.C.2.b, for the final rule, DOE decided to remove the 71-percent and 72-percent AFUE levels from its analysis. DOE introduced the 70-percent AFUE level, which it believes has the necessary dimensions to fit in replacement applications. This level includes electronic ignition, and DOE included a cost for installation of electrical wiring.

Regarding gas wall fan type DHE, AHRI commented that adding to the heat exchanger to increase efficiency would make the upright models bigger, such that they may not be able to fit in the same space as the unit they are replacing. The result could be added installation costs. For the max-tech level for gas wall fan type DHE (80-percent AFUE), DOE added carpentry cost for cutting and repairing the wall to increase the dimensions of the wall opening for a fraction of installations. That fraction also takes into account

[5] National Fire Protection Association, National Fuel Gas Code—2009 Edition. Available at: *http://www.nfpa.org/AboutTheCodes/AboutTheCodes.asp?DocNum=54.*

[6] U.S. Department of Energy—Office of Codes and Standards, Technical Support Document: Energy Efficiency Standards for Consumer Products: Room Air Conditioners, Water Heaters, Direct Heating Equipment, Mobile Home Furnaces, Kitchen Ranges and Ovens, Pool Heaters, Fluorescent Lamp Ballasts & Television Sets, 1993. Washington, DC. Vol. 1 of 3. Report No. DOE/EE–0009.

that some installations are "console units" and do not have this issue, and that some upright installations are not installed inside the wall and, therefore, do not have this issue.

c. Pool Heaters

DOE developed installation cost data for the baseline pool heater in its December 2009 NOPR analysis using *RS Means* and information in a consultant's report. DOE incorporated additional installation costs for designs involving electronic ignition and/or condensing technology.

In the December 2009 NOPR analysis, DOE included a cost for adding electricity at efficiencies above 82 percent (which use electronic ignition only) for installations where the unit currently uses a pilot light. For the December 2009 NOPR, DOE estimated that 26.5 percent of installations would incur this cost. Raypak stated that 8 percent of pool heaters are millivolt pool heaters (*i.e.,* use a pilot light), and the cost of adding electricity is not insignificant. (Raypak, No. 67 at p. 2) For the final rule, DOE has adopted the 8-percent value provided by Raypak to estimate the fraction of installations that would require addition of electricity at efficiencies above 82 percent. For further details on DOE's derivation of installation costs for pool heaters, *see* chapter 8 of the TSD.

3. Annual Energy Use

DOE determined the annual energy use in the field for the three types of heating products as described above in section IV.E.

4. Energy Prices

For the December 2009 NOPR analysis, 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 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 average annual regional residential electricity prices as well as average monthly regional electricity prices. For the December 2009 NOPR, DOE used data from 2007. For the final rule analysis, DOE used more recent 2008 data from the same sources.

DOE estimated average annual residential natural gas prices in each of the 13 geographic areas based on data from EIA's *Natural Gas Navigator.*[7] For the December 2009 NOPR, DOE used EIA data from 2007. For today's final rule, DOE used more recent 2008 data from the same source.

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.[8] For the December 2009 NOPR, DOE used data from 2006. For today's final rule, DOE used the more recent 2007 data from the same source.

DOE estimated average residential prices for oil in each of the 13 geographic areas based on data from EIA's *Petroleum Navigator.*[9] For the December 2009 NOPR, DOE used data from 2007. For today's final rule, DOE used more recent 2008 data from the same source.

5. Energy Price Trend

To estimate the trends in electricity prices for the December 2009 NOPR, DOE used the regional price forecasts in the 2009 *Annual Energy Outlook (AEO 2009)* April Release.[10] To arrive at prices in future years, DOE multiplied the average prices described above by the forecast of annual average price changes in each region. Because the *AEO 2009* forecasts prices only to 2030, DOE followed past guidelines provided to the Federal Energy Management Program by EIA and used the average rate of change during 2020–2030 to estimate the price trends beyond 2030. For today's final rule, DOE updated its analysis to use the price forecasts in the *AEO 2010* Early Release, which includes price forecasts until 2035. DOE used the average rate of change from 2025 to 2035 to estimate price trends beyond 2035.

The spreadsheet tools used to conduct the LCC and PBP analysis allow users to select either the *AEO's* high-price case or low-price case price forecasts to estimate the sensitivity of the LCC and PBP to different energy price forecasts. The *AEO 2009* April Release and *AEO 2010* Early Release only provide forecasts for the Reference Case. Therefore, for the December 2009 NOPR, DOE used the *AEO 2009* March Release high-price or low-price forecasts directly to estimate high-price and low-price trends. For today's final rule, DOE updated the low-price and high-price forecasts to be based on the ratio between the *AEO 2009* March Release low- or high-price forecasts and the *AEO 2009* March Release reference case. DOE then applied these ratios to the *AEO 2010* Early Release reference case to construct its high-price and low-price forecasts. DOE did not receive any substantive comments on its forecast of energy price trends. Thus, DOE retained the same approach for the final rule.

6. 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. Addressing water heaters, A.O. Smith commented that the repair and maintenance costs presented in the December 2009 NOPR are reasonably accurate. (A.O. Smith, No. 76 at p. 4) For more information on DOE's development of repair and maintenance cost estimates, *see* chapter 8 of the TSD.

For the December 2009 NOPR analysis, DOE assumed that there would be some instances where professional maintenance would be needed for heat pump water heaters. 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 to much of the United States.

Commenting on the December 2009 NOPR, BWC stated that heat pump water heaters are installed with an optional component and that the repair and maintenance costs of the optional components were not taken into account, although the commenter provided no specific information regarding the nature or prevalence of such optional components. (BWC, No. 61 at p. 3) Daikin stated that heat pump water heaters generally do not require maintenance for the first 10 years of operation. (Daikin, No. 82 at p. 2) GE stated that the maintenance cost for heat pump water heaters is overstated. (GE, No. 84 at p. 1) In response, DOE acknowledges that many heat pump water heaters may require little or no maintenance. However, DOE believes that because the field experience with

[7] *See* Energy Information Administration, *Natural Gas Navigator* (2009). Available at: *http://tonto.eia.doe.gov/dnav/ng/ng_pri_sum_dcu_nus_m.htm.*

[8] *See* Energy Information Administration, *2007 State Energy Consumption, Price, and Expenditure Estimates (SEDS).* Available at: *http://www.eia.doe.gov/emeu/states/_seds.html.*

[9] *See* Energy Information Administration, *Petroleum Navigator, December (2009). Available at: http://tonto.eia.doe.gov/dnav/pet/pet_cons_821dsta_a_EPD0_VAR_Mgal_a.htm.*

[10] All *AEO* publications are available online at: *http://www.eia.doe.gov/oiaf/aeo/.*

heat pump water heaters is limited, it is reasonable to apply a maintenance cost for some installations. DOE assumed that optional components, which are an addition to the water heater, are not uniformly applicable, and thus, it did not include them in its analysis.

Therefore, for the reasons above, DOE has retained the approach to repair and maintenance costs used for the December 2009 NOPR for the final rule. The approach also accounts for repair or replacement of common components such as heating elements, fans, and compressors.

7. Product Lifetime

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 water heater product class and for DHE and pool heaters, DOE characterized the product lifetime using a Weibull probability distribution that ranged from minimum to maximum lifetime estimates. *See* chapter 8 of the December 2009 NOPR TSD for further details on the sources DOE used to develop product lifetimes.

a. Water Heaters

For the December 2009 NOPR analysis, DOE used an average lifetime of 13 years for gas-fired, electric, and oil-fired storage water heaters. DOE did not receive any comments on this value, and it continued to use it for the final rule.

For the December 2009 NOPR analysis, DOE used an average lifetime of 20 years for gas-fired instantaneous water heaters. A.O. Smith stated that a 20 year lifetime for gas-fired instantaneous water heaters is too long, and is largely based on manufacturers' literature or advertising claims. It referred to its experience with commercial water heating equipment that uses a similar copper-tube type heat exchanger as gas-fired instantaneous water heaters and similar input combustion systems of around 200,000 Btu/h, and the commenter concluded that the same service life (*i.e.,* 13 years) as a tank-type heater should be used for gas-fired instantaneous water heaters. (A.O. Smith, No. 76 at pp. 4–5)

DOE acknowledges that, given that long-term field experience with gas-fired instantaneous water heaters is relatively limited, there is uncertainty regarding the lifetime of these products. Furthermore, the lifetime is influenced by maintenance practices. The 20-year mean lifetime used by DOE is primarily based on the value reported in the National Association of Home Builders/Bank of America Home Equity Study of Life Expectancy of Home Components, which is 20+ years.[11] Regarding the analogy between gas-fired instantaneous water heaters and commercial water heating equipment mentioned by A.O. Smith, DOE notes that the usage patterns in residential applications are different (*e.g.,* less hot water use), and these patterns have a significant impact on the lifetime. Given the available data, DOE decided to retain the mean lifetime of 20 years for the final rule analysis.

b. Direct Heating Equipment

For the December 2009 NOPR analysis, DOE used an average lifetime of 15 years for DHE. DOE did not receive any comments on this value, and it continued to use it for the final rule.

c. Pool Heaters

For the December 2009 NOPR analysis, DOE used an average lifetime of 8 years for pool heaters. In the public meeting, Lochinvar stated that pool heaters live longer than 6–8 years. (Lochinvar, Public Meeting Transcript, No. 57.4 at p. 224) For the final rule, DOE subsequently reviewed information provided by an expert consultant and based upon this information, decided to use a mean lifetime of 10 years for pool heaters, with the same distribution as in the December 2009 NOPR analysis (3 to 20 years).

8. Discount Rates

For the December 2009 NOPR, DOE developed separate distributions of discount rates for new construction and replacement applications. Because the cost of heating products installed in new homes is part of the home selling price, 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. 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, 2004, and 2007.[12] 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 seven 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 the final rule, it added 2009 values for interest or return rates to the distributions for some of the asset classes. The resulting average rate across all types of household debt and equity, weighted by the shares of each class, is 5.1 percent.

DOE did not receive any comments on the discount rates it used in the LCC analysis, and it continued to apply the approach used in the December 2009 NOPR, with the updates discussed above, for the final rule.

9. Compliance Date

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 the Energy Policy Act of 2005 and section 305 of the Energy Independence and Security Act of 2007,[13] 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). Comments on the compliance date for the three types of heating products are presented and responded to in section V.B of this final rule. 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.

[11] National Association of Home Builders (NAHB), "Study of Life Expectancy of Home Components" (Feb. 2007). Available at: *http://www.nahb.org/fileUpload_details.aspx?contentID=99359.*

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

[13] Available at: *http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/2010_feb_report_to_congress.pdf.*

10. 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.

To estimate the base-case market shares of various energy efficiency levels for water heaters in the compliance 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. (*See* chapter 8 of the TSD for citations for these data sources.) For the final rule, DOE updated its estimates using the February 2010 AHRI Directory. To estimate the base-case market shares of gas-fired and electric storage water heaters, DOE considered the market penetration goals set by the ENERGY STAR program, in combination with its assessment of constraints on such penetration. The projected base-case energy efficiency market shares for water heaters that DOE used for the final rule, shown in Table IV.24, are half of the ENERGY STAR goal for heat pump water heaters (EF of 2.0 and 2.2), and one-fifth of the ENERGY STAR goal for gas-fired condensing water heaters (EF of 0.77). These market shares represent the products that households would purchase in 2015 in the absence of revised energy conservation standards.

TABLE IV.24—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	63.9	0.90	29.8	0.53	0.0	0.62	1.0
0.62	23.4	0.91	16.8	0.54	20.0	0.69	2.9
0.63	1.6	0.92	11.2	0.56	0.0	0.78	1.0
0.64	4.8	0.93	26.1	0.58	0.0	0.80	4.9
0.65	0.0	0.94	7.5	0.60	10.0	0.82	52.4
0.67	5.3	0.95	3.7	0.62	20.0	0.84	1.9
0.77	1.0	2.0	4.0	0.66	25.0	0.85	3.9
		2.2	1.0	0.68	25.0	0.92	20.4
						0.95	11.7
	100%		100%		100%		100%

* The base-case market shares of each product class are estimated in the shipment analysis, as described in chapter 9 of the final rule TSD.

For DHE, DOE estimated the market shares of different energy efficiency levels within each product class in the base case using data in the AHRI Directory. For the final rule, DOE updated its estimates using the February 2010 AHRI Directory, and for hearth products, DOE also consulted manufacturers' Web sites in addition to the 2010 AHRI Directory (*see* chapter 8 of the TSD for the citation and detailed information). For pool heaters, DOE estimated the market shares of different energy efficiency levels in the base-case by using 2008 data from the Federal Trade Commission (FTC) on the number of gas-fired pool heater models at different energy efficiency levels as a proxy for shipments. For the final rule, DOE updated its estimates using 2009 FTC data.

DOE did not receive any comments on its estimation of base-case energy efficiency market shares for the three types of heating products. For further information on DOE's estimation of base-case market shares, *see* chapter 8 of the TSD.

11. 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. For these calculations, DOE uses a simple payback period, which 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. DOE did not receive any comments on its methodology for the payback period analysis.

As noted above, EPCA, as amended, establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the energy (and, as applicable, water) savings during the first year that the consumer will receive as a result of the standard, as calculated under the test procedure in place for that standard. (42 U.S.C. 6295(o)(2)(B)(iii)) For each TSL, DOE determined the value of the first year's energy savings by calculating the quantity of those savings in accordance with the applicable DOE test procedure, and multiplying that amount by the average energy price forecast for the year in which compliance with the amended standard would be required.

Results of DOE's payback period analysis, including both the rebuttable presumption analysis and the payback period analysis considering all of the relevant statutory factors, are discussed in section VI.

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

1. General

DOE's National Impact Analysis (NIA) assesses the national energy savings (NES) and the national net present value (NPV) of total consumer costs and savings expected to result from standards at specific efficiency levels. DOE applied the NIA spreadsheet to calculate NES and NPV, using the annual energy consumption and total installed cost data from the LCC analysis. DOE forecasted the energy savings, energy cost savings, equipment costs, and NPV for each product class from 2013 through 2043 for DHE and pool heaters, and from 2015 through 2045 for water heaters. The forecasts provide annual and cumulative values for all four parameters. In addition, DOE incorporated into its NIA spreadsheet the capability to analyze the sensitivity of the results to forecasted energy prices and equipment efficiency trends. Table IV.25 summarizes the approach and data DOE used to derive the inputs to the NES and NPV analyses for the December 2009 NOPR, and also summarizes the changes DOE made for today's final rule. These changes are described in the following sections, and more details are available in chapter 10 of the final rule TSD. Comments on the NIA, as presented in the December 2009 NOPR, and DOE's response are presented in the sections that follow.

TABLE IV.25—APPROACH AND DATA USED FOR THE NATIONAL IMPACTS ANALYSIS

Inputs	NOPR	Changes for the final rule
Shipments	Annual shipments from shipments model	See table IV.4.
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. Sales-weighted energy factor (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 for water heaters and DHE 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.
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 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	*AEO2009* forecasts (to 2030) and extrapolation to 2043 (and 2045).	Updated using *AEO2010* (Early Release) 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 2010, when the final rule will be published.	No change.

2. 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.26 summarizes the approach and data DOE used to derive the inputs to the shipments analysis for the December 2009 NOPR analysis, and the changes DOE made for today's final rule, based on public comments. A discussion of these inputs and changes follows. For details on the shipments analysis, *see* chapter 9 of the TSD.

TABLE IV.26—APPROACH AND DATA USED FOR THE SHIPMENTS ANALYSIS

Inputs	NOPR analysis	Changes for the final rule
Historical Shipments	Water Heaters: Data provided by AHRI	Water Heaters: Used new data for GIWH for 2008 and 2009.
	DHE: Data provided by AHRI and DOE estimates, and data from manufacturers and the trade association for hearth products.	DHE: Derived new data based on manufacturer input.

TABLE IV.26—APPROACH AND DATA USED FOR THE SHIPMENTS ANALYSIS—Continued

Inputs	NOPR analysis	Changes for the final rule
	Pool Heaters: Data from 1993 TSD, inputs from manufacturers, and DOE estimates.	Pool Heaters: Used data provided by manufacturers trade association.
New Construction Shipments	For water heaters and pool heaters, determined by multiplying housing forecasts by forecasted saturation of products in new housing. Housing forecasts based on *AEO2009* projections. New housing product saturations based on American Housing Survey for water heaters, consultant data for pool heaters.	No change in approach. New housing forecast updated with *AEO2010* projections.
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. For pool heaters, included estimated non-replacement of some pool heaters.	No change.

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 2008 for new housing completions and mobile home placements and adopted the projections from *AEO2009* for 2009 to 2030. DOE updated its new housing projections for today's final rule using *AEO2010* Early Release, which provides projections from 2010 to 2035. DOE kept completions constant after 2035. DOE estimated replacements using historical shipments data and product retirement functions that it developed from product lifetimes. Table IV.27 provides a summary of total shipments in 2009 for residential water heaters, direct heating equipment, and pool heaters.

TABLE IV.27—RESIDENTIAL WATER HEATERS, DIRECT HEATING EQUIPMENT AND POOL HEATERS SHIPMENTS (2009)

	Total shipments (million)
Residential Water Heaters	
Gas-fired Storage	3.76
Electric Storage	3.75
Oil-fired Storage	* 0.031
Gas-fired Instantaneous	* 0.384
Direct Heating Equipment	
Gas Wall Fan	* 0.030
Gas Wall Gravity	* 0.103
Gas Floor	* 0.003
Gas Room	* 0.020
Gas Hearth	* 0.286
Pool Heaters	
Gas-fired	0.118

* Estimated.

a. Water Heaters

For the December 2009 NOPR analysis, DOE used information on choice of water heater products in recently-built housing to estimate shipments of each product class to the new construction market. DOE calculated the average market shares of water heaters using a particular fuel in new homes during 2000 to 2008, and assumed that these shares would hold throughout the forecast period. AGA stated that DOE should not fix market shares, and should realize that increasing disparity between gas and electric installed cost will exacerbate a trend away from gas-fired units. (AGA, No. 78 at pp. 7–8) In response, DOE notes that its data on water heater choice in new homes does not show a clear trend away from gas-fired units during the period from 2000 to 2008 (as documented in chapter 9 of the TSD), nor did AGA provide any data to substantiate such a trend. DOE recognizes that future market dynamics may result in changes from the average pattern seen in 2000 to 2008, but DOE does not have sufficient information to forecast the various factors that affect water heater choice in new homes. Therefore, DOE has retained the approach used in the December 2009 NOPR analysis for the final rule.

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.G.2.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 products (20 to 55 gallons rated storage volume) and large-volume products (over 55 gallons rated storage volume) would remain the same throughout the forecast period. The shipments market shares for large-volume products are 4 percent for gas-fired storage water heaters and 9 percent for electric storage water heaters.

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 scenarios of their market penetration 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* chapter 9 of the TSD for information on the past and projected market penetration in Australia.)

Commenting on the December 2009 NOPR approach, AHRI stated that the experience of gas-fired instantaneous water heaters in Australia is too dissimilar to the U.S. market to be used to predict future U.S. shipments. (AHRI, No. 91 at p. 3) Rheem stated that the Australian market was primarily based on outdoor installations, and was influenced by local government programs. (Rheem, No. 89 at p. 13) A.O. Smith stated that in 2009, gas-fired instantaneous water heater shipments will be about 9.4 percent of the total gas market, not 20 percent as the DOE forecast suggests. A.O. Smith estimated a more moderate growth curve for gas-fired instantaneous water heaters, growing to 13–15 percent of the gas market, consistent with DOE's low-penetration scenario. Moreover, A.O. Smith stated that this level will not be reached for 5–7 years, unlike the DOE forecast of 1–2 years. (A.O. Smith, No. 76 at p. 5)

In response, DOE acknowledges the uncertainty associated with basing its forecasted market penetration of gas-fired instantaneous water heaters on the Australian experience, but it believes that there is no other market that could provide an approximate model for forecasting U.S. market penetration. In making use of the Australian experience, DOE's December 2009 NOPR analysis 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. In response to the comments from A.O. Smith, however, DOE made modifications to its approach for the final rule. First, it incorporated A.O. Smith's estimated market share for 2009 (as well as data it provided on the actual share in 2008). Second, based on the new data on shipments, DOE significantly moderated the growth curve for gas-fired instantaneous water heater market penetration such that the rise is less steep than had been assumed for the December 2009 NOPR. Because of broad similarities between the U.S. and Australian water heating markets, DOE continued to use scenarios of market penetration that are partly based on the Australian experience for the final rule. Differences in retail prices and installation costs for instantaneous water heaters, as well as in government incentives, suggest that the growth in the U.S. market will be less strong than in Australia. However, DOE believes that the rapid growth seen in the U.S. before 2008, together with the reputation of instantaneous gas-fired water heaters as an energy-efficient water heating option suggest that the ultimate market penetration may be higher than 13 to 15 percent of the gas water heating market. Therefore, DOE estimated that the U.S. market share (*i.e.,* 28 percent) approaches a level equal to half of the Australian level (*i.e.,* 56 percent) by around 2025. Chapter 9 of the TSD presents more details on DOE's projection.

b. Direct Heating Equipment

To estimate historical shipments of direct heating equipment for the December 2009 NOPR analysis, DOE used two sets of data from AHRI and information from the 1993 TSD. As noted above, 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, along with assumptions regarding future trends. For gas hearth DHE shipments, the forecast used for the December 2009 NOPR related shipments to projected new housing completions.

AHRI stated that the December 2009 NOPR assumption that future shipments of traditional DHE (*i.e.,* all of the product classes except gas hearth DHE) will be flat is unrealistically optimistic and contrary to the last 30 years of shipment history. The commenter stated that this is a declining market not only because these products are sold primarily as replacements, but also because in some cases, the failing unit is replaced not with a similar model but rather with a vented fireplace heater. AHRI recommended that, at a minimum, the shipment forecast for traditional DHE use a 30-percent decrease over the next 30 years. (AHRI, No. 91 at p. 11) In response, for the final rule analysis, DOE modified its forecast such that total shipments of traditional DHE decrease by 30 percent between 2005 and 2042. The modification of the shipments forecast for each of the four traditional DHE product classes is described in chapter 9 of the TSD.

c. Pool Heaters

To forecast pool heater shipments for new construction for the December 2009 NOPR 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. In addition, DOE assumed that some households would not replace their pool heater when it fails due to cost considerations. 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.

The Association of Pool and Spa Professionals (APSP) stated that DOE's data on pool heater shipments are overstated, and they submitted shipments data for 2003–2009. (APSP, No. 64 at p. 1) AHRI made similar comments. (AHRI, No. 91 at p. 8) DOE appreciates the information provided by APSP. For the final rule, it used the data for 2003–2009 as a basis for its shipments forecast.

Raypak stated that the pool heater forecasts are overstated, and that DOE's projection of a huge recovery in first-time pool owners is inaccurate, because of the significant reduction in property values and more difficult access to credit. (Raypak, Public Meeting Transcript, No. 57.4 at pp. 258–259) AHRI stated that DOE did not recognize the increasing sales of electric heat pump pool heaters, which will reduce the shipments of gas-fired pool heaters. (AHRI, No. 91 at p. 9) In response, DOE notes that incorporating the new data for 2003–2009 reduces the forecast of future shipments. DOE agrees with Raypak regarding first-time pool owners and reduced the number of such installations in the early years of its forecast. DOE was not able to consider the impact of heat pump pool heaters as well as electric resistance pool heaters on the market because shipments data were not available. Furthermore, DOE did not include electric pool heaters in the current rulemaking for reasons explained in the NOPR. 74 FR 65852, 65866 (Dec. 11, 2009). Finally, DOE notes that the longer pool heater lifetime used for the final rule (as described in section IV.F.7.c) results in fewer replacement shipments.

d. Impact of Standards on Shipments

i. Water Heaters

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 a natural gas supply 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 December 2009 NOPR 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 three potential combinations 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 power vent; and (3) electric heat pump water heater and a gas-fired storage water heater using condensing technology. DOE used data from the 2005 RECS to estimate the percentage of households expected to purchase an electric water heater in the base case that could switch to gas-fired water heater because they had the necessary infrastructure. To estimate how many of these households would switch to gas-fired water heaters, 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. The estimated 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 require condensing technology, to 9 percent with a standard level for gas-fired storage water heaters that require power vent technology.

DOE did not quantify the potential for switching to gas water heating in the case of a standard that requires 0.95 EF for some or all electric water heaters, as the installed cost is only moderately higher than the baseline electric water heater (0.90 EF). DOE judged that this increase would not be sufficient to prompt consumers to consider switching to gas water heating, given the higher cost of a gas water heater and the fact that such switching would usually require installation of a venting system, which adds significant cost.

Commenting on DOE's December 2009 NOPR analysis, A.O. Smith stated that there will not be appreciable fuel switching in retrofits. (A.O. Smith, No. 76 at p. 4) GE stated that fuel switching is impractical for most consumers. (GE, No. 84 at p. 2) The American Public Power Association (APPA) stated that TSL 3 and TSL 4 would not likely induce fuel switching, but higher TSLs would. (APPA, No. 92 at p. 4) Rheem stated that TSL 6 (*i.e.,* requiring heat pump water heaters) would encourage a shift to instantaneous electric water heaters. In response, DOE believes that the high equipment and installation cost of instantaneous electric water heaters, which may involve upgrading the electrical wiring, along with the high operating cost, will limit the prevalence of a shift to these products. Given that the remaining comments are generally supportive of the estimates in the December 2009 NOPR, DOE retained its December 2009 NOPR analysis of fuel switching for the final rule. However, DOE expanded its analysis to consider the potential for product switching within the same fuel type, as discussed below.

In the December 2009 NOPR analysis, for TSL 5, DOE combined an efficiency level requiring heat pump technology for large-volume electric storage water heaters with an efficiency level requiring condensing technology for large-volume gas storage water heaters. Because these technologies have roughly comparable estimated installed costs and there are constraints in switching from gas to electric or from electric to gas water heaters, DOE did not project that fuel switching would occur under TSL 5.

DOE received a number of comments on potential reaction of consumers to TSL 5. Rheem stated that TSL 5 would provide a strong value incentive for the replacement consumer to replace one large electric resistance unit with two smaller electric storage water heaters to avoid the higher first cost impact associated with a heat pump water heater. It also pointed to other approaches consumers might choose, and noted that TSL 5 could encourage installation of large commercial tank type models in residential applications, where such products often lack an equitable certification status for safe operation. (Rheem, No. 89 at p. 6) A.O. Smith stated that the added cost of a heat pump water heater would induce consumers to install two smaller-storage-capacity, lower-cost heaters in the place of one larger-capacity unit. (A.O. Smith, No. 76 at p. 4) AHRI stated that the market may react to TSL 5 by replacing a large electric storage water heater with either a 50-gallon model with a tempering valve, a 50-gallon model with higher input heating elements, two smaller storage water heaters, or multiple instantaneous water heaters. (AHRI, No. 91 at p. 7) NPCC stated that in emergency replacements of electric water heaters, switching to two smaller water heaters is unlikely because it would require a new 30 amp circuit, which would require a contractor. (NPCC, Public Meeting Transcript, No. 57.4 at pp. 106–107) Regarding TSL 5's requirement of condensing gas-fired storage water heaters for large-volume water heaters, Southern stated that consumers could instead install a non-condensing unit with a 75,000 Btu burner and 55-gallon tank. (Southern, No. 90 at pp. 6–7) In contrast to these comments, NRDC opined that it is unlikely that TSL 5 would cause product switching. (NRDC, No. 85 at p. 6)

In response, DOE agrees that the December 2009 NOPR TSL 5 would present consumers of large water heaters with a total installed cost that could lead some of them to consider alternatives to purchasing a new large water heater. To estimate the likely incidence of switching away from large-volume units under TSL 5 and TSL 6 in today's final rule (*see* section VI.A for description of TSLs), DOE considered several alternatives to purchasing a new large water heater, as well as constraints that would likely limit their adoption.

First, DOE considered factors that would cause some households to choose not to install an alternative to a new large-volume unit. Most important is the need for emergency replacement, which, according to comments from Bradford White (BWC, No. 62 at p. 4), accounts for 95 percent of water heater replacements. This may preclude consideration of switching in some cases. In addition, based on shipments data from AHRI [14] and equipment stock information from AEO 2010 [15], DOE determined that at least 15 percent of furnace shipments go to households that are switching from non-condensing to condensing gas furnace and also have a gas water heater. Some of these households may want to also install a condensing gas water heater to avoid complex venting system modifications. The details are described in chapter 9 of the TSD. DOE judged that the above factors would reduce the fraction of installations estimated to adopt an alternative to purchasing a large-volume water heater by 25 percent.

One alternative applicable to both gas-fired storage water heaters and electric storage water heaters involves installing a small-volume water heater, increasing the setpoint, and applying a tempering valve. DOE believes that this strategy would only be viable for a fraction of 66-gallon units.[16] This strategy results in the household having roughly the same amount of hot water with a small-volume water heater as they would have with a large-volume unit; higher-temperature water is stored in a smaller tank, and then mixed with cold water using the valve. For units larger than 66 gallons, meeting the household's hot water demand would require increasing the setpoint above the 140 °F limit, which could result in deposits on the internal surface of the tank. To assess the viability of this approach for each of the sample households with 66-gallon

[14] AHRI furnace shipment data. Available at *http://www.ahrinet.org/Content/Furnaces_609.aspx.*

[15] AEO 2010 (Early Release): Table 31. Residential Sector Equipment Stock and Efficiency. Available at: *http://www.eia.doe.gov/oiaf/aeo/supplement/supref.html.*

[16] DOE notes that production of large gas-fired water heaters tends to be clustered around models with a rated storage volume of 66 gallons or 75 gallons. DOE assumed that the strategies discussed here are likewise relevant to water heaters with a rated capacity from 56 gallons to 66 gallons.

water heaters, DOE calculated whether the first-hour rating of a small-volume water heater with a tempering valve would meet the first-hour rating of the existing 66-gallon water heater without exceeding a 140 °F setpoint. (The first hour rating is the amount of hot water in gallons the heater can supply per hour, starting with a tank full of hot water). If so, DOE assumed the household would choose this option.

For gas-fired storage water heaters, DOE considered the approach of switching to a small-volume unit with high input capacity (larger burner). DOE understands that designs for units below 56-gallon rated volume that have very high rated input (*e.g.,* 75 kBtu/h) are not common. There are some 50-gallon models with an input of 65 kBtu/h; these designs usually incorporate a 5-inch internal flue tube (instead of 4-inch), and the tank is usually taller to accommodate the same water storage volume. These units are likely to require venting modifications (upgrade to 4-inch vent). In addition, for many installations the input rate for the existing 66-gallon or larger unit is already 55 kBtu/h or higher, and a 50-gallon unit with a high-capacity burner may not satisfy the household hot water requirements. DOE accounted for the above constraints to estimate the fraction of installations that would switch to a small-volume with high input capacity. DOE also evaluated a similar strategy for electric storage water heaters that involves switching to a small-volume unit with high input heating elements.

To consider the alternative of installing two small-volume units, for each sample household with a large-volume water heater that, according to DOE's estimation, would not adopt either of the above two strategies, DOE first considered space constraints that would limit this approach, depending on the water heater location. For those households judged not to have such constraints, DOE compared the total installed cost of either a heat pump water heater or a gas-fired condensing water heater with the alternative of installing two small-volume units. For the cost of this alternative, DOE used information from a consultant report. Because installing two small-volume units is more complicated and takes longer, DOE assumed that households would choose to install two small-volume units only if the total installed cost was at least 10 percent less than the cost for a heat pump water heater or a gas-fired condensing water heater.

The results of DOE's analysis indicate that switching away from a large-volume water heater would occur in 37 percent of large-volume electric storage water heater installations and in 22 percent of large-volume gas-fired storage water heater installations. The details of DOE's approach and the estimated degree of switching using each of the alternatives described above are provided in chapter 9 of the TSD.

ii. Direct Heating Equipment and Pool Heaters

For DHE and pool heaters, in the December 2009 NOPR analysis, DOE did not find any data it could use to estimate the extent of switching away from the products subject to this rulemaking if energy conservation standards were to result in a significant increase in installed costs. Raypak stated that as pool heaters become more expensive, more may be repaired instead of being replaced, so the fraction of non-replacements should be higher. (Raypak, Public Meeting Transcript, No. 57.4 at p. 249) It also stated that the proposed standard for pool heaters would induce product switching to solar or heat pump pool heaters. (Raypak, No. 67 at p. 3) In response, DOE believes that the standard adopted for pool heaters in this final rule (82-percent thermal efficiency) does not increase the installed cost enough to induce most consumers to not replace the product or to switch to a different product.

3. Base-Case and Standards-Case Efficiency Distributions

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 December 2009 NOPR analysis, DOE used the shipment-weighted average energy efficiencies for 2013 (for DHE and pool heaters) or 2015 (for water heaters) 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-fired 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 recently-established ENERGY STAR efficiency levels for water heaters (*see* section IV.F.10). 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 its determination of standards-case forecasted efficiencies, DOE used a "roll-up" scenario in the preliminary analysis and the December 2009 NOPR to establish the SWEF for the year that compliance with the standards would be required 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. DOE did not receive any comments on its forecasts of energy efficiency distributions, so for today's final rule, DOE maintained the approach described above.

4. National Energy Savings

DOE calculates NES for each year as the difference between energy consumption of the product stock using the average unit energy consumption (UEC) of the stock in the base case (without new standards) or in a case given new standards. In addition to annual shipments, key inputs for determining NES are annual UEC and the site-to-source conversion factor.

a. Annual Unit Energy Consumption

For each year in the forecast period, DOE used the shipments-weighted energy efficiencies for the base case and standards cases, along with the data on annual energy use by efficiency level, to estimate the shipments-weighted average annual per-unit energy consumption for each product class under the base case and standards cases. When calculating energy consumption at each considered efficiency level above the baseline, DOE applied a rebound effect of 10 percent for water heaters, 15 percent for DHE, and 10 percent for pool heaters. A rebound effect refers to increased energy consumption resulting from actions that increase energy efficiency and reduce consumer costs. (For example, if energy efficiency improvements were to reduce the energy consumption of a room air conditioner (thereby decreasing its electricity costs), a consumer may choose to run the unit more often, thereby increasing comfort but returning a portion of the savings arising from DOE's standards.) When the rebound effect is incorporated, calculated energy savings are lower than if no rebound effect were considered.

DOE's calculation of UEC accounts for the product switching that DOE anticipates will occur under specific TSLs. That is, DOE accounted for the energy use of the products to which some fraction of households are assumed to switch. For example, in the case of switching from a large-volume water heater to two small-volume units, DOE calculated and incorporated the energy use of the two small-volume units.

b. 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 December 2009 NOPR analysis, DOE used annual site-to-source conversion factors based on the version of NEMS that corresponds to *AEO2009.* For today's final rule, DOE updated its conversion factors based on *AEO2010* Early Release. The *AEO* does not provide energy forecasts beyond 2035; DOE used conversion factors that remain constant at the 2035 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.[17]

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.[18]

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 timeframes 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

[17] *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).

[18] 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 (Sept. 2000).

generation by fuel type can be used to estimate the impact of a changing mix of fuels. However, NEMS currently provides no information on potential changes to the relative ease with which the different fuels can be extracted and processed.

AGA stated that the December 2009 NOPR's energy consumption estimates for specific design options do not reflect a full-fuel-cycle analysis of the energy consumed. Referring to the NRC committee's report, AGA recommended that DOE use "extended site energy" analysis in the near term.[19] (AGA, No. 78 at pp. 2–3) In response, DOE refers to the preceding discussion of why it has not yet adopted a full-fuel-cycle measure of energy use. DOE's calculation of national energy savings does in fact use the extended site measure of energy consumption, which includes generation, transmission, and distribution but, unlike the full-fuel-cycle measure, does not include the energy consumed in extracting, processing, and transporting primary fuels. The calculation of energy consumption that DOE uses in the LCC analysis does not use an extended site energy measure, because the purpose of the calculation is to estimate the operating costs that consumers will face with alternative appliance efficiency levels. The site energy calculated in the LCC analysis is converted to extended site energy (*i.e.,* source or primary energy) in the NIA. 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.

5. Consumer Net Present Value

The consumer NPV is the net value in the present of the costs and savings experienced by consumers of the considered products. DOE calculates the NPV using the value of increased total installed costs, the value of operating cost savings (including energy, repair, and maintenance costs) in each year in which such savings occur, and a discount rate.

a. Increased Total Installed Costs and Operating Cost Savings

The increase in total annual installed cost is equal to the annual change in the per-unit total installed cost (difference between base case and standards cases) multiplied by the shipments forecasted for the standards case. Similarly, the total annual savings in operating costs are equal to the change in annual operating costs (difference between base case and standards case) per unit multiplied by the shipments forecasted for the standards case.

DOE's calculation of total annual installed cost and total annual savings in operating costs accounts for the fuel and product switching that was estimated to occur under specific TSLs (*see* section IV.G.2.d). The accounting of the energy use of the products to which a fraction of households are assumed to switch was described above in section IV.G.4.a. DOE also accounted for the installed cost of those products. For example, in the case of switching from a large-volume water heater to two small-volume units, DOE calculated and incorporated the installed cost of the two units.

b. Discount Rates

DOE multiplies monetary values in future years by the discount factor to determine the present value. For the December 2009 NOPR analysis and today's final rule, 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"). DOE did not receive any comments on the discount rates used to calculate the NPV of appliance consumer benefits, and consequently, DOE has retained those discount rates in this final rule.

H. Consumer Subgroup Analysis

In analyzing the potential impact of new or amended energy conservation 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. For the December 2009 NOPR and today's final rule, DOE used 2005 RECS data to analyze the potential effect of energy conservation standards on the considered consumer subgroups for selected heating products. 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.

DOE did not receive any comments on its approach for the consumer subgroup analysis, and for today's final rule, DOE has made no change to its method for estimating consumer subgroup impacts. Details on the consumer subgroup analysis and results can be found in chapter 11 of the TSD.

I. Manufacturer Impact Analysis

DOE conducted the MIA to estimate the financial impact of amended energy conservation standards on water heater, DHE, and pool heater manufacturers and to calculate the impact of such standards on gross domestic manufacturing employment and capacity. The MIA has both quantitative and qualitative aspects. The quantitative part of the MIA primarily relies on the GRIM—an industry-cash-flow model customized for the three products covered by this rulemaking. The GRIM inputs are data characterizing the industry cost structure, investments, shipments, and markups. The key MIA output is the INPV. Different sets of assumptions (scenarios) produce different results. DOE presents the industry impacts by the major product types. DOE estimated the industry impacts for gas-fired and electric storage water heaters together because these product groupings represent a market that is served by the same manufacturers and these products are typically produced in the same factories. Similarly, DOE presents the other MIA results separately for oil-fired storage water heaters, gas-fired instantaneous water heaters, the traditional DHE product categories, gas hearth DHE, and gas-fired pool heaters.

The qualitative part of the MIA addresses factors such as product characteristics, market and product

[19] AGA cited the "Report" issued by the National Academy of Sciences, but it is evident that AGA was referring to the report by the NRC committee cited in footnote 12.

trends, as well as an assessment of the impacts of standards on subgroups of manufacturers. DOE outlined its methodology for the MIA in the December 2009 NOPR. 74 FR 65852, 65915–22 (December 11, 2009). The complete MIA for the December 2009 NOPR is presented in chapter 12 of the NOPR TSD.

In overview, for the final rule, DOE updated the MIA to reflect changes in the outputs of two other key DOE analyses that feed into the GRIM. Product costs are key inputs to the GRIM. For today's final rule, DOE incorporated the changes made to the engineering analysis, including updates to the MPCs (*see* section IV.C). In the MIA, DOE updated its shipment forecasts and efficiency distributions. In turn, DOE updated the GRIM to incorporate these revised costs and shipments.

For consistency in nominal dollars, for the final rule, DOE inflated the NOPR capital and product conversion costs to 2009$ from 2008$ using producer price index (PPI) information for the relevant industries. See *http://data.bls.gov:8080/PDQ/outside.jsp?survey=pc*. The PPI industry information is related to the North American Industry Classification System (NAICS) code. For gas-fired storage, oil-fired storage, and gas-fired instantaneous water heaters, DOE updated the conversion costs using PPI information under series id PCU3352283352283—"Household water heaters, except electric." DOE updated the conversion costs for electric storage water heaters using series id PCU3352283352281—"Household water heaters, electric, for permanent installation." DOE updated the DHE conversion costs using series id PCU3334143334147—"Floor and wall furnaces, unit heaters, infrared heaters, and mechanical stokers." Finally, DOE updated the conversion costs for pool heaters using series id PCU3334143334149—"Other heating equipment, except electric." For the final rule, DOE also updated its traditional DHE product line analysis used to calculate industry-wide conversion costs to account for new products that have come on to the market and to account for changes to the traditional DHE efficiency levels and TSLs, as reflected in the most current information in the AHRI certification database (*see http://www.ahridirectory.org/ahridirectory/pages/home.aspx*.).

DOE used the GRIM to revise the MIA results from the December 2009 NOPR to reflect the updated MPCs, shipments, and conversion costs. For direct employment calculations, DOE revised the GRIM to include the latest U.S. Census information available from the 2007 Economic Census.[20]

The following sections discuss interested parties' comments on the December 2009 NOPR MIA methodology. In general, DOE provides background on an issue that was raised by interested parties, summarizes the interested parties' comment, and discusses DOE's response to the comments.

1. Water Heater Conversion Costs

For the MIA, DOE classified one-time conversion costs into two major categories: (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.

In response to the December 2009 NOPR, AHRI stated that TSL 4 would require more than 75 percent of gas 40-gallon water heater models and more than 90 percent of electric 50-gallon water heater models from the AHRI Directory to be either redesigned or dropped from production. AHRI added that the severity of this change is even greater than this example suggests because shipments are more skewed towards current Federal minimum efficiency standards than the proportion of models suggests. (AHRI, No. 91 at pp. 1–2)

DOE acknowledges that a significant effort may be necessary for manufacturers to reach the efficiencies required by TSL 4. In the December 2009 NOPR, DOE noted that over 80 percent of the gas-fired water heaters currently sold do not meet the efficiency requirements at TSL 2 through TSL 4 and that only a small portion of the electric storage water heaters currently on the market meet the required efficiencies at TSL 4. This current product distribution drives the estimate of capital conversion costs at TSL 4 and, consequently, contributes to the overall results. These conversion costs reflect the need for manufacturers to add foaming stations and additional production lines to maintain current production levels with water heaters that require much thicker insulation. 74 FR 65852, 65936–37 (Dec. 11, 2009).

BWC commented that the significant increase in insulation thickness necessary to achieve the proposed level for water heaters would require additional assembly time to manufacture the same production quantity. In order to achieve the same manufacturing capacity, BWC stated that it would require a combination of more labor, a reconfiguration of production lines, more foaming equipment on production lines, and/or additional production lines. BWC stated that any of these options result in expensive capital conversion costs, which BWC does not believe were fully taken into consideration. (BWC, No. 61 at pp. 1–2)

DOE's initial estimates for the capital conversion costs for water heaters at each TSL can be found in the December 2009 NOPR. 74 FR 65852, 65936–41 (Dec. 11, 2009). During interviews with manufacturers prior to the publication of the December 2009 NOPR, DOE solicited confidential information about the required capital conversion costs at each efficiency level. In the December 2009 NOPR, DOE stated that it based its capital conversion costs for gas-fired and electric storage water heaters on information learned during these interviews. 74 FR 65852, 65917–18 (Dec. 11, 2009). DOE verified its industry-wide estimates for the gas-fired and electric storage water heaters by comparing the NOPR estimates to a separate bottoms-up estimate of the sub-assembly lines, assembly lines, and tooling changes required by each manufacturer and the level of investments that would be required to maintain a historic value for net plant, property, and equipment as a ratio of total revenue. For oil-fired storage and gas-fired instantaneous water heaters, DOE estimated its capital conversion costs using 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 both oil-fired storage and gas-fired instantaneous water heaters at each TSL. *Id.* Pages 12–35 to 12–39 of the December 2009 NOPR TSD also contained DOE's estimated capital conversion costs as well as additional information about the assumptions

[20] Annual Economic Census: 2007, *American FactFinder,* Bureau of the Census (Available at: *http://www.census.gov/econ/census07/*) (Last accessed Feb. 2010).

behind the required changes at each efficiency level.

For the gas-fired and electric storage water heater capital conversion costs at TSL 4 and TSL 5 in the December 2009 NOPR, DOE noted and agrees with BWC's comment that the increased insulation thickness would require manufacturers to lengthen existing assembly lines or add additional assembly lines because the much thicker insulation requirements lower the throughput of existing assembly lines. However, DOE continues to believe it has adequately addressed BWC's concerns about the capital conversion cost estimates for two reasons. First, DOE's capital conversion cost estimates are drawn from industry-wide aggregated data gathered during manufacturer interviews. Second, DOE's assumptions regarding the required plant changes at the proposed TSL in the December 2009 NOPR are consistent with the plant changes noted in BWC's comment. Finally, BWC did not provide any additional data supporting its comment that DOE's capital conversion cost estimates did not fully capture the potential costs.

For today's final rule, DOE continues to use the same methodology to calculate the water heater conversion costs. Additional details of DOE's estimates can be found in chapter 12 of the TSD.

DOE also received several comments from manufacturers regarding issues that would arise under a potential amended standard for electric storage water heaters that would effectively require heat pump water heaters (*i.e.,* TSL 5 through TSL 8). Broadly, the comments addressed three issues: (1) Potential changes to current facilities; (2) the cost to manufacture heat pump water heaters; and (3) the unique challenges presented by the December 2009 NOPR TSL 5.

At the public meeting, A.O. Smith stated that it is in the final stages of implementing production for heat pump water heaters on a small scale relative to what would be required if the entire market moved to heat pump water heaters. (A.O. Smith, Public Meeting Transcript, No. 57.4 at pp. 91–92) In written comments, A.O. Smith extrapolated the cost of setting up this limited production line to estimate the cost of shifting the entirety of its electric storage market share to heat pump water heaters. A.O. Smith stated that a new facility capable of producing two million heat pump water heaters annually would cost $90 million to build—before accounting for investment in land and other fees—and would take 2–3 years to complete. A.O. Smith stated that it would likely build a new facility because line speed and assembly operations would not allow for the product to be integrated into current production lines at high shipment volumes. A.O. Smith also stated that it would probably be cheaper to set up a new line than to rework the production lines in existing facilities. (A.O. Smith, Public Meeting Transcript, No. 57.4 at p. 92)

AHRI stated that an amended standard effectively requiring heat pump water heaters would force all manufacturers to continue to provide electric storage water heaters utilizing resistance technologies until the compliance date of the amended standard due to competitive pressures. A competitor that did not have to continue manufacturing resistance water heaters until the compliance date (because, presumably, it did not serve this market in the base case) could have an advantage. (AHRI, Public Meeting Transcript, No. 57.4 at pp. 100–103) BWC added that a standard that required heat pump water heaters would disrupt its manufacturing facility since existing manufacturing lines are optimized for specific products. Heat pump water heaters would require production lines to be redesigned to handle all new components and their assembly. Finally, a combination of additional production lines and/or a new manufacturing facility would be required to manufacture heat pump water heaters without interrupting current production. (BWC, No. 61 at pp. 2–3)

DOE agrees that modifying existing production facilities to exclusively heat pump water heaters could be very disruptive to ongoing operations there. During on-site manufacturing impact interviews, most manufacturers were still developing their heat pump water heaters. At that time, manufacturers responded to questions about how they would approach the manufacture of heat pump water heaters by describing the necessary changes to existing facilities. For example, manufacturers anticipated that they would purchase the heat pump modules from outside vendors if heat pump water heaters were required for all electric storage water heaters for three reasons: (1) They lacked experience manufacturing high-volume sealed refrigeration systems; (2) they had limited refrigeration engineering expertise; and (3) they lacked space in their facilities to produce heat pump module subassemblies. DOE incorporated these comments into its NOPR capital cost conversion analysis in the following manner: (1) Manufacturers would initially source the heat pump modules; (2) electric storage water heater assembly and subassembly lines would have to be modified to accommodate the assembly of heat pump water heaters; (3) assembly lines would need to be lengthened to merge new tank assemblies with the heat pump modules; and (4) heat pump water heater integration would require manufacturers to install advanced testing equipment to verify performance, operation, etc. In sum, DOE estimated in the NOPR that manufacturers would incur almost $70 million in capital conversion costs to modify their production facilities to exclusively manufacture heat pump electric storage water heaters. DOE estimated these investments take place between 2010, the announcement date of the standard, and 2015, the year manufacturers must comply with the standard. However, the capital conversion cost estimates did not include the cost of building manufacturing capacity to produce the heat pump modules in house because DOE believed manufacturers would likely purchase these as subassemblies. 74 FR 65852, 65921, 65938 (Dec. 11, 2009).

Manufacturers can choose among multiple design paths and production options for heat pump water heaters, so capital, manufacturing, and product development expenses will vary accordingly. DOE agrees with A.O. Smith that one possible reaction by manufacturers at the NOPR TSL 6 or TSL 7 (equivalently, TSL 7 and TSL 8 in the final rule) could be to build a new facility to exclusively manufacture heat pump water heaters. In the December 2009 NOPR, DOE stated that manufacturers could consider moving all or part of their existing production capacity abroad if NOPR TSL 6 were selected, as the benefit to the manufacturer of a new facility abroad could be greater than modifying an existing facility. In the NOPR, DOE noted that building a new facility could entail less business disruption risk than attempting to completely redesign and upgrade existing facilities. Combined with lower labor rates overseas, this prospect could compel manufacturers to move their production facilities outside of the U.S. 74 FR 65852, 65938, 65952 (Dec. 11, 2009).

While acknowledging there are multiple strategic paths to manufacturer heat pump water heaters, DOE believes it has used a consistent approach to characterize the costs facing the industry. DOE also believes its approach captures manufacturers' concerns about the technology changes required at the

NOPR TSL 6 and TSL 7. While DOE did not include the conversion costs to manufacture the heat pump module or to build new facilities, DOE did include the substantial costs to modify all existing production lines. Furthermore, DOE believes that existing facilities could be modified to produce heat pump water heaters at the final rule TSL 7 and TSL 8, although at a substantial capital conversion cost. Supporting this notion, DOE notes that most existing heat pump water heater designs from major manufacturers incorporate parts of standard electric resistance water heaters. For example, the tank portion of existing heat pump water heater designs are very similar to electric resistance water heater designs, thereby limiting most changes to the assembly line area of a plant. The designs of heat pump water heaters at TSL 7 or TSL 8 would likely be similar to recently-released heat pump water heaters and would maintain these similarities with electric resistance water heaters.

Current manufacturing operations are highly optimized to manufacture water heaters that utilize resistive elements and relatively few additional components (*e.g.,* thermostats), whereas heat pump water heater modules require additional assembly steps even if they are purchased as completed sub-assemblies. While a new manufacturing facility would make the integration of heat pump modules simpler, the $90 million estimate for such a facility projected by A.O. Smith indicates that this approach could also be more costly. Alternatively, manufacturers could choose to build an annex for assembling heat pump water heater modules and then deliver them to the final assembly area in a manner similar to completed tank assemblies. When queried in manufacturer impact interviews, no manufacturer of electric water heater with traditional resistive elements had yet decided on a specific path towards high-volume heat pump water heater production. However, DOE believes that the capital conversion costs that assume manufacturers modify existing facilities to accommodate integrating a sourced heat pump module would be the most likely scenario on account of lower capital expenditures than a "green field" facility, established supplier bases, trained work force, etc. Hence, DOE believes that this scenario captures the significant impacts on electric storage water heater manufacturers.

Finally, both the preservation of return on invested capital scenario and the preservation of operating profit scenario incorporate the financial burdens to substantially modify facilities to manufacture heat pump water heaters and the significant expenses that would be required to carry inventory that is many times more expensive than in the base case (because the MPCs of heat pump water heaters are multiple times the MPCs of resistance water heaters). In addition, the preservation of operating profit scenario models the impacts on manufacturers that would occur after the compliance date of the standard if they cannot fully markup the substantial cost of a sourced heat pump module. Therefore, the costs and market disruption to manufacture heat pump water heaters are modeled in the MIA scenarios.

In response to DOE's request for comment at the public meeting on the required conversion costs for all considered NOPR TSLs, Rheem did not comment specifically because it deemed conversion costs confidential and proprietary. However, Rheem wished to advise DOE that this information was submitted confidentially to DOE's contractor during MIA interviews. (Rheem, No. 89 at p. 9) During the public meeting, Rheem did state that converting all of its electric water heater models to heat pump water heaters (as the December 2009 NOPR TSL 6 or TSL 7 would require) would be a very significant undertaking requiring capital and new manufacturing capabilities. As evidence to that point, Rheem noted that it has to date released only one heat pump water heater model. (Rheem, Public Meeting Transcript No. 57.4 at p. 93–94)

DOE agrees that migrating electric storage production entirely to heat pump water heater production would require a significant investment in time and resources. DOE asked each participant during manufacturer interviews to quantify the costs to manufacture exclusively heat pump water heaters. DOE's own analysis of these conversion costs proved consistent with the estimates submitted by the industry at large. Therefore, DOE believes that its capital conversion costs for the industry are reasonable and that it has adequately modeled the impacts of the significant plant changes that would be required to exclusively manufacture heat pump water heaters in the electric storage water heaters product class. The significant product and capital conversion costs associated with the technology and the required production changes contribute to large, negative impacts on INPV at the December 2009 NOPR TSL 6 and TSL 7.

As discussed earlier, the December 2009 NOPR TSL 5 would effectively require heat pump water heaters for tanks with rated storage volumes greater than 55 gallons. BWC commented that this proposed level would likely result in a smaller percentage of the market above the 55-gallon breakpoint, which would make it more difficult to finance the high conversion costs for moving large tank production to heat pump water heaters. BWC also stated it would have to cut down on its product offerings due to the high development and capital conversion costs. (BWC, No. 61 at p. 2) A.O. Smith stated it has two dedicated factories that build commercial condensing products, and the commenter stated, after studying the production volumes at the December 2009 NOPR TSL 5, that it would likely have to add production lines. Water heater manufacturers would have to invest a significant amount to learn how to manufacture a device with a refrigerant circuit for a small number of units per year. (A.O. Smith, Public Meeting Transcript, 122–123, 126) In its written comments, Rheem added that the December 2009 NOPR TSL 5 introduces added burden and risk because it requires manufacturers to continue to produce conventional storage products in large quantities while incrementally preparing for production of maximum technology products which could involve additional production lines and new facilities. (Rheem, No. 89 at p. 10) AHRI stated that separate minimum efficiency levels for larger size water heaters would require separate production lines for these models. Given the significant differences in the process of manufacturing either heat pump water heaters or condensing gas-fired water heaters, these models could not be interspersed into the high-speed production lines currently operating in water heater manufacturing plants. (AHRI, No. 91 at p. 6) Finally, BWC, A.O. Smith, and Rheem all commented that the lower volume of water heaters above 55-gallons made the business case for the investments in the advanced technology harder to justify. (BWC, No. 61 at p. 2; A.O. Smith, Public Meeting Transcript, No. 57.4 at pp. 98–99; Rheem, Public Meeting Transcript No. 57.4 at pp. 99–100)

DOE agrees with BWC, A.O. Smith, Rheem, and AHRI that the December 2009 NOPR TSL 5 (*i.e.,* TSL 6 for this final rule) would likely require additional production lines for manufacturers to produce heat pump water heaters and condensing products for high-volume products. While DOE believes that existing facilities could be modified to manufacture exclusively heat pump water heaters, DOE does not believe individual manufacturers could integrate heat pump water heaters or condensing gas-fired water heaters above 55-gallons into existing production lines. Rather, DOE calculated the cost for each manufacturer to build a separate production line as an annex to an existing facility to maintain their current market share of the gas-fired and electric storage water heater markets above 55-gallons. DOE also assumed that the capital conversion costs for rated storage volumes less than 55-gallons at the NOPR TSL 5 would not decline if the efficiency requirements were higher for rated storage volumes greater than 55-gallons (*see* pages 12–36 to 12–37 of the December 2009 NOPR TSD). 74 FR 65852, 65918 (Dec. 11, 2009). In addition, DOE calculated the product conversion costs for large rated storage volumes at the December 2009 NOPR TSL 5 by multiplying its estimate for the industry to offer heat pump products at TSL 6 and condensing gas-fired products at TSL 7 for all rated storage volumes by the percentage of total electric storage and gas-fired storage water heater models that exceed a 55-gallon rated volume. 74 FR 65852, 65917 (Dec. 11, 2009). DOE did not modify its approach to calculate the conversion costs at TSL 5 and TSL 6 for the final rule because its approach is consistent with manufacturers' comments. Finally, DOE notes that there are a disproportionately large number of models above 55-gallons relative to the shipment volumes of those products. Thus, the economic impacts to convert those products to a new technology are proportionately more burdensome for those manufacturers. Therefore, DOE agrees that the business case is harder to justify for the larger storage volumes and that this is captured by the MIA, but notes that the impacts are still less severe than requiring manufacturers to exclusively offer either advanced technology.

DOE also received a number of comments about the impacts of the oil-fired storage water heater conversion costs on manufacturers. BWC stated that the business case to make the investments at the December 2009 NOPR TSL 4 is difficult because the industry is small and declining and could lead them to exit the oil-fired market. (BWC, No. 61 at p. 2; Public Meeting Transcript, No. 57.4 at p. 289) AHRI stated that the cost to redesign, develop, and retool production for oil-fired models is high at the proposed December 2009 NOPR TSL 4 compared to the very small market, which offers limited opportunity for a return. AHRI added that this TSL is not currently met by all current 50-gallon residential oil-fired water heaters and all 30-gallon and 32-gallon models except those offered by one manufacturer. Consequently, some manufacturers could drop out of the oil water heater market. (AHRI, No. 91 at p. 2)

DOE agrees that there are no existing 50-gallon oil-fired water heaters on the market that meet the efficiencies required at the December 2009 NOPR TSL 4. However, DOE notes that there are three existing 30-gallon products from two manufacturers that meet these efficiencies using conventional technology. Therefore, DOE continues to believe that models that do not meet the required efficiencies could be made to do so by manufacturers using insulation changes. While not insignificant, the conversion costs to make insulation changes to existing products would not be as substantial as a higher efficiency requirement, which could require manufacturers to use significantly different technology. DOE noted in the December 2009 NOPR that if any manufacturer had to meet the standard using a more complex technology, these costs could force them to exit the oil-fired storage water heater market. 74 FR 65852, 65940 (Dec. 11, 2009). Whether a given manufacturer chooses to exit the market will depend on a variety of internal and external factors, but based upon the available information, DOE believes it has appropriately captured the magnitude of investments that the various TSLs require.

2. Manufacturer Markups and Markup Scenarios

The MPCs from the engineering analysis are key inputs to the GRIMs used in this rule. For water heaters, the MSP is comprised of production costs (the direct manufacturing costs or MPCs), non-production costs (indirect costs like selling, general, and administrative expenses (SG&A)), and profit. For gas-fired, electric, and oil-fired storage water heaters in the MIA, MSP is calculated by multiplying the MPC by the manufacturer markup and adding the shipping cost. For all other products, MSP is calculated by multiplying the MPC by the appropriate manufacturer markup. DOE used several standards-case markup scenarios to bound the range of uncertainty about the potential impacts on prices and profitability following the implementation of amended energy conservation standards.

In both its written submission and comments at the public meeting, BWC stated that profit margins for water heater manufacturers are falling due to the decline of new construction and the industry having excess capacity. BWC argued that because the profitability estimates in DOE's analysis are incorrect, it would be difficult to sustain the costs associated with the December 2009 NOPR TSL 4. Detailed profit data were supplied by BWC in previous communication with DOE's contractor. (BWC, No. 61 at p. 2; Public Meeting Transcript, No. 57.4 at p. 40)

As background, DOE used publicly-available information to calculate its initial markup estimates. Because not all manufacturers in the industry are public and because those that are public often compete in different businesses, DOE calibrated its initial estimates based on information received during manufacturer interviews. During the NOPR phase, DOE refined the manufacturer markup based on feedback from manufacturers to better reflect the residential heating products market. 74 FR 65852, 65892 (Dec. 11, 2009). Given this process, DOE believes the manufacturer markups used in the engineering analysis and manufacturer impact analysis are representative of the industry as a whole. In addition, DOE used estimated market shares to weigh feedback it received on the financial parameters (including the industry capital structure) to determine an aggregate number representative of the entire industry. While individual manufacturers have different gross margins depending on a variety of factors, DOE's use of weighted average financial parameters yields cash flow from operations that are consistent with the overall industry. For example, in the base case, earnings before interest and taxes (EBIT) for gas-fired and electric storage water heating manufacturing is approximately 5 percent. Finally, with respect to BWC's concern that margins have compressed due to the housing downturn, DOE acknowledges that the current economic environment, particularly in new construction, has adversely impacted the industry. DOE notes that the two markup scenarios it models are used to bound the potential impacts on manufacturers due to amended energy conservation standards, in light of the inherent uncertainty in how pricing will adjust in the marketplace. The preservation of operating profit scenario models a case in which margins and profitability decline in response to amended energy conservation standards. DOE believes that the impacts captured by the preservation of operating profit scenario would be a better indicator of the likely impacts on manufacturers than specifically attempting to model a short-term effect that also impacts margins in the base case. A short-term effect that would be impacted in the base case and standards case would not model long-term financial impacts caused by standards and would not consider the impacts on INPV over the entire analysis period. Consequently, DOE has decided to continue to use the markup scenarios modeled in the December 2009 NOPR.

DOE also received comments from traditional DHE manufacturers about the markup scenarios in the MIA. As opposed to the preservation of return on invested capital scenario, LTS stated that it expects profitability to decrease, possibly to zero or below in the event of standards. LTS argued this outcome is likely because manufacturers will either have to abandon some product categories or face lower consumer demand following standards because features the consumer wants would no longer be available, such as the ability to retrofit replacement products and operate without line power. (LTS, No. 56.7 at p. 2; Public Meeting Transcript, No. 57.4 at p. 21) LTS further argued that the preservation of operating profit scenario is too optimistic in the event product offerings are reduced. (LTS, No. 56.7 at p. 2) Finally, LTS stated that the large negative impacts on industry net present values suggest that manufacturers would be substantially harmed if profitability were impacted. (LTS, Public Meeting Transcript, No. 57.4 at pp. 21–22)

In response, DOE created two markup scenarios to bound the potential impacts on DHE manufacturers, as discussed in TSD chapter 12. DOE believes the less optimistic scenario—in which manufacturers do not earn any additional profit from any of the changes required by standards despite increased investment—captures LTS's concerns. DOE agrees with LTS that profitability could decrease if consumer demand was lower or product lines were dropped. At the same time, if manufacturers dropped selected product lines, they would not incur the capital investments included in DOE's estimates because DOE assumes manufacturers convert all product lines. While DOE acknowledges that manufacturers could choose to eliminate certain product lines, DOE believes that its markup scenarios would still reflect the negative impact on industry value. DOE also agrees that lower consumer demand would impact profitability. All of the concerns raised by manufacturers indicate that the range of impacts would be towards the higher end calculated by DOE. While DOE's results changed slightly from the NOPR to account for the latest available data on the industry's product lines, as discussed in chapter 12 of the TSD, DOE believes that the analytical tools correctly capture the impacts on traditional DHE manufacturers. DOE is not adopting the same TSL for traditional DHE as was proposed in the NOPR, in part because of these impacts. DOE further discusses how it weighs the benefits and burden of the amended energy conservation standards, including the impact on traditional DHE manufacturers, in section VI.D.3.

3. Pool Heater Conversion Costs

Raypak agreed with DOE's statement that TSL 5 and TSL 6 would require manufacturers to incur significant product and capital conversion costs. Raypak commented that this statement is also true for TSL 3 and TSL 4. While most manufacturers have some products at these efficiency levels, Raypak argued that manufacturing all products at the levels proposed in the December 2009 NOPR would require substantial tooling and product conversion costs. (Raypak, No. 67 at p. 2; Public Meeting Transcript, No. 57.4 at p. 308) In addition, Zodiac stated that even small efficiency improvements often require significant efforts and burden manufacturers. (Zodiac, No. 68 at p. 1)

DOE agrees that the conversion costs at TSL 3 and TSL 4 are also significant. However, DOE notes that the plant changes at TSL 5 and TSL 6 increase substantially over those necessary at TSL 4, because manufacturers would have to make changes to both component parts (including heating exchanger fabrication) and their main assembly lines. DOE calculated the conversion costs for manufacturers to convert all existing products that did not meet the standard. Therefore, the conversion costs for each manufacturer would vary depending on their experience with high-efficiency products and the range of their current product offerings. DOE believes it has adequately captured the impacts of the conversion costs in the MIA.

4. Employment

Bock stated that the employment impacts discussion in the December 2009 NOPR for oil-fired water heaters did not take into consideration manufacturers shutting down or moving production outside of the United States. (Bock, No. 101 at p. 2)

In the December 2009 NOPR, DOE calculated the potential impacts of amended energy conservation standards on direct employment by bounding the range of potential impacts. 74 FR 65852, 65947–49 (Dec. 11, 2009). For the upper end of the range, the direct employment analysis estimated the number of U.S. production workers who are impacted by this rulemaking, assuming that manufacturers continue to produce the same scope of covered products after the compliance date and that the existing domestic production is not shifted to other countries. In this best case scenario, the direct employment impact analysis shows approximately no change in the number of U.S. production workers in the residential oil-fired storage water heater market. To calculate the lower bound of the range of potential impacts, DOE calculated the total number of domestic production workers that would lose their jobs if all production were no longer made domestically. *Id.* In this scenario, manufacturers respond to the higher labor requirements by shifting production to lower-labor-cost countries or exit the oil-fired market. Since a major US manufacturer has oil-fired storage water heaters that exceed the standard proposed in the December 2009 NOPR, a complete exit from the market or a complete shift to lower-labor-cost countries by industry is unlikely. In the December 2009 NOPR, DOE did not expect substantial changes to U.S. production workers in the residential oil-fired market if manufacturers were able to implement the insulation design options presented in the engineering analysis. 74 FR 65852, 65949 (Dec. 11, 2009).

A.O. Smith stated that the December 2009 NOPR TSL 6 or TSL 7 would require manufacturers to keep their electric resistance water heater lines running while implementing new heat pump water heater production lines. This assumption implies manufacturers would be building new factories or production lines, which could be outside of the United States. (A.O. Smith, Public Meeting Transcript, No. 57.4 at pp. 316–317) A.O. Smith also noted that it would expect to utilize low-cost-labor countries to produce the heat pump portion of the assembly, similar to the trend in the room air conditioning industry. (A.O. Smith, No. 76 at p. 4) BWC added that a disruptive heat pump water heater standard could cause a new manufacturing facility to be located abroad to not disrupt manufacturing in their existing U.S. facility. (BWC, No. 61 at pp. 2–3)

As stated in section IV.I.1, DOE believes that an electric storage water heater standard that effectively mandated heat pump water heaters would not require manufacturers to build new production facilities, because those products would mimic current heat pump water heater designs that simplify manufacturing by maintaining similarities with electric resistance water heaters. However, DOE does recognize that heat pump water heaters have higher labor content than water heaters that only use a resistance element, which could put additional pressure on U.S. manufacturing employment. DOE also believes that these pressures exist at a standard level that would only effectively require heat pump water heaters for products with rated storage volumes greater than 55-gallons. In particular, DOE believes TSL 5 or TSL 6 could cause a change in direct employment if manufacturers with multiple facilities in the U.S. build a dedicated heat pump water heater line at a factory abroad or relocate domestic production for large rated storage volumes.

Also in response to the December 2009 NOPR, ACEEE stated that focusing on manufacturing jobs within the heating products industry is too narrow, because energy savings creates more jobs, including direct employment impacts as noted by DOE's statement that significant technology changes (such as heat pump water heaters) could increase other manufacturing employment. Finally, ACEEE expressed its belief that compared to the total number of jobs in the US economy and given the uncertainties of projections five years into the future, the small employment numbers estimated are not significant and should not be a determining factor in DOE's decision. (ACEEE, No. 79 at pp. 3–4)

DOE agrees with ACEEE that the energy savings from more-efficient standards would likely result in increased net employment. DOE analyzes how consumer savings increase employment in other sectors of the economy in the indirect employment analysis (*see* section IV.J). Furthermore, DOE agrees that more-efficient technologies such as heat pump water heaters could increase direct employment in the United States. DOE noted that even at the December 2009 NOPR TSL 5, if manufacturers build a dedicated heat pump water heater line in the United States, additional labor would be required. DOE also noted that even sourcing heat pump modules could increase U.S. employment because existing assembly lines would need to be lengthened and the manufacturing process would take additional time to assemble and test. 74 FR 65852, 65948–49 (Dec. 11, 2009). However, DOE continues to believe that the higher labor content for assembling heat pump water heaters could also put additional pressure on manufacturers to relocate existing manufacturing facilities in lower-labor-cost countries. Therefore, in light of the multiple strategic options manufacturers could pursue, DOE believes that presentation and consideration of the range of direct employment impacts is appropriate, in that it represents these possibilities. Lastly, while not the only determining factor, a potential reduction in industry employment is a consideration in terms of the impacts on manufacturers for the MIA.

DOE received a number of comments about the direct employment impacts for traditional DHE at the standard levels proposed in the December 2009 NOPR. Specifically, LTS expressed its agreement with DOE's statement that TSL 3 would likely lead to the discontinuation of product lines and could cause small businesses to exit the market completely. LTS believes that both of these outcomes could be possible and that either would have a significant impact on future employment in their industry. (LTS, No. 56.7 at p. 2; Public Meeting Transcript, No. 57.4 at p. 22) LTS also stated that reduced demand, if product features like retrofitability were eliminated, would also harm employment. (LTS, Public Meeting Transcript, No. 57.4 at p. 317) Empire stated that jobs would be lost due to poor prospects for a sufficient return on investment needed in the traditional DHE categories. (Empire, No. 100 at p. 1; Public Meeting Transcript, No. 57.4 at p. 299) Finally, Williams added that increased efficiency standards would force them to eliminate jobs as a result of current products not meeting the new standards. (Williams, No. 96 at p. 1)

In response, DOE notes that it calculated the potential impacts of amended energy conservation standards on domestic production employment for traditional DHE by bounding the range of potential impacts. The upper end of the range assumes that domestic production is not shifted to lower-labor-cost countries and that production volume does not decrease. In this best-case scenario, where shipments do not decrease and higher-efficiency products require more labor, the direct employment impact analysis shows a net increase in the number of domestic jobs for traditional direct heating equipment. To calculate the upper end of the range of direct employment impacts, DOE believes it is reasonable to assume that production volume could be sustained by selectively upgrading certain product lines and increasing shipments of products that meet the amended energy conservation standard. Under this set of assumptions, customers would likely continue to demand these products for the replacement market, and manufacturers would likely selectively upgrade their most popular products to maintain as many sales as possible with their limited resources.

However, at some standard levels, including the December 2009 NOPR TSL 3, the capital conversion and product development costs could be prohibitive for the small domestic manufacturers of traditional DHE. Because DOE agrees that the December 2009 NOPR TSL 3 could lead to the risk of manufacturers exiting the market or reducing the scope of their product lines, the lower end of the range illustrates the industry dynamic in which not all product lines continue to be produced in the U.S. In this scenario, small domestic manufacturers could exit the market rather than invest in new designs, which would result in a loss of domestic employment at these firms. In summary, DOE agrees that all the possibilities raised by manufacturers could result in a loss of direct employment in the traditional DHE market. DOE acknowledged this possibility in the December 2009 NOPR. 74 FR 65852, 65949–50 (Dec. 11, 2009). However, DOE believes it has appropriately bounded the range of employment impacts. DOE continues to believe that amended energy conservation standards could impact DHE direct employment, but believes it has taken the potential into consideration in examining the economic impact on manufacturers in the industry. DOE also notes that it has reviewed its analysis on the potential impacts on small business manufacturers in light of the changes made since the December 2009 NOPR publication and believes it has taken the necessary steps to limit the possibility of manufacturers exiting the market.

AHRI stated that the negative direct employment impacts for traditional direct heating equipment could be larger than the indirect employment gains. (AHRI, Public Meeting Transcript, No. 57.4 at pp. 324–325)

In response, DOE notes that direct and indirect employment impacts are assessed in different analyses for this rulemaking. The MIA assesses the direct employment impacts on manufacturers that make the covered products. The indirect employment impacts are jobs that are created from the consumer savings on energy as a result of the amended energy conservation standards. In light of the results of these analyses, DOE agrees with AHRI that the positive, indirect employment impacts due to the traditional DHE energy conservation standards could be offset by possible direct industry employment losses. Specifically, DOE calculated that the indirect net employment benefits would be fewer than 250 jobs gained in any year, whereas DOE calculated that there are approximately 300 production workers currently in the traditional DHE market. *See* chapter 14 of the TSD for a more complete discussion of the indirect employment impacts related to the traditional DHE industry.

BWC stated that while it does not meet the SBA definition of a small business, BWC is a small company, especially compared to its closest competitors. BWC stated that the December 2009 NOPR TSL 4, and the large cost increases and capital investments it would entail, could threaten the company's survival, because it would place a disproportionate burden on their small company. (BWC, No. 61 at p. 1)

While BWC is not a small business, DOE recognizes that the impacts on all manufacturers are not uniform. However, DOE believes that as a full-line competitor in the residential water heater market, BWC's concerns about the capital investments are most appropriately captured in the industry-wide impacts which are considered when determining what TSL is economically justifiable. DOE also notes that DOJ was primarily concerned about the potential impacts on competition in the traditional DHE market which is discussed in section VI.C.5.

5. Access to Capital

BWC stated that financing the costs associated with the December 2009 NOPR TSL 4 for water heaters would be difficult, because banks are more hesitant to lend in the current economic environment. (BWC, No. 61 at p. 2)

In response, DOE acknowledges that it may be difficult for a given manufacturer to access the capital necessary to finance the investments required by this final rule, particularly given the recent state of capital markets. In response to a similar comment in the December 2009 NOPR, DOE noted that the compliance date for the residential water heater standard is 2015. In the GRIM, DOE assumes the product conversion and capital conversion costs are allocated in between the announcement of the final rule adopting amended energy conservation standards (estimated to be March 2010) and the compliance date of the standard, with more of conversion costs occurring 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, the economic conditions at that time will likely be different than they are currently. 74 FR 65852, 65919 (Dec. 11, 2009). With that said, DOE's current analytical tools do not have the capability to model the state of financial markets in future years, nor how those changes will impact the industry's financing capabilities. DOE acknowledges that the impacts on individual manufacturers are not uniform, particularly in terms of access to capital. However, during the course of manufacturer interviews, DOE received feedback from manufacturers on their capital structure, and DOE adjusted the discount rate for each of the water heater product types to be reflective of the manufacturers in the industry. While it could be difficult to obtain the necessary funding for TSL 4 and higher TSLs, DOE believes it has accurately captured the requisite level of expenditures to meet the amended energy conservation standards.

LTS stated it does not have the required capital estimated by DOE to make the necessary conversions at TSL 3 and, with the current credit markets, LTS does not think it can borrow it. (LTS, No. 56.7 at pp. 2–3; Public Meeting Transcript, No. 57.4 at p. 23)

Again, DOE acknowledges that it may be difficult for a given manufacturer to access the capital necessary to finance the investments required by this final rule, particularly given the recent state of capital markets. This is particularly true for small business manufacturers who cannot rely on a parent company's other operations to help finance the necessary investments. At the same time, DOE believes it would be inappropriate to extrapolate the health of the financial markets at any one particular time to future periods of time. As discussed above, there is a real possibility that small manufacturers may choose not to improve all product lines, whether due to limited access to capital or insufficient expected return on capital. To that point, DOE believes it has captured the level of expenditures necessary to meet the amended energy conservation standards and included the cost for manufacturers to convert all existing product lines to model the impacts these changes would have on the industry. These considerations are included in the assessment of the economic justification of the standard. Finally, DOE notes that the impact of amended energy conservation standards specifically considered the potential impacts on small business manufacturers.

J. Employment Impact Analysis

DOE considers employment impacts in the domestic economy as one factor in selecting an energy conservation standard. Employment impacts include direct and indirect impacts. Direct employment impacts are changes in the number of employees for manufacturers of equipment subject to standards, their suppliers, and related service firms. The MIA addresses these impacts.

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 the purchase price of new equipment; 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 employment statistics in different economic sectors, which are compiled and published by the Bureau of Labor Statistics (BLS). 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.[21] 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). Thus, based on the BLS data alone, DOE believes net national employment will increase due

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

to shifts in economic activity resulting from standards.

In developing the December 2009 NOPR, DOE estimated indirect national employment impacts using an input/output model of the U.S. economy called Impact of Sector Energy Technologies (ImSET).[22] 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 188 sectors most relevant to industrial, commercial, and residential building energy use.

DOE did not receive any comments on its employment impacts analysis, and DOE has made no change to its method for estimating employment impacts for today's final rule. For further details, *see* chapter 14 of the final rule TSD.

K. Utility Impact Analysis

The utility impact analysis estimates the change in the forecasted power generation capacity for the Nation that would be expected to result from adoption of new energy conservation standards. For the December 2009 NOPR and today's final rule, DOE calculated this change using the NEMS–BT computer model. NEMS–BT models certain policy scenarios such as the effect of reduced energy consumption by fuel type. The output of the analysis provides a forecast for the needed generation capacities at each TSL. While DOE was able to use the forecasts from the *AEO 2010* Early Release for the national impacts analysis, the NEMS–BT model corresponding to this case was not yet available. Thus, for the utility impact analysis, the estimated net benefit of the standards in today's final rule is the difference between the forecasted generation capacities by NEMS–BT and the *AEO 2009* April Release Reference Case. DOE expects that the results would be only minimally different if it had been able to use the NEMS–BT model corresponding to the *AEO 2010* Early Release. DOE obtained the energy savings inputs associated with efficiency improvements to considered products from the NIA. These inputs reflect the effects of both fuel (natural gas) and electricity consumption savings. Chapter 13 of the final rule TSD presents more information on the utility impact analysis.

[22] More information regarding ImSET is available online at: *http://www.pnl.gov/main/publications/external/technical_reports/PNNL-15273.pdf.*

1. Effects of Standards on Energy Prices and Associated Benefits

To evaluate potentially important indirect effects of energy conservation standards on energy users in general, in its December 2009 NOPR 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 users in all sectors of the economy. 74 FR 65852, 65914–15 (Dec. 11, 2009). (DOE did not include natural gas savings from amended standards on DHE and pool heaters in its analysis because they are not large enough to have a noticeable impact.) DOE used NEMS–BT to model the impact of the natural gas savings associated with possible standards on natural gas prices. 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 observed in the NEMS output changes over the forecast period based on the model's dynamics of natural gas supply and demand. For each year, DOE calculated the nominal savings in total natural gas expenditures by multiplying the estimated annual change in the average end-user natural gas price by the annual total U.S. natural gas consumption, adjusted for the estimated natural gas savings associated with each TSL. 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. However, 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.

NRDC stated that DOE should give full weight to the aggregate benefit of reduced natural gas prices that result from the standards. NRDC stated that this consumer benefit needs to be quantified and included in the national impact analysis. NRDC disagreed with DOE that this factor not be given heavy weight because lower natural gas prices may be a benefits transfer from producers to consumers, and stated that there is no logical or statutory basis for failing to give the reduction in natural gas prices from efficiency standards their full weight (NRDC, No. 85 at p. 4) In response, DOE notes that the benefits to all consumers associated with reductions in energy prices resulting from standards is not listed among the seven factors that EPCA directs DOE to evaluate in determining whether an energy conservation standard for covered products is economically justified. (42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII)) Indeed, EPCA specifically directs DOE to consider the economic impact of the standard on manufacturers and consumers of the products subject to the standard. While it is true that EPCA directs DOE to consider other factors the Secretary of Energy considers relevant, in so doing, DOE takes under advisement the guidance provided by OMB on the development of regulatory analysis. Specifically, at page 38, Circular A–4 states, "You should not include transfers in the estimates of the benefits and costs of a regulation."

As discussed in the December 2009 NOPR, when gas prices drop in response to lower demand and 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. DOE is continuing to investigate the extent to which a change in natural gas prices projected to result from standards represents a net gain to society. At this time, however, DOE retains the position that it should not give a heavy weight to this factor in its consideration of the economic justification of standards on heating products.

In its December 2009 NOPR analysis, DOE also considered the possibility of estimating the impact of specific standard levels on electricity prices. Investigation conducted for the rulemaking for general service fluorescent lamps and incandescent reflector lamps[23] 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 actors are

[23] *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, 16978–79 (April 13, 2009).

more diverse. For these and other reasons, DOE decided not to estimate the value of potentially reduced electricity costs for all consumers associated with amended standards for heating products.

NPCC stated that DOE should estimate the economic benefits of the reduced need for new electric power plants and infrastructure and include such estimation in the utility impacts analysis. It stated that since a primary goal of the Federal appliance standards program is to avoid construction and operation of unnecessary generating facilities and their associated environmental impacts, failure to quantify the economic value of doing so appears to be a fundamental oversight. (NPPC, No. 87 at p. 6) In a similar vein, NRDC criticized DOE for not analyzing the benefits associated with reduced electricity prices resulting from standards. NDRC stated that the use of NEMS–BT should be explored as a way to quantify the benefit of avoided generation and the corresponding rate impact, and that DOE should give full weight to the aggregate benefit of reduced electricity prices that result from the standards. (NRDC, No. 85 at p. 4–5)

In response to the above comments, DOE used NEMS–BT to assess the impacts of the reduced need for new electric power plants and infrastructure projected to result from standards. In NEMS–BT, changes in power generation infrastructure affect utility revenue requirements, which in turn affect electricity prices. As described in chapter 13 of the TSD, DOE found that the impact on electricity prices from a change in electricity demand is smaller than the impact seen for natural gas prices. Although the aggregate benefits for all electricity users are potentially large, DOE believes that there is uncertainty about the extent to which the calculated impacts from reduced electricity prices are a benefits transfer from the actors involved in electricity supply. Because of the aforementioned complexity and diversity of the electric power sector in the U.S., DOE has concluded that, at present, it should not give a heavy weight to this factor in its consideration of the economic justification of standards on heating products. DOE is continuing to investigate the extent to which change in electricity prices projected to result from standards represents a net gain to society.

L. Environmental Assessment

Pursuant to the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. 4321 *et seq.*) 42 U.S.C. 6295(o)(2)(B)(i)(VI), DOE prepared a draft environmental assessment (EA) of the potential impacts of the standards for heating products in today's final rule, which it has included as chapter 16 of the TSD. DOE found that the environmental effects associated with the standards for heating products were not significant. Therefore, DOE is issuing a Finding of No Significant Impact (FONSI), pursuant to NEPA, the regulations of the Council on Environmental Quality (40 CFR parts 1500–1508), and DOE's regulations for compliance with NEPA (10 CFR part 1021). The FONSI is available in the docket for this rulemaking.

In the EA, DOE estimated the reduction in power sector emissions of CO_2, NO_X, and Hg using the NEMS–BT computer model. In the EA, NEMS–BT is run similarly to the *AEO* NEMS, except that energy use of the heating products is reduced by the amount of energy saved (by fuel type) due to the TSLs. The inputs of national energy savings come from the NIA analysis; the output is the forecasted physical emissions. The estimated net benefit of the standards in today's final rule is the difference between the forecasted emissions by NEMS–BT at each TSL and the *AEO 2009* April Early Release 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. 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.

DOE has 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 impact of energy conservation standards on SO_2 emissions. Because of the cap, energy reductions due to energy conservation standards result in no reduction in SO_2 emissions, although the costs of meeting such emission cap requirements are reflected in the electricity prices and forecasts used in DOE's analysis of the standards. 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. Under existing EPA regulations, any excess SO_2 emission allowances resulting from the lower electricity demand caused by the imposition of an efficiency standard could be used to permit offsetting increases in SO_2 emissions by any regulated EGU. However, if the standard resulted in a permanent increase in the quantity of unused emission allowances, there would be an overall reduction in SO_2 emissions from the standards. While there remains some uncertainty about the ultimate effects of efficiency standards on SO_2 emissions covered by the existing cap-and-trade system, the NEMS–BT modeling system that DOE uses to forecast emissions reductions currently indicates that no physical reductions in power sector emissions would occur for SO_2.

Much like SO_2 emissions, NO_X emissions from 28 eastern States and D.C. are limited under the CAIR. Although CAIR has been remanded to EPA by the U.S. Court of Appeals for the District of Columbia Circuit (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). These court positions were taken into account in the analysis conducted for the December 2009 NOPR and in today's final rule. 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 D.C. where CAIR is in effect, DOE's forecasts indicate that no NO_X emissions reductions will occur due to energy conservation standards because of the permanent cap. Energy conservation standards have the potential to produce an economic impact in the form of lower prices for NO_X emissions allowances, if their impact on electricity demand is large enough. However, DOE has concluded that the standards in today's final rule will not have such an effect because the estimated reduction in electricity demand in States covered by the CAIR cap would be too small to affect allowance prices for NO_X under the CAIR.

New or amended energy conservation standards would reduce NO_X emissions in those 22 States that are not affected by the CAIR. DOE used the NEMS–BT to forecast emission reductions from the standards in today's final rule.

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 from 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, which reflects CAMR being vacated and does not incorporate CAMR emission caps, to estimate the changes in Hg emissions resulting from today's final rule. However, DOE continues to review the impact of rules that reduce energy consumption on Hg emissions, and may revise its assessment of Hg emission reductions in future rulemakings.

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 standards in today's final rule on the above site emissions based on emissions factors derived from the literature. *See* Chapter 16 of the final rule TSD for additional details.

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-based 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. 95 at p. 5)

As noted in chapter 16 of the TSD, DOE developed only qualitative estimates of effects on upstream fuel-cycle emissions because NEMS–BT does a thorough accounting only of emissions at the power plant due to downstream energy consumption. In other words, NEMS–BT does not account for upstream emissions. Therefore, the environmental assessment for today's final rule reports only power plant emissions.

EEI stated that DOE should consider the production process in the EA, especially if higher efficiency standards result in more water heaters being manufactured in other countries. (EEI, No. 95 at p. 5) In response, DOE believes that the standards in today's final rule are unlikely to result in significant change in the location of water heater manufacturing. The dimensions and weight of water heaters, and the resulting shipping expense, mitigate against overseas production of the entire unit.

M. Monetizing Carbon Dioxide and Other Emissions Impacts

As part of the development of this final rule, DOE considered the estimated monetary benefits likely to result from the reduced emissions of CO_2 and other pollutants that are expected to result from each of the TSLs considered. This section summarizes the basis for the estimated monetary values used for each of these emissions and presents the benefits estimates considered.

For today's final rule, DOE is relying on a new set of values for the social cost of carbon (SCC) that were recently developed by an interagency process. A summary of the basis for these new values is provided below, and a more detailed description of the methodologies used is provided as an Annex to Chapter 16 of the TSD.

1. Social Cost of Carbon

Under Executive Order 12866, agencies are required, to the extent permitted by law, "to assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs." The purpose of the SCC estimates presented here is to allow agencies to incorporate the social benefits of reducing CO_2 emissions into cost-benefit analyses of regulatory actions that have small, or "marginal," impacts on cumulative global emissions. The estimates are presented with an acknowledgement of the many uncertainties involved and with a clear understanding that they should be updated over time to reflect increasing knowledge of the science and economics of climate impacts.

The SCC is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change.

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

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

TABLE IV.28—SOCIAL COST OF CO_2, 2010–2050 (IN 2007 DOLLARS)

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

a. Monetizing Carbon Dioxide Emissions

The "social cost of carbon" (SCC) is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services. Estimates of the social cost of carbon are provided in dollars per metric ton of carbon dioxide. [24]

When attempting to assess the incremental economic impacts of carbon dioxide emissions, the analyst faces a number of serious challenges. A recent report from the National Academies of Science (*Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use.* National Academies Press. 2009) points out that any assessment will suffer from uncertainty, speculation, and lack of information about: (1) Future emissions of greenhouse gases, (2) the effects of past and future emissions on the climate system, (3) the impact of changes in climate on the physical and biological environment, and (4) the translation of these environmental impacts into economic damages. As a result, any effort to quantify and monetize the harms associated with climate change will raise serious questions of science, economics, and ethics and should be viewed as provisional.

Despite the serious limits of both quantification and monetization, SCC estimates can be useful in estimating the social benefits of reducing carbon dioxide emissions. Under Executive Order 12866, agencies are required, to the extent permitted by law, "to assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs." The purpose of the SCC estimates presented here is to make it possible for agencies to incorporate the social benefits from reducing carbon dioxide emissions into cost-benefit analyses of regulatory actions that have small, or "marginal," impacts on cumulative global emissions. Most Federal regulatory actions can be expected to have marginal impacts on global emissions.

For such policies, the benefits from reduced (or costs from increased) emissions in any future year can be estimated by multiplying the change in emissions in that year by the SCC value appropriate for that year. The net present value of the benefits can then be calculated by multiplying each of these future benefits by an appropriate discount factor and summing across all affected years. This approach assumes that the marginal damages from increased emissions are constant for small departures from the baseline emissions path, an approximation that is reasonable for policies that have effects on emissions that are small relative to cumulative global carbon dioxide emissions. For policies that have a large (non-marginal) impact on global cumulative emissions, there is a separate question of whether the SCC is an appropriate tool for calculating the benefits of reduced emissions; we do not attempt to answer that question here.

An interagency group convened on a regular basis to consider public comments, explore the technical literature in relevant fields, and discuss key inputs and assumptions in order to generate SCC estimates. Agencies that actively participated in the interagency process include the Environmental Protection Agency, and the Departments of Agriculture, Commerce, Energy, Transportation, and Treasury. This process was convened by the Council of Economic Advisers and the Office of Management and Budget, with active participation and regular input from the Council on Environmental Quality, National Economic Council, Office of Energy and Climate Change, and Office of Science and Technology Policy. The main objective of this process was to develop a range of SCC values using a defensible set of input assumptions that are grounded in the existing literature. In this way, key uncertainties and model differences can more transparently and consistently inform the range of SCC estimates used in the rulemaking process.

The interagency group selected four SCC estimates for use in regulatory analyses. For 2010, these estimates are $4.7, $21.4, $35.1, and $64.9 (in 2007 dollars). The first three estimates are based on the average SCC across models and socio-economic and emissions scenarios at the 5, 3, and 2.5-percent discount rates, respectively. The fourth value is included to represent the higher-than-expected impacts from temperature change further out in the tails of the SCC distribution. For this purpose, we use the SCC value for the 95th percentile at a 3-percent discount rate. The central value is the average SCC across models at the 3-percent discount rate. For purposes of capturing the uncertainties involved in regulatory impact analysis, we emphasize the importance and value of considering the full range. These SCC estimates also grow over time. For instance, the central value increases to $24 per ton of CO_2 in 2015 and $26 per ton of CO_2 in 2020. *See* Appendix A of the Annex to Chapter 16 of the TSD for the full range of annual SCC estimates from 2010 to 2050.

It is important to emphasize that the interagency process is committed to updating these estimates as the science and economic understanding of climate change and its impacts on society improves over time. Specifically, the interagency group set a preliminary goal of revisiting the SCC values within two years or at such time as substantially updated models become available, and to continue to support research in this area. In the meantime, we will continue to explore the issues raised by this analysis and consider public comments as part of the ongoing interagency process.

b. Social Cost of Carbon Values Used in Past Regulatory Analyses

To date, economic analyses for Federal regulations have used a wide range of values to estimate the benefits associated with reducing carbon dioxide emissions. In the final model year 2011 CAFE rule, the Department of Transportation (DOT) used both a "domestic" SCC value of $2 per ton of CO_2 and a "global" SCC value of $33 per ton of CO_2 for 2007 emission reductions (in 2007 dollars), increasing both values at 2.4 percent per year. It also included a sensitivity analysis at $80 per ton of CO_2. A domestic SCC value is meant to reflect the value of damages in the United States resulting from a unit change in carbon dioxide emissions, while a global SCC value is meant to reflect the value of damages worldwide.

A 2008 regulation proposed by DOT assumed a domestic SCC value of $7 per ton CO_2 (in 2006 dollars) for 2011 emission reductions (with a range of $0-$14 for sensitivity analysis), also increasing at 2.4 percent per year. A regulation finalized by DOE in October of 2008 used a domestic SCC range of $0 to $20 per ton CO_2 for 2007 emission reductions (in 2007 dollars). In addition, EPA's 2008 Advance Notice of Proposed Rulemaking for Greenhouse Gases identified what it described as "very preliminary" SCC estimates subject to revision. EPA's global mean values were

[24] In this document, DOE presents all values of the SCC as the cost per metric ton of CO_2 emissions. Alternatively, one could report the SCC as the cost per metric ton of carbon emissions. The multiplier for translating between mass of CO_2 and the mass of carbon is 3.67 (the molecular weight of CO_2 divided by the molecular weight of carbon = 44/12 = 3.67).

$68 and $40 per ton CO_2 for discount rates of approximately 2 percent and 3 percent, respectively (in 2006 dollars for 2007 emissions).

In 2009, an interagency process was initiated to offer a preliminary assessment of how best to quantify the benefits from reducing carbon dioxide emissions. To ensure consistency in how benefits are evaluated across agencies, the Administration sought to develop a transparent and defensible method, specifically designed for the rulemaking process, to quantify avoided climate change damages from reduced CO_2 emissions. The interagency group did not undertake any original analysis. Instead, it combined SCC estimates from the existing literature to use as interim values until a more comprehensive analysis could be conducted.

The outcome of the preliminary assessment by the interagency group was a set of five interim values: Global SCC estimates for 2007 (in 2006 dollars) of $55, $33, $19, $10, and $5 per ton of CO_2. The $33 and $5 values represented model-weighted means of the published estimates produced from the most recently available versions of three integrated assessment models—DICE, PAGE, and FUND—at approximately 3 and 5 percent discount rates. The $55 and $10 values were derived by adjusting the published estimates for uncertainty in the discount rate (using factors developed by Newell and Pizer (2003)) at 3 and 5 percent discount rates, respectively. The $19 value was chosen as a central value between the $5 and $33 per ton estimates. All of these values were assumed to increase at 3 percent annually to represent growth in incremental damages over time as the magnitude of climate change increases.

These interim values represent the first sustained interagency effort within the U.S. Government to develop an SCC for use in regulatory analysis. The results of this preliminary effort were presented in several proposed and final rules and were offered for public comment in connection with proposed rules, including the joint EPA–DOT fuel economy and CO_2 tailpipe emission proposed rules.

c. Approach and Key Assumptions

Since the release of the interim values, interagency group reconvened on a regular basis to generate improved SCC estimates considered for this final rule. Specifically, the group considered public comments and further explored the technical literature in relevant fields.

It is important to recognize that a number of key uncertainties remain, and that current SCC estimates should be treated as provisional and revisable since they will evolve with improved scientific and economic understanding. The interagency group also recognizes that the existing models are imperfect and incomplete. The National Academy of Science (2009) points out that there is tension between the goal of producing quantified estimates of the economic damages from an incremental ton of carbon and the limits of existing efforts to model these effects. There are a number of concerns and problems that should be addressed by the research community, including research programs housed in many of the agencies participating in the interagency process to estimate the SCC.

The U.S. Government will periodically review and reconsider estimates of the SCC used for cost-benefit analyses to reflect increasing knowledge of the science and economics of climate impacts, as well as improvements in modeling. In this context, statements recognizing the limitations of the analysis and calling for further research take on exceptional significance. The interagency group offers the new SCC values with all due humility about the uncertainties embedded in them and with a sincere promise to continue work to improve them.

In summary, in considering the potential global benefits resulting from reduced CO_2 emissions, DOE used the most recent values identified by the interagency process, adjusted to 2009$ using the standard GDP deflator values for 2008 and 2009. For each of the four cases specified, the values for emissions in 2010 used were approximately $5, $22, $36, and $67 per metric ton avoided (values expressed in 2009$). To monetize the CO_2 emissions reductions expected to result from amended standards for residential water heaters in 2015–2045 and for direct heating equipment and pool heaters in 2013–2043, DOE used the values identified in Table A1 of the "Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866," which is reprinted as an Annex to Chapter 16 of the TSD, appropriately escalated to 2009$. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the four cases using the discount rates that had been used to obtain the SCC values in each case.

NRDC stated that the economic impacts of avoided CO_2 emissions should be aggregated into the NIA. (NRDC, No. 85 at p. 3) As discussed in section IV.G.1, the NIA assesses the national energy savings and the national net present value of total consumer costs and savings expected to result from standards at specific efficiency levels. The NPV is not intended as a measure of all national economic benefits associated with standards. Although DOE does not aggregate the estimated economic benefits of avoided CO_2 emissions (and other emissions) into the NIA, it does believe that 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. Therefore, in section VI of this final rule, DOE presents the NPV values that would result if DOE were to add the estimates of the potential economic benefits resulting from reduced CO_2 and NO_X emissions in each of four valuation scenarios to the NPV of consumer savings calculated for each TSL considered in this rulemaking.

2. Monetary Values of Non-Carbon Emissions

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 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 (although there remains uncertainty about whether physical reduction of SO_2 will occur), 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 of factors such as credit banking that can change the trajectory of prices. From its modeling to date, DOE is unable to estimate a benefit from energy conservation standards on the prices of emissions allowances at this time. *See* the environmental assessment in the final rule TSD for further details.

DOE also investigated the potential monetary benefit of reduced NO_X emissions from the TSLs it considered. As noted above, new or amended energy conservation standards would reduce NO_X emissions in those 22 States that are not affected by 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 final rule based on environmental damage estimates from the literature. Available estimates suggest a very wide range of monetary values for NO_X emissions, ranging from $370 per ton to $3,800 per ton of NO_X from stationary sources, measured in 2001$ (equivalent to a range of $447 to $4,591 per ton in 2009$).[25]

EEI stated that the costs of remediating emissions are included in the electricity rates that consumers pay, and care should be taken not to double count the benefits of reduced emissions. (EEI, No. 95 at p. 5) 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 and NO_X emissions by avoiding electricity generation. Because these emissions impose societal costs, their reduction has an economic value that can be estimated.

DOE is not including monetization estimates of Hg in today's final rule. DOE is aware of multiple agency efforts to determine the appropriate range of values used in evaluating the potential economic benefits of reduced Hg emissions. DOE has decided to await further guidance regarding consistent valuation and reporting of Hg emissions before further monetizing Hg in its rulemakings. As explained earlier, DOE was able to use the NEMS–BT model to estimate the changes in Hg emissions resulting from today's final rule, and it has considered these physical emissions reductions as part of the standard-setting process. DOE notes that the amounts of Hg under consideration in today's final rule are not large, so the monetized results would be unlikely to be significant as compared to the total costs and benefits of the rule.

V. Discussion of Other Comments

A. Trial Standard Levels and Proposed Standards

Since DOE opened the docket for this rulemaking, it has received more than one hundred unique written comments, with hundreds of signatories, from a diverse set of parties, including manufacturers and their representatives, State Attorneys General, members of Congress, energy conservation advocates, consumer advocacy groups, electric and gas utilities, and private citizens. DOE also received more than 17,000 form letter submissions recommending that DOE strengthen the proposed energy conservation standards. All substantive comments on the analytical methodologies DOE used are discussed above. DOE also received many comments related to the relative merits of various TSLs. Generally, these comments either stated that a certain TSL was economically justified, technologically feasible, and maximized energy, or they argued how DOE should weigh the various factors that go into making that determination. *See* section VI.D for a discussion of DOE's analytical results and how it weighed those factors in establishing today's final rule.

For today's final rule, DOE has revised the NOPR TSLs for water heaters and direct heating equipment and continued to analyze the same TSLs for pool heaters. A detailed description of these TSL revisions for water heaters and direct heating equipment is provided in section VI.A. A brief summary is provided in the sections that follow.

1. Water Heaters

In the NOPR, DOE proposed TSL 4 for water heaters. 74 FR 65852, 65854 (Dec. 11, 2009). As discussed in that document, DOE strongly considered NOPR TSL 5, which would provide additional energy and carbon savings, while mitigating some of the issues associated with a national heat pump water heater standard, but it identified a number of potential issues for which DOE did not have adequate information to address before the publication of the NOPR. (See 74 FR 65852, 65965–67 (Dec. 11, 2009)). DOE is adding a new TSL 5 for the final rule, which is a slight modification of the NOPR TSL 5. The NOPR TSL 5 is now referred to as TSL 6 for the final rule. DOE tentatively concluded that at NOPR TSL 5 (now final rule TSL 6), the benefits would be outweighed by several burdens, but it stated that it will revisit this decision and strongly consider adoption of TSL 6 in the final rule in light of any comments and data submitted by interested parties. Many of those comments were discussed in section IV. Below DOE presents further comments on NOPR TSL 5 (now final rule TSL 6), as well as on the proposed NOPR TSL 4.

Support for setting a standard at NOPR TSL 5 (TSL 6 for this final rule) was expressed by several interested parties. As noted above, DOE received over 17,000 form letters from private citizens advocating stronger standards for water heaters. (Private Citizens, No. 63 and 74) The Joint Advocacy comment (submitted by ASAP) stated that its signatories are very pleased with the DOE's proposed new efficiency standards for most storage-type residential water heaters but urged DOE to adopt stronger efficiency levels (NOPR TSL 5) for the largest units, which would help assure a market for these new emerging products where they are most cost-effective. It stated that NOPR TSL 5 offers a middle ground that increases savings relative to NOPR TSL 4 while also fostering the development of precisely the knowledge base and market infrastructure needed for a longer term, market-wide transition to high-efficiency technologies. It strongly urged DOE to choose NOPR TSL 5 (now TSL 6), for the final rule. (ASAP, No. 102 at p. 2) NRDC stated that NOPR TSL 5 should be adopted for water heaters as it is technically feasible, economically justified, and provides significant additional energy, economic, and environmental savings. (NRDC, No. 85 at p. 2) A comment provided by eight utilities stated support for NOPR TSL 5 because stronger standards for the biggest units would boost total energy and economic savings by more than 40 percent compared to the proposed rule, and DOE would be helping advanced technologies become mainstream products, thereby speeding transition to next-generation water heaters. (Eight utilities, No. 72 at p. 1) ASE stated that at NOPR TSL 5 the advanced technology requirements are limited to a modest share of total water heater shipments, which is a sensible means of addressing the issue of manufacturers being able to scale up the production of these products to meet the needs of the market. (ASE, No. 77 at p. 2) Other parties expressing support for choosing NOPR TSL 5 included Alabama Consumer Advocate, Avista, Energy Consumers Alliance of New England, KCP&L, Energy Trust of Oregon, Alliance to Save Energy, and NEEA. (ACA, No. 60 at p. 1; Avista, No. 66 at pp.1–2; Energy Consumers Alliance of New England, No. 59 at p. 1; KCP&L, No. 97 at p. 1; Energy Trust of Oregon, No. 69 at p. 1; Alliance to Save Energy, No. 56.4 at p.1; NEEA, No. 88 at p. 1)

Opposition to setting a standard at NOPR TSL 5 (now TSL 6 for the final rule) was also expressed by several interested parties. AHRI stated that NOPR TSL 5 would cause installation issues for large-volume, advanced-technology models and that consumers may opt for less-efficient alternative options. It stated that DOE's analysis has undervalued these factors, and as a result, AHRI expects that the actual energy savings will fall well short of the savings projected in the TSD. (AHRI, No. 91 at p. 6) A.O. Smith stated that it does not support NOPR TSL 5. It believes that the energy savings are overstated because many consumers,

[25] 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.

when faced with the increased cost of large-storage-capacity water heaters that are required to use either condensing gas or electric heat pump technology, would elect to install two smaller-storage-capacity water heaters instead of one larger capacity unit. (A.O. Smith, No. 76 at p. 4) Rheem commented that the energy savings from TSL 6 are significantly overstated, and it pointed to several options for consumers to work around the standards on large-volume units. (Rheem, No. 89 at pp. 6–7) BWC stated that the efficiency levels under consideration for larger-capacity water heaters would be difficult and expensive to obtain. (BWC, No. 61 at p. 1) Referring to NOPR TSL 5 and NOPR TSL 6, APPA stated that they do not support a standard that eliminates high efficiency electric resistance water heaters as a consumer option. It believes that these TSLs would cause an adverse economic impact for consumers and lessen the utility of the product. (APPA, No. 92 at p. 2) Southern Company stated that it does not agree with NOPR TSL 6 because performance of heat pump water heaters depends on climate and installation location. (Southern, No. 90 at pp. 3–4)

Support for NOPR TSL 4 (unchanged in the final rule), was expressed by APPA and A.O. Smith. (APPA, No. 92 at p. 2; A.O. Smith, No. 76 at p. 1) AHRI recommended that DOE should adopt minimum efficiency requirements for gas-fired and electric storage water heaters that have their basis in TSL 4 but have been modified to address issues related to the needs of the replacement market and unique attributes of some models. For electric storage water heaters 65 gallons and larger, AHRI recommended that DOE select TSL 3 (also unchanged for the final rule), as TSL 4 for this size presents a disproportionately large increase in efficiency. For oil-fired storage water heaters it recommended that DOE adopt TSL 3. For gas-fired instantaneous water heaters, AHRI recommended that the standard be changed to a minimum EF of 0.80 for models using an external electric supply and a minimum EF of 0.78 for models that do not use an external electric supply. (AHRI, No. 91 at p. 1) Rheem also supported a 0.80 EF level for gas-fired instantaneous water heaters and noted that the 0.82 EF level has a high payback period. (Rheem, No. 89 at p. 13) Bock supported TSL 3 because all storage water heater manufacturers are capable of meeting the standard, and it would allow consumers to have abundant hot water at a reasonable cost. (Bock, No. 101 at p. 3)

DOE acknowledges the positions expressed regarding adoption of either the proposed standards (TSL 4) or NOPR TSL 5 for water heaters. It addresses the arguments raised by the commenters, as well as other factors, in its discussion of the merits of the various considered TSLs in section VI.D.

2. Direct Heating Equipment

In the NOPR, DOE proposed TSL 3 for direct heating equipment. 74 FR 65852, 65854 (Dec. 11, 2009). The only modifications made to the TSLs analyzed for the final rule compared to those analyzed for the NOPR were to the efficiency levels in TSLs 3, 4, 5, and 6 for gas wall gravity DHE. DOE revised the efficiency levels analyzed for gas wall gravity DHE in the final rule to more accurately reflect the current market for products within the representative rated capacity. A detailed description of these changes is provided in section IV.C.2.b.

AHRI stated that no amended energy conservation standards should be set for traditional DHE because of the significant impact on manufacturers and the small energy savings. (AHRI, No. 91 at p. 10) AGA stated that standards should not be set for DHE because the low and declining shipments represent a minimal opportunity for energy savings, and the increased installed cost of DHE may lead to greater use of central heating, thereby increasing overall energy consumption (AGA, No. 78 at p. 11) Williams recommended that DOE not adopt standards for DHE because of the significant impact on manufacturers, the unique utility of DHE to heat homes without ductwork, design constraints, and safety concerns. Williams stated that manufacturers, as well as consumers, would be negatively impacted by the proposed rule. (Williams, No. 96 at pp. 1–2)

AHRI stated its belief that the proposed standards for traditional DHE (NOPR TSL 3) are too high and that the impact on manufacturers needs to be reconsidered. According to the commenter, the proposed levels would have very significant and costly effects on manufacturers. The DHE results show negative impact on the profitability of the manufacturers, all of which are small manufacturers, and there is a real concern about whether they could stay in business and make a profit at these levels. (AHRI, Public Meeting Transcript, No. 57.4 at pp. 28–29) AHRI reiterated DOE's estimates for the INPV decreasing between 6 and 33.5 percent at the proposed level, industry cash flow dropping from $1.4 million to −$0.9 million (a 162-percent decrease), and the conversion costs reaching $2.31 million per manufacturer (about 350 percent of estimated earnings before interest and taxation). AHRI also stated that the number of product lines per manufacturer would drop from 5 to 3 and that all of AHRI's members indicated a loss of employment would result. Finally, AHRI stated all these negative impacts would be compounded by a decline in sales. Because of all these negative impacts and insignificant energy savings, AHRI stated that DOE should not consider TSL 3 for the final rule (AHRI, No. 91 at p. 13)

LTS stated that DOE estimated that the conversion costs for a typical small DHE manufacturer at the proposed level would be $2.3 million or 347 percent of each company's earnings before interest and taxes. LTS questioned having to spend three or four years' profit to meet a standard they are certain will make them less profitable overall. (LTS, No. 56.7 at pp. 2–3; Public Meeting Transcript, No. 57.4 at p. 23) LTS reiterated the NOPR's estimate that industry cash flow could decrease up to 161.8 percent. Finally, LTS reiterated DOE's statement that the large estimated impact on INPV suggests that manufacturers would be substantially harmed if profitability were impacted. (LTS, No. 56.7 at p. 2)

Congressman Costello and Congressman Shimkus urged DOE to consider Empire's testimony and related concerns. Congressman Costello and Congressman Shimkus stated that Empire strongly believes the technology necessary to meet these proposed efficiency standards is not in place and that the cost of retrofitting these product lines does not justify the small energy savings for the small traditional DHE market. (Costello, No. 62 at p. 1)

DOE acknowledges the positions expressed regarding adoption of the proposed standards (TSL 3) for direct heating equipment. It addresses the arguments raised by the commenters, as well as other factors, in its discussion of the merits of the various considered TSLs in section VI.D.

3. Pool Heaters

In the NOPR, DOE proposed NOPR TSL 3 for pool heaters. 74 FR 65852, 65854 (Dec. 11, 2009). The TSLs analyzed in the final rule are identical to those analyzed in the NOPR. AHRI stated that the proposed standard for pool heaters is not economically justified because its payback period well exceeds product lifetime. It recommended the proposed standard for pool heaters be lowered to 81 percent. (AHRI, No. 91 at p. 9) Raypak stated that the proposed standard for pool heaters has a very high payback period which is outside the lifetime of the appliance, so the commenter argued that such level should not be considered economically justified. Raypak supported adoption of amended energy conservation standards at TSL 1 for pool heaters because it would raise the efficiency level by 3 percentage points, while preventing the elimination of the millivolt design option. (Raypak, No. 67 at pp. 3–4) APSP stated that the proposed level could result in a significantly negative impact on the pool heater industry in these already turbulent economic times. (APSP, No. 64 at p. 1)

DOE acknowledges the positions expressed regarding adoption of the proposed standards (TSL 3) for pool heaters. It addresses the arguments raised by the commenters, as well as other factors, in its discussion of the merits of the various considered TSLs in section VI.D.

B. Compliance Date of Amended Standards

As discussed in section IV.F.9, compliance with amended energy conservation standards for direct heating equipment and pool heaters is required three years after the final rule is published in the **Federal Register** (*i.e.,* in 2013); compliance with amended energy conservation standards for water heaters is required five years after the final rule is published (*i.e.,* in 2015).

Raypak stated that the date of when the standard goes into effect should be changed to five years for pool heaters. (Raypak, No. 67 at p. 3) In response, DOE notes that the language in 42 U.S.C. 6295(e)(4) specifies compliance dates for amended standards (if any) for the heating products that are the subject of this rulemaking. These statutory dates were set such that they were to apply to products manufactured on or after the 36-month period beginning on the date such final rule was to be published for the first iteration of rulemaking and on or after the 60-month period beginning on the date such final rule was to be 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 pool heaters that are manufactured precisely three years after publication of the final rule and prospectively thereafter. Although DOE did not meet the rulemaking dates set by the statute, DOE continues to believe 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. Consequently, for the final rule, DOE has maintained a compliance date corresponding to three years after final rule publication in the **Federal Register** for direct heating equipment and pool heaters, and five years after the date of publication in the **Federal Register** for water heaters.

VI. Analytical Results and Conclusions

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 December 2009 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. For the December 2009 NOPR, DOE analyzed seven TSLs for water heaters, six TSLs for direct heating equipment, and six TSLs for pool heaters. 74 FR 65852, 65929–32 (Dec. 11, 2009).

For today's final rule, DOE has revised the TSLs for water heaters and direct heating equipment and continued to analyze the same TSLs for pool heaters. 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 used in TSL combinations in today's final rule, DOE presents the results for all efficiency levels analyzed in the final rule TSD.

1. Water Heaters

Table VI.1 shows the eight TSLs DOE analyzed for water heaters for the final rule. 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 further discussed in the December 2009 NOPR (74 FR 65852, 65929 (Dec. 11, 2009)), 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 TSLs 1, 2, 3, and 4, DOE is using the rated storage volume divisions developed in the engineering analysis and the energy efficiency equations as shown in section IV.C.6, which specify a two-slope approach. TSLs 1, 2, 3, and 4 are identical to those presented in the December 2009 NOPR. 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.

DOE is adding a new TSL 5 for the final rule, which is a slight modification of the December 2009 NOPR TSL 5 (currently referred to as TSL 6 for the final rule). For both TSL 5 and TSL 6, DOE considered 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 category. Consequently, DOE pairs an efficiency level effectively 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 effectively 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. The only difference between TSL 5 and TSL 6 for the final rule is the requirements for gas-fired storage water heaters. DOE reanalyzed these levels due to potential safety concerns, which were discussed above and are further discussed below. For gas-fired water heaters at TSL 5, DOE analyzed energy efficiency level 1 for small volumes paired with efficiency level 6 for large volumes. For gas-fired water heaters at TSL 6, DOE analyzed energy efficiency level 2 for small volumes paired with efficiency level 6 for large volumes.

Although it paired different technologies for small-volume and large-volume products for TSL 5 and TSL 6, DOE maintained the same division point between small-volume and large-volume gas-fired and electric storage water heaters just as was done in the December 2009 NOPR. As further explained in the December 2009 NOPR, DOE is concerned that increased standards for large-volume water heaters may drive production and sales of water heaters at volumes just below the division points. 74 FR 65852, 65929 (Dec. 11, 2009). As a result, in analyzing TSL 5 and 6 for the final rule, DOE is using the same division points as it used for the December 2009 NOPR TSL 5, which is 55 gallons for gas-fired and electric storage water heaters, to attempt to mitigate the potential migration to small-volume units described above. TSL 5 and 6 include 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 and TSL 6 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 and TSL 6 division.

TSL 7 uses the same divisions as TSLs 1, 2, 3, and 4 for gas-fired water heaters (*i.e.,* does not include the distinction at TSL 5 and TSL 6 for units above and below a 55-gallon storage capacity). TSL 7 is identical to TSL 4 except DOE is considering what is effectively a heat pump water heater level for electric storage water heaters across the entire range of storage volumes that is compatible with ENERGY STAR criteria for electric storage water heaters at the representative rated storage volume.

TSL 8 consists of the max-tech efficiency levels for each of the water heater product classes at the time the analysis was developed. The max-tech efficiency levels were revised for the final rule as described in the engineering analysis. TSL 7 and 8 both set efficiency levels that effectively require use of heat pump technology for electric storage water heaters. TSL 8, however, requires a higher efficiency level than TSL 7, which corresponds to the max-tech efficiency level for the representative rated storage capacity (*i.e.,* 2.35 EF at 50 gallons). TSL 8 also sets efficiency levels that effectively require use of condensing technology for gas-fired storage and instantaneous water heaters.

Table VI.1 presents the energy efficiency equations and associated two-slope divisions for TSL 1 through TSL 8.

TABLE VI.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):	

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

	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 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 80 gallons: EF = 0.960 − (0.0003 × Rated Storage Volume in gallons).	For ESWHs with a Rated Storage Volume above 80 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).	
TSL 5	For GSWHs with a Rated Storage Volume at or below 55 gallons: EF = 0.675 − (0.0015 × Rated Storage Volume in gallons).	For GSWHs with a Rated Storage Volume above 55 gallons: EF = 0.8012 − (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 55 gallons: EF = 0.675 − (0.0012 × Rated Storage Volume in gallons).	For GSWHs with a Rated Storage Volume above 55 gallons: EF = 0.8012 − (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 7	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 8	For GSWHs (over the Entire Rated Storage Volume range): EF = 0.8012 − (0.00078 × Rated Storage Volume in gallons).	
	For ESWHs (over the Entire Rated Storage Volume range): EF = 2.406 − (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).	

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

	For GIWHs (over the Entire Rated Storage Volume range): EF = 0.95 − (0.0019 × Rated Storage Volume in gallons).

2. Direct Heating Equipment

Table VI.2 presents the six TSLs DOE analyzed for DHE in the final rule. The only modifications made to the TSLs analyzed for the final rule compared to those analyzed for the December 2009 NOPR were to the efficiency levels in TSLs 3, 4, 5, and 6 for gas wall gravity DHE. These changes were made due to a review of the gas wall gravity units currently offered for sale and the adjustment of the max-tech efficiency level in response to commenters.

In general, 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 for all of the DHE product classes.

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

Product class	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
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%	66%	69%	69%	70%	70%
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 VI.3 shows the six TSLs DOE analyzed for pool heaters, which are identical to the TSLs analyzed in the December 2009 NOPR. TSL 1 consists of the efficiency level that is close to the current shipment-weighted average efficiency. TSL 2 and TSL 3 consist of 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 VI.3—TRIAL STANDARD LEVELS FOR POOL HEATERS (THERMAL EFFICIENCY)

Product class	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Gas-fired	81%	82%	83%	84%	86%	95%

B. Significance of Energy Savings

To estimate the energy savings due to potential standards, from 2013 to 2043 for DHE and pool heaters and from 2015 to 2045 for water heaters, DOE compared the energy consumption attributable to the three types of heating products under the base case (no standards) to energy consumption attributable to these products under each standards case (each TSL that DOE has considered). Table VI.4, Table VI.5, and Table VI.6 present DOE's national energy savings (NES) estimates (undiscounted) for each of the three types of heating products, by product class at each TSL. Chapter 10 of the TSD describes these estimates in more detail.

TABLE VI.4—WATER HEATERS: CUMULATIVE NATIONAL ENERGY SAVINGS IN QUADS

Product class	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8
Gas-Fired Storage	0.69	1.17	1.17	1.17	0.81	1.29	1.17	4.91
Electric Storage	0.29	0.41	0.79	1.09	1.67	1.67	8.90	11.22
Oil-Fired Storage	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02
Gas-Fired Instantaneous	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.58
Total	1.07	1.66	2.05	2.35	2.58	3.06	10.16	16.73

TABLE VI.5—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	0.01	0.01	0.01	0.03	0.01	0.03
Gas Wall Gravity	0.01	0.01	0.03	0.03	0.06	0.06
Gas Floor	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Gas Room	0.001	0.002	0.004	0.004	0.04	0.04
Gas Hearth	0.19	0.19	0.19	0.37	0.37	1.13
Total	0.20	0.21	0.23	0.43	0.48	1.26

TABLE VI.6—POOL HEATERS: CUMULATIVE NATIONAL ENERGY SAVINGS IN QUADS

	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Gas-Fired	0.01	0.02	0.04	0.06	0.09	0.22

C. Economic Justification

1. Economic Impact on Consumers

a. Life-Cycle Costs and Payback Period

Consumers affected by amended standards usually experience higher product purchase prices and lower operating costs. Generally, these impacts are captured by changes in life-cycle costs and by the payback period. Therefore, DOE calculated the LCC and PBP for the standard levels considered in this rulemaking.

DOE's LCC and PBP analyses provide seven key outputs for each TSL, which are reported in Table VI.7 through Table VI.16 below. The first two of these outputs is the average LCC and average LCC savings. (A negative "LCC savings" for a standard level indicates that the life-cycle cost of a standards-compliant product would be higher than the life-cycle cost of a baseline product.) The next three outputs are the proportion of purchases of the product that already comply with the TSL and that would create a net life-cycle cost, no impact, or a net life-cycle savings for the purchaser.

The sixth and seventh outputs are the median and average PBPs, respectively, for the consumer purchasing a design that complies with the TSL compared with purchasing a baseline product. The PBP is the number of years it would take for the purchaser to recover, as a result of energy savings, the increased cost of a higher-efficiency product based on operating cost savings from the first year of ownership. The PBP is an economic benefit-cost measure that uses benefits and costs without discounting. DOE's analysis includes both the analysis contemplated under the rebuttable presumption test, which is based on energy use as determined under conditions prescribed by the DOE test procedure, and analysis of the payback period based on conditions of actual use of the product by purchasers. DOE derived the median and average PBPs in Table VI.7 through Table VI.16 by using the latter method. While DOE examined the rebuttable presumption criterion (*see* chapter 8 of the TSD), it also evaluated the standard levels adopted in today's rule through a more detailed analysis of the economic impacts of these levels pursuant to section 325(o)(2)(B)(i) of EPCA. (42 U.S.C. 6295(o)(2)(B)(i))

TSD chapter 8 provides detailed information on the LCC and PBP analyses.

TABLE VI.7—GAS-FIRED STORAGE WATER HEATERS: LCC AND PBP RESULTS

TSL	Energy factor	LCC					Payback period	
		Average LCC 2009$	Average LCC savings 2009$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1	0.62	$3,528	$16	25	36	39	2.0	17.0
2, 3, 4	0.63	3,537	7	32	22	45	4.5	18.6
5*	0.62	3,528	18	27	33	40	2.3	16.9
6*	0.63	3,537	9	34	21	46	4.7	18.3
7	0.67	3,793	−218	70	6	23	21.5	27.1
8	0.77	3,771	−195	70	1	28	15.6	16.8

* For TSL 5 and 6, 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 (40 gal).

TABLE VI.8—ELECTRIC STORAGE WATER HEATERS: LCC AND PBP RESULTS

TSL	Energy factor	LCC					Payback period	
		Average LCC 2009$	Average LCC savings 2009$	Net cost %	No impact %	Net benefit %	Median years	Average years
1	0.92	$3,255	$5	11	44	45	4.0	10.2
2	0.93	3,245	11	12	39	48	4.0	10.0
3	0.94	3,236	18	21	17	62	5.0	9.3
4	0.95	3,236	18	32	10	59	6.7	9.9
5, 6	*1.04	3,188	64	33	9	58	6.8	10.2
7	2.00	3,136	112	50	5	45	9.4	26.2
8	2.35	3,076	171	50	1	49	9.0	20.0

* For TSL 5 and 6, 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 VI.9—OIL-FIRED STORAGE WATER HEATERS: LCC AND PBP RESULTS

TSL	Energy factor	LCC	Average LCC 2009$				Payback period	
			Average LCC savings 2009$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1	0.58	$8,102	$101	0	76	24	0.9	0.9
2	0.60	7,885	203	0	54	46	0.3	0.2
3, 4, 5, 6, 7	0.62	7,721	295	0	47	53	0.5	0.7
8	0.68	7,463	495	0	17	83	1.9	2.1

TABLE VI.10—GAS-FIRED INSTANTANEOUS WATER HEATERS: LCC AND PBP RESULTS

TSL	Energy factor	LCC					Payback period	
		Average LCC 2009$	Average LCC savings 2009$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1 through 7	0.82	$5,505	$9	5	91	4	14.8	24.3
8	0.95	5,913	−259	77	12	11	38.7	55.0

TABLE VI.11—GAS WALL FAN DHE: LCC AND PBP RESULTS

TSL	AFUE %	LCC					Payback period	
		Average LCC 2009$	Average LCC savings 2009$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1, 5	75	$7,170	$83	0	60	40	2.7	2.7
2	76	7,131	102	3	53	44	3.2	3.9
3	77	7,114	114	19	26	55	5.0	9.9
4, 6	80	7,189	43	53	7	40	12.2	33.7

TABLE VI.12—GAS WALL GRAVITY DHE: LCC AND PBP RESULTS

TSL	AFUE %	LCC					Payback period	
		Average LCC 2009$	Average LCC savings 2009$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1, 2	66	$6,848	$21	10	75	15	7.5	13.8
3, 4	69	6,760	64	33	37	30	11.0	22.5
5, 6	70	6,880	−56	70	0	30	16.5	18.6

TABLE VI.13—GAS FLOOR DHE: LCC AND PBP RESULTS

TSL	AFUE %	LCC					Payback period	
		Average LCC 2009$	Average LCC savings 2009$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1, 2, 3, 4, 5, 6	58	$7,755	$13	23	58	19	10.7	16.5

TABLE VI.14—GAS ROOM DHE: LCC AND PBP RESULTS

TSL	AFUE %	LCC					Payback period	
		Average LCC 2009$	Average LCC savings 2009$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1	66	$7,349	$26	9	74	16	6.7	11.8
2	67	7,284	60	12	50	38	4.5	8.3
3, 4	68	7,226	104	19	25	57	4.8	8.2
5, 6	83	6,628	702	32	0	68	6.9	8.7

TABLE VI.15—GAS HEARTH DHE: LCC AND PBP RESULTS

TSL	AFUE %	LCC					Payback period	
		Average LCC 2009$	Average LCC savings 2009$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1, 2, 3	67	$5,146	$112	3	61	37	0.0	3.1
4, 5	72	5,324	−28	55	23	21	17.1	47
6	93	5,475	−179	77	1	22	26.8	60.2

TABLE VI.16—GAS-FIRED POOL HEATERS: LCC AND PBP RESULTS

TSL	Thermal efficiency %	LCC					Payback period	
		Average LCC 2009$	Average LCC savings 2009$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1	81	$8,212	$25	5	72	23	2.7	5.4
2	82	8,217	22	27	51	22	8.6	15.2
3	83	8,264	−6	60	23	17	18.2	32.3
4	84	8,322	−52	64	21	15	19.2	39.0
5	86	8,959	−632	88	9	3	38.1	85.8
6	95	9,698	−1,361	95	1	4	33.2	74.1

b. Consumer Subgroup Analysis

For water heaters, DOE estimated consumer subgroup impacts for low-income households and senior-only households by determining the LCC impacts of the TSLs considered for gas-fired and electric storage water heaters. In addition, DOE estimated consumer subgroup impacts on households in multi-family housing and households in manufactured homes for the TSLs considered for gas-fired and electric storage water heaters. DOE also estimated the consumer subgroup impacts for low-income households and senior-only households for gas wall fan and gas wall gravity DHE.

For gas-fired storage water heaters, the impacts of the standard in today's final rule are roughly the same for the senior-only subgroup and the low-income subgroup as they are for the full household sample for this product class (*see* Table VI.17 and Table VI.18). For the multi-family subgroup, the results report an average LCC increase (*i.e.,* negative savings) of $13, and they also show a 36-percent share of households with a net LCC benefit, and a 31-percent share of households with a net LCC cost (*see* Table VI.19). For the manufactured home subgroup, the results report an average LCC increase (*i.e.,* negative savings) of $17, and they also show a 35-percent share of households with a net LCC benefit, and a 36-percent share of households with a net LCC cost (*see* Table VI.20).

TABLE VI.17—GAS-FIRED STORAGE WATER HEATERS: LCC AND PBP RESULTS FOR SENIOR-ONLY HOUSEHOLDS

TSL	Energy factor	LCC					Payback period	
		Average LCC 2009$	Average LCC savings 2009$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1	0.62	$3,072	$14	27	32	41	1.9	19.4
2, 3, 4	0.63	3,081	7	34	19	47	4.1	19.5
5*	0.62	3,071	16	27	31	41	2.0	19.4
6*	0.63	3,079	9	34	19	47	4.2	19.3
7	0.67	3,355	−235	71	6	22	22.5	27.8

TABLE VI.17—GAS-FIRED STORAGE WATER HEATERS: LCC AND PBP RESULTS FOR SENIOR-ONLY HOUSEHOLDS—Continued

TSL	Energy factor	LCC					Payback period	
		Average LCC 2009$	Average LCC savings 2009$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
8	0.77	3,377	−257	75	1	24	17.4	18.2

* For TSL 5 and TSL 6, 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 (40 gal).

TABLE VI.18—GAS-FIRED STORAGE WATER HEATERS: LCC AND PBP RESULTS FOR LOW-INCOME HOUSEHOLDS

TSL	Energy factor	LCC					Payback period	
		Average LCC 2009$	Average LCC savings 2009$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1	0.62	$3,591	$9	29	31	40	2.1	18.7
2, 3, 4	0.63	3,610	−8	36	19	45	6.1	21.2
5*	0.62	3,586	15	29	31	41	2.1	18.7
6*	0.63	3,605	−2	36	19	45	6.2	21.2
7	0.67	3,877	−243	71	6	23	22.9	28.5
8	0.77	3,847	−213	70	2	28	16.4	17.6

* For TSL 5 and TSL 6, 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 (40 gal).

TABLE VI.19—GAS-FIRED STORAGE WATER HEATERS: LCC AND PBP RESULTS FOR MULTI-FAMILY HOUSEHOLDS

TSL	Energy factor	LCC					Payback period	
		Average LCC 2009$	Average LCC savings 2009$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1	0.62	$2,825	−$11	31	33	36	2.4	26.5
2, 3, 4	0.63	2,868	−45	41	21	38	11.0	27.2
5*	0.62	2,827	−13	31	32	36	2.5	26.5
6*	0.63	2,870	−46	41	21	37	11.0	27.2
7	0.67	3,182	−324	74	6	19	27.2	35.2
8	0.77	3,239	−380	79	2	19	21.2	23.2

* For TSL 5 and TSL 6, 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 (40 gal).

TABLE VI.20—GAS-FIRED STORAGE WATER HEATERS: LCC AND PBP RESULTS FOR MANUFACTURED HOME HOUSEHOLDS

TSL	Energy factor	LCC					Payback period	
		Average LCC 2009$	Average LCC savings 2009$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1	0.62	$4,035	−$17	36	29	35	9.9	25.1
2, 3, 4	0.63	4,082	−59	48	17	34	13.1	26.7
5*	0.62	4,035	−17	36	29	35	9.9	25.1
6*	0.63	4,082	−59	48	17	34	13.1	26.7
7	0.67	4,275	−232	69	6	25	21.1	27.3
8	0.77	4,207	−164	64	2	34	14.7	17.0

* For TSL 5 and TSL 6, 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 (40 gal).

For electric storage water heaters, the impacts of the standard in today's final rule are approximately the same for the senior-only subgroup as they are for the full household sample for this product class (*see* Table VI.21). For the low-income subgroup, the results show an average LCC savings of $18, a 53-percent share of households with a net LCC benefit, and a 39-percent share of households with a net LCC cost (*see* Table VI.22). For the multi-family subgroup, the results report an average LCC increase (*i.e.,* negative savings) of $8, and they also show a 53-percent share of households with a net LCC benefit, and a 38-percent share of households with a net LCC cost (*see* Table VI.23). For the manufactured home subgroup, the results report an average LCC increase (*i.e.,* negative savings) of $20, and they also show a 38-percent share of households with a net LCC benefit, and a 54-percent share of households with a net LCC cost (*see* Table VI.24).

TABLE VI.21—ELECTRIC STORAGE WATER HEATERS: LCC AND PBP RESULTS FOR SENIOR-ONLY HOUSEHOLDS

TSL	Energy factor	LCC					Payback period	
		Average LCC 2009$	Average LCC savings 2009$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1	0.92	$2,859	$6	11	42	47	3.8	10.1
2	0.93	2,849	11	12	38	50	3.8	9.9
3	0.94	2,839	19	21	16	63	5.0	9.2
4	0.95	2,837	20	30	10	60	6.3	9.6
5, 6	* 1.04	2,826	31	32	9	59	6.6	10.1
7	2.00	2,937	−76	59	5	36	11.0	21.6
8	2.35	2,895	−34	58	1	41	10.5	17.5

* For TSL 5 and TSL 6, 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 VI.22—ELECTRIC STORAGE WATER HEATERS: LCC AND PBP RESULTS FOR LOW-INCOME HOUSEHOLDS

TSL	Energy factor	LCC					Payback period	
		Average LCC 2009$	Average LCC savings 2009$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1	0.92	$3,203	−$3	15	39	46	4.2	12.4
2	0.93	3,196	1	16	36	48	4.2	12.2
3	0.94	3,196	0	29	14	57	5.5	11.1
4	0.95	3,197	−1	38	9	53	7.1	11.3
5, 6	* 1.04	3,178	18	39	9	53	7.3	11.5
7	2.00	3,132	61	54	5	41	10.1	28.4
8	2.35	3,078	114	54	1	45	9.9	23.0

* For TSL 5 and TSL 6, 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 VI.23—ELECTRIC STORAGE WATER HEATERS: LCC AND PBP RESULTS FOR MULTI-FAMILY HOUSEHOLDS

TSL	Energy factor	LCC					Payback period	
		Average LCC 2009$	Average LCC savings 2009$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1	0.92	$2,015	−$2	14	35	50	4.0	11.6
2	0.93	2,009	1	15	32	52	4.0	11.3
3	0.94	2,017	−6	31	13	56	5.6	11.7
4	0.95	2,018	−7	37	9	54	6.9	11.6
5, 6	* 1.04	2,019	−8	38	9	53	7.0	11.9
7	2.00	2,468	−436	79	5	16	25.5	67.9
8	2.35	2,479	−447	81	1	18	24.4	50.8

* For TSL 5 and TSL 6, 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 VI.24—ELECTRIC STORAGE WATER HEATERS: LCC AND PBP RESULTS FOR MANUFACTURED HOME HOUSEHOLDS

TSL	Energy factor	LCC					Payback period	
		Average LCC 2009$	Average LCC savings 2009$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
1	0.92	$3,152	−$32	31	35	33	7.0	21.8
2	0.93	3,151	−31	33	33	35	7.7	21.4

TABLE VI.24—ELECTRIC STORAGE WATER HEATERS: LCC AND PBP RESULTS FOR MANUFACTURED HOME HOUSEHOLDS—Continued

TSL	Energy factor	LCC					Payback period	
		Average LCC 2009$	Average LCC savings 2009$	Households with			Median years	Average years
				Net cost %	No impact %	Net benefit %		
3	0.94	3,153	−33	47	14	40	13.0	15.4
4	0.95	3,154	−35	54	9	38	12.9	14.8
5, 6	* 1.04	3,140	−20	54	9	38	13.4	15.0
7	2.00	3,103	14	56	5	39	10.5	25.0
8	2.35	3,055	61	55	1	44	10.1	21.4

* For TSL 5 and TSL 6, 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).

For gas wall fan and gas wall gravity DHE, DOE estimated that the impacts of the standards in today's final rule 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. For gas hearth DHE, DOE performed the senior-only analysis but did not perform the low-income analysis due to the extremely small sample size and relatively high product cost. The results for the gas hearth DHE senior-only sample were about the same as for the full household sample. (*See* tables in chapter 11 of the TSD).

DOE did not estimate the impacts of consumer subgroups for oil-fired storage water heaters, gas floor DHE, and gas room DHE due to low product shipments, and for gas-fired instantaneous water heaters due to insufficient data. For pool heaters, DOE did not perform consumer subgroup analyses since this product is typically not owned by these subgroups.

Chapter 11 of the TSD explains DOE's methodology for conducting the consumer subgroup analysis and presents the detailed results of that analysis for each considered efficiency level.

c. Rebuttable Presumption Payback

As discussed in section III.D.2, EPCA provides a rebuttable presumption that an energy conservation standard is economically justified if the increase in purchase cost for a product that meets the standard is less than three times the value of the first-year energy (and, as applicable, water) savings resulting from the standard. DOE's LCC and PBP analyses generate values that calculate the payback period for consumers of potential energy conservation standards, which include, but are not limited to, the 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 evaluate definitively the economic justification for a potential standard level (thereby supporting or rebutting the results of any preliminary determination of economic justification).

As required by EPCA, DOE based the calculation of rebuttable presumption payback period on the assumptions in the DOE test procedures for each of the three types of heating products. For water heaters and DHE, respectively, Table VI.24 and Table VI.25 show the rebuttable presumption PBPs for those TSLs that have a rebuttable presumption payback period of less than 3 years. For pool heaters, only one of the considered efficiency levels has a rebuttable presumption payback period of less than 3 years—81 percent thermal efficiency has a rebuttable presumption payback period of 2.7 years.

TABLE VI.24—WATER HEATERS: REBUTTABLE PRESUMPTION PAYBACK PERIODS

TSL	Payback period, years			
	Gas-fired storage	Electric storage	Oil-fired storage	Gas-fired instantaneous
1	>3	>3	0.8	>3
2	>3	>3	0.4	>3
3	>3	>3	0.6	>3
4	>3	>3	0.6	>3
5	>3	>3	0.6	>3
6	>3	>3	0.6	>3
7	>3	>3	0.6	>3
8	>3	>3	0.9	>3

TABLE VI.25—DIRECT HEATING EQUIPMENT: REBUTTABLE PRESUMPTION PAYBACK PERIODS

TSL	Payback period, *years*				
	Gas wall fan DHE	Gas wall gravity DHE	Gas furnace DHE	Gas wall room DHE	Gas hearth DHE
1	>3	>3	>3	>3	2.5
2	>3	>3	>3	>3	2.5

TABLE VI.25—DIRECT HEATING EQUIPMENT: REBUTTABLE PRESUMPTION PAYBACK PERIODS—Continued

TSL	Payback period, *years*				
	Gas wall fan DHE	Gas wall gravity DHE	Gas furnace DHE	Gas wall room DHE	Gas hearth DHE
3	>3	>3	>3	>3	2.5
4	>3	>3	>3	>3	>3
5	>3	>3	>3	>3	>3
6	>3	>3	>3	>3	>3

2. Economic Impact on Manufacturers

For the MIA in the December 2009 NOPR, DOE used the INPV to compare the financial impacts of different TSLs on water heater, DHE, and pool heater manufacturers. 74 FR 65852, 65935–47 (Dec. 11, 2009). DOE presented the results by grouping product classes made by the same manufacturers and uses the scenarios that show the likely changes in industry value following amended energy conservation standards. DOE used the GRIM to compare the INPV of the base case (no new energy conservation standards) to that of each TSL for each covered product. The INPV is the sum of all net cash flows discounted by the industry's cost of capital (discount rate). The difference in INPV between the base case and the standards case is an estimate of the economic impacts that implementing that standard level would have on the entire industry.

For today's final rule, DOE continues to use the methodology presented in the December 2009 NOPR (74 FR 65852, 65915–22 (Dec. 11, 2009)) and in section IV.I. DOE modeled two different markup scenarios to estimate the potential impacts of amended energy conservation standards on manufacturers. To assess the lower end of the range of potential impacts on manufacturers, DOE modeled the preservation of return on invested capital scenario. In addition to the impact of the main NIA shipment scenario and the required capital and product conversion costs on INPV, this case models a situation in which manufacturers would maintain the base-case return on invested capital in the standards case. This scenario represents the lower (more favorable) end of the range of potential impacts on manufacturers because the industry generates a historical rate of 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 manufacturers of the three types of heating products, DOE modeled the preservation of operating profit markup scenario in which higher energy conservation standards result in lower manufacturer markups. This scenario models a scenario in which the higher production costs of more-efficient technology and required investments are not fully passed on to customers, consequently lowering operating profit margins. This 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 to meet the amended energy conservation standards.

In overview, DOE notes that for water heaters, the main NIA scenario used the Reference Case gas-fired instantaneous water heater market share scenario, the *AEO* Reference Case economic growth scenario, and the moderate rate of efficiency growth scenarios. The main NIA scenario for water heaters also accounts for fuel switching at a level that effectively requires HPWHs for all rated storage volumes (final rule TSL 7 and TSL 8) and capacity switching at a level that required advanced technology for water heaters with rated storage volumes above 55 gallons (final rule TSL 5 and TSL 6). In all standards-case shipment scenarios for all three types of heating products, DOE assumed that shipments at efficiencies below the projected minimum standard levels would roll up to the new standard levels in response to amended energy conservation standards.

The sections below outline comments on the economic impacts on manufacturers presented in the December 2009 NOPR and provide DOE's response. The complete MIA results section can be found in the December 2009 NOPR (74 FR 65852, 65935–54 (Dec. 11, 2009)) and chapter 12 of the TSD.

a. Cash-Flow Analysis Results for Water Heaters

i. Cash-Flow Analysis Results for Gas-Fired and Electric Storage Water Heaters

TABLE VI.26—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	8
INPV	(2009$ millions)	$880.4	$875.5	$876.0	$875.1	$875.5	$854.4	$856.8	$869.9	$959.6
Change in INPV	(2009$ millions)		−4.9	−4.3	−5.2	−4.8	−25.9	−23.6	−10.5	79.2
	(%)		−0.56%	−0.49%	−0.59%	−0.55%	−2.94%	−2.68%	−1.19%	9.00%
Product Conversion Costs	(2009$ millions)		12.1	14.5	14.5	14.5	31.8	31.8	61.1	79.7
Capital Conversion Costs	(2009$ millions)		0.0	4.3	4.3	40.7	63.7	63.7	76.0	208.0
Total Conversion Costs.	(2009$ millions)		12.1	18.7	18.7	55.1	95.4	95.4	137.1	287.8

TABLE VI.27—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	8
INPV	(2009$ millions)	$880.4	$866.1	$849.0	$842.1	$790.9	$757.8	$745.7	$530.2	$233.4
Change in INPV	(2009$ millions)		−14.2	−31.4	−38.3	−89.4	−122.6	−134.6	−350.2	−647.0
	(%)		−1.62	−3.56	−4.35	−10.16	−13.93	−15.29	−39.78	−73.49
Product Conversion Costs	(2009$ millions)		12.1	14.5	14.5	14.5	31.8	31.8	61.1	79.7
Capital Conversion Costs	(2009$ millions)		0.0	4.3	4.3	40.7	63.7	63.7	76.0	208.0
Total Conversion Costs	(2009$ millions)		12.1	18.7	18.7	55.1	95.4	95.4	137.1	287.8

The December 2009 NOPR discusses the estimated impact of amended energy conservation standards on INPV for gas-fired and electric storage water heater manufacturers in further detail. 74 FR 65852, 65936–39 (Dec. 11, 2009). DOE did not receive any comments on the gas-fired and electric storage water heaters INPV results. Those comments related to conversion costs and methodology are discussed in section IV.I.1.

ii. Cash-Flow Analysis Results for Oil-Fired Storage Water Heaters

TABLE VI.28—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	8
INPV	(2009$ millions)	$9.1	$8.9	$8.9	$8.9	$8.9	$8.9	$8.9	$8.9	$7.7
Change in INPV	(2009$ millions)		(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(1.4)
	(%)		−1.98	−1.85	−2.01	−2.01	−2.01	−2.01	−2.01	−15.37
Product Conversion Costs	(2009$ millions)		0.3	0.3	0.3	0.3	0.3	0.3	0.3	1.1
Capital Conversion Costs	(2009$ millions)		0.2	0.2	0.2	0.2	0.2	0.2	0.2	4.0
Total Conversion Costs	(2009$ millions)		0.5	0.5	0.5	0.5	0.5	0.5	0.5	5.1

TABLE VI.29—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	8
INPV	(2009$ millions)	$9.1	$8.8	$8.8	$8.7	$8.7	$8.7	$8.7	$8.7	$5.3
Change in INPV	(2009$ millions)		(0.4)	(0.3)	(0.4)	(0.4)	(0.4)	(0.4)	(0.4)	(3.8)
	(%)		−3.85	−3.56	−4.23	−4.23	−4.23	−4.23	−4.23	−41.44
Product Conversion Costs	(2009$ millions)		0.3	0.3	0.3	0.3	0.3	0.3	0.3	1.1
Capital Conversion Costs	(2009$ millions)		0.2	0.2	0.2	0.2	0.2	0.2	0.2	4.0
Total Conversion Costs	(2009$ millions)		0.5	0.5	0.5	0.5	0.5	0.5	0.5	5.1

The December 2009 NOPR discusses the estimated impact of amended energy conservation standards on INPV for oil-fired storage water heater manufacturers in further detail. 74 FR 65852, 65939–40 (Dec. 11, 2009). DOE did not receive any comments on the oil-fired water heaters INPV results. Those comments related to conversion costs and methodology are discussed in section IV.I.1.

iii. Cash-Flow Analysis Results for Gas-Fired Instantaneous Water Heaters

TABLE VI.30—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	8
INPV	(2009$ millions)	$648.2	$650.6	$650.6	$650.6	$650.6	$650.6	$650.6	$650.6	$739.7
Change in INPV	(2009$ millions)		2.3	2.3	2.3	2.3	2.3	2.3	2.3	91.4
	(%)		0.36	0.36	0.36	0.36	0.36	0.36	0.36	14.10
Product Conversion Costs	(2009$ millions)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.8
Capital Conversion Costs	(2009$ millions)		0.0	0.00	0.00	0.0	0.0	0.0	0.0	10.6
Total Conversion Costs	(2009$ millions)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.4

TABLE VI.31—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	8
INPV	(2009$ millions)	$648.2	$647.0	$647.0	$647.0	$647.0	$647.0	$647.0	$647.0	$590.6
Change in INPV	(2009$ millions)		(1.2)	(1.2)	(1.2)	(1.2)	(1.2)	(1.2)	(1.2)	(57.6)
	(%)		−0.19%	−0.19%	−0.19%	−0.19%	−0.19%	−0.19%	−0.19%	−8.89%
Product Conversion Costs	(2009$ millions)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.8
Capital Conversion Costs	(2009$ millions)		0.0	0.00	0.00	0.0	0.0	0.0	0.0	10.6
Total Conversion Costs	(2009$ millions)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.4

The December 2009 NOPR discusses the estimated impact of amended energy conservation standards on INPV for gas-fired instantaneous water heater manufacturers in further detail. 74 FR 65852, 65940–41 (Dec. 11, 2009). DOE did not receive any comments on the gas-fired instantaneous water heater INPV results.

b. Cash-Flow Analysis Results for Direct Heating Equipment

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 VI.32—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	(2009$ millions)	$16.6	$15.7	$15.4	$14.7	$14.7	$12.8	$12.7
Change in INPV	(2009$ millions)		(0.9)	(1.2)	(1.9)	(1.9)	(3.8)	(3.9)
	(%)		−5.24%	−7.17%	−11.31%	−11.62%	−22.74%	−23.65%
Product Conversion Costs.	(2009$ millions)		0.95	1.38	2.41	2.95	5.02	5.91
Capital Conversion Costs.	(2009$ millions)		1.96	3.24	5.60	6.95	6.75	9.11
Total Conversion Costs	(2009$ millions)		2.91	4.62	8.00	9.90	11.77	15.02

TABLE VI.33—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	(2009$ millions)	$16.6	$14.1	$12.7	$9.6	$7.8	$6.2	$3.2
Change in INPV	(2009$ millions)		(2.5)	(3.9)	(7.0)	(8.8)	(10.4)	(13.4)
	(%)		−14.88%	−23.61%	−42.38%	−53.12%	−62.40%	−80.85%
Product Conversion Costs.	(2009$ millions)		0.95	1.38	2.41	2.95	5.02	5.91
Capital Conversion Costs.	(2009$ millions)		1.96	3.24	5.60	6.95	6.75	9.11
Total Conversion Costs	(2009$ millions)		2.91	4.62	8.00	9.90	11.77	15.02

The December 2009 NOPR discusses the estimated impact of amended energy conservation standards on INPV for traditional DHE manufacturers in further detail. 74 FR 65852, 65942–44 (Dec. 11, 2009). DOE addresses all the comments about the impacts on traditional DHE manufacturers in sections IV.I.4 and VII.B of today's final rule.

ii. Cash-Flow Analysis Results for Gas Hearth Direct Heating Equipment

TABLE VI.34—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	(2009$ millions)	$77.1	$76.2	$76.2	$76.2	$78.7	$78.7	$85.7
Change in INPV	(2009$ millions)		(0.9)	(0.9)	(0.9)	1.6	1.6	8.6
	(%)		−1.22%	−1.22%	−1.22%	2.04%	2.04%	11.09%

TABLE VI.34—MANUFACTURER IMPACT ANALYSIS FOR GAS HEARTH DIRECT HEATING EQUIPMENT—PRESERVATION OF RETURN ON INVESTED CAPITAL MARKUP SCENARIO—Continued

	Units	Base case	Trial standard level					
			1	2	3	4	5	6
Product Conversion Costs.	(2009$ millions)	....	0.56	0.56	0.56	1.46	1.46	8.42
Capital Conversion Costs.	(2009$ millions)	....	0.21	0.21	0.21	0.55	0.55	4.20
Total Conversion Costs	(2009$ millions)	....	0.77	0.77	0.77	2.01	2.01	12.62

TABLE VI.35—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	(2009$ millions)	$77.1	$76.9	$76.9	$76.9	$63.9	$63.9	$23.5
Change in INPV	(2009$ millions)	....	(0.2)	(0.2)	(0.2)	(13.2)	(13.2)	(53.6)
	(%)	....	−0.30%	−0.30%	−0.30%	−17.13%	−17.13%	−69.49%
Product Conversion Costs.	(2009$ millions)	....	0.56	0.56	0.56	1.46	1.46	8.42
Capital Conversion Costs.	(2009$ millions)	....	0.21	0.21	0.21	0.55	0.55	4.20
Total Conversion Costs	(2009$ millions)	....	0.77	0.77	0.77	2.01	2.01	12.62

The December 2009 NOPR discusses the estimated impact of amended energy conservation standards on INPV for gas hearth DHE manufacturers in further detail. 74 FR 65852, 65944–45 (Dec. 11, 2009). DOE did not receive any comments on the gas hearth DHE INPV results.

c. Cash-Flow Analysis Results for Pool Heaters

TABLE VI.36—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	(2009$ millions)	$49.0	$49.1	$49.3	$48.2	$48.7	$49.8	$56.4
Change in INPV	(2009$ millions)	....	0.0	0.3	(0.8)	(0.3)	0.8	7.3
	(%)	....	0.10%	0.54%	−1.72%	−0.63%	1.61%	14.93%
Product Conversion Costs.	(2009$ millions)	....	0.0	0.0	2.7	2.7	4.8	5.7
Capital Conversion Costs.	(2009$ millions)	....	0.0	0.3	1.3	1.5	4.6	7.4
Total Conversion Costs	(2009$ millions)	....	0.0	0.3	4.0	4.2	9.4	13.1

TABLE VI.37—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	(2009$ millions)	$49.0	$48.9	$48.2	$44.0	$42.4	$31.9	$10.8
Change in INPV	(2009$ millions)	....	(0.1)	(0.8)	(5.0)	(6.6)	(17.2)	(38.3)
	(%)	....	−0.25%	−1.72%	−10.22%	−13.48%	−35.05%	−78.00%
Product Conversion Costs.	(2009$ millions)	....	0.0	0.0	2.7	2.7	4.8	5.7
Capital Conversion Costs.	(2009$ millions)	....	0.0	0.3	1.3	1.5	4.6	7.4
Total Conversion Costs	(2009$ millions)	....	0.0	0.3	4.0	4.2	9.4	13.1

The December 2009 NOPR discusses the estimated impact of amended energy conservation standards on INPV for gas-fired pool heaters in further detail. 74 FR 65852, 65945–47 (Dec. 11, 2009). DOE did not receive any comments on the pool heaters INPV results. Those comments related to conversion costs and methodology are discussed in section IV.I.3.

d. Impacts on Employment

As discussed in detail in the December 2009 NOPR and in today's final rule, DOE quantitatively assessed the impacts of potential amended energy conservation standards on gross employment for each of the three types of heating products that are the subject of this rulemaking. DOE presented a range of the potential production employment levels that could result following the implementation of amended energy conservation standards. The upper end of the results represented the maximum potential increase in production workers after amended energy conservation standards if manufacturers continue to produce the same scope of covered products in the same production facilities. The lower end of the range of employment results included the estimate of the total number of U.S. production workers in the industry that could lose their jobs if all existing production were to no longer be made domestically. For example, DOE calculates that the impacts on gas-fired and electric storage water heaters could range from an increase of 439 employees to a decrease of 3,610. For oil-fired water heaters, DOE expects an increase of one employee to a decrease of 37 employees. Similarly, at the upper end of modeled impacts, the traditional DHE, gas hearth DHE, and pool heater industries could experience an increase of six, six, and 19 employees, respectively. At the low end, these three industries could sustain decreases in direct employment of 275, 1280, and 512 employees, respectively. 74 FR 65852, 65947–51 (Dec. 11, 2009). Further details are also found in chapter 12 of the TSD. DOE discusses and responds to public comments received regarding the impacts on the direct employment in section IV.I.4.

e. Impacts on Manufacturing Capacity

In the December 2009 NOPR, DOE provided a complete discussion of the potential impacts on manufacturing capacity for the three types of heating products as a result of amended energy conservation standards. 74 FR 65852, 65951–53 (Dec. 11, 2009).

In response to that discussion, Raypak stated that it does not believe three years would allow sufficient time for the proper development, testing, and tooling necessary to achieve reliable pool heater products, because pool heaters are installed outdoors and face harsher operating conditions than the other products covered by this rulemaking. (Raypak, No. 67 at p. 3) The commenter agreed with DOE's statement that setting an amended energy conservation standard for pool heaters at or above TSL 5, which would require condensing or near-condensing technology, could lead to short-term capacity problems if manufacturers cannot make the substantially higher tooling, equipment, and assembly changes required at these levels in time to meet the standard. Moreover, Raypak argued that these same issues exist at TSL 3 and TSL 4, because at TSL 3 and above manufacturers would have difficulty changing their production lines and tooling to a new construction while still producing product to meet current market demands. (Raypak, No. 67 at p. 2; Public Meeting Transcript, No. 57.4 at pp. 308–310)

In response, DOE agrees that the proposed standard in the December 2009 NOPR would require substantial changes for pool heater manufacturers. At an 84-percent thermal efficiency level, manufacturers would be required to make multiple improvements over the most common atmospheric models on the market today. However, DOE did not receive any comments that suggested the conversion costs for the industry presented in the NOPR were not representative at any TSL. Also, multiple manufacturers have products that meet and/or exceed the proposed standard in the December 2009 NOPR. While manufacturers would be required to spend resources to increase the production of those products or to modify existing products, DOE believes that manufacturers have the experience necessary to achieve the requisite operating conditions at the level proposed in the December 2009 NOPR (TSL 4) and, in general, to offer durable products by the compliance date for the amended standards being adopted in this final rule.

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. The cumulative regulatory burden focuses on the impacts on manufacturers of other 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. The cumulative burden was outlined in the December 2009 NOPR, which included a discussion of the impact of low and ultra-low NO_X regulations and other environmental and safety regulations. 74 FR 65852, 65953 (Dec. 11, 2009). For further detail, *see* the cumulative regulatory burden discussion in Chapter 12 of the TSD.

Regarding the cumulative regulatory burden discussed in the NOPR, BWC stated that refrigerant regulations are constantly changing and could force manufacturers to redesign heat pump water heaters that have been recently commercialized. To this point, BWC noted that R–134a is being phased out in Europe, but the prospect of a similar phase-out in the U.S. was not considered in the NOPR analysis. (BWC, No. 61 at p. 2) Rheem also stated that proposed legislation that phases out hydrofluorocarbons (HFCs) would require double the amount of refrigerant, because the alternative is not as efficient. Rheem also added that a cap-and-trade program would have a significant effect on the heat pump water heater business. (Rheem, Public Meeting Transcript No. 57.4 at pp. 294–295)

DOE acknowledges that an HFC phase-out or alternative legislation requiring a refrigerant change could necessitate substantial design changes for heat pump water heaters. However, for this heating products energy conservation standards rulemaking, DOE did not consider proposed legislation that would require a reduction in consumption of HFCs including refrigerants (*i.e.,* phase-down) or a cap and trade program. It would be highly speculative to try to predict the passage of such legislation, much less the details of its provisions, all of which are highly uncertain.

BWC stated that DOE should consider that additional Air Quality Management Districts have enacted standards since the rulemaking began. (BWC, No. 61 at pp. 3–4) In response, DOE has monitored the Air Quality Management Districts' regulations. In the analysis, DOE assumed that the Air Quality Managements Districts with ultra-low NO_X requirements would represent 50 percent of shipments to California, or 8.7 percent of shipments nationally, by the compliance date of today's final rule in 2015. Thus, DOE's analysis of the ultra-low NO_X water heater shipments is up to date. DOE accounted for the higher costs of these ultra-low NO_X gas-fired water heaters in both the LCC and the MIA.

AHRI stated lower NO_X requirements will affect future designs of gas-fired instantaneous water heaters and may cause design changes that reduce the efficiency of the product. (AHRI, No. 91 at p. 3)

DOE accounted for the added production costs 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 AHRI that the California Air Quality Management Districts will begin to regulate the emissions of gas-fired instantaneous water heaters beginning in 2012. However, DOE is not aware of any ultra-low NO_X instantaneous gas-fired water heaters currently on the market and could not create a separate cost curve to account for the additional cost of instantaneous water heaters.

Raypak stated that pool heaters are not exempt from ultra-low NO_X requirements, but have only been exempted from any revisions to the existing requirements. Raypak stated that pool heaters are required to meet a maximum of 55 ppm of NO_X in the South Coast Air Quality Management District. In addition, the Bay Area Air Quality Management District has implemented new NO_X requirements for pool heaters starting on January 1, 2012. (Raypak, No. 67 at p. 2; Public Meeting Transcript, No. 57.4 at pp. 336–37)

DOE agrees with Raypak that it should have indicated that gas-fired pool heaters were only exempted from revisions to existing low-NO_X requirements that would have required more-stringent emission standards. Furthermore, DOE agrees with Raypak that gas-fired pool heaters must meet the local low-NO_X requirements in the Air Quality Management Districts shown in Table 12.7.9 of the TSD. In the engineering analysis, DOE examined several low-NO_X pool heaters and believes its analysis is representative of both types of pool heaters. Chapter 12 of the TSD also addresses in greater detail the issue of cumulative regulatory burden.

g. Impacts on Manufacturers That Are Small Businesses

As discussed in the December 2009 NOPR, DOE identified small business manufacturers of all three types of heating products. 74 FR 65852, 65953–54 (Dec. 11, 2009). Due to the large number of comments about the impacts on traditional DHE manufacturers, DOE has moved and addressed all these comments in sections IV.I and VII.B. Section VII.B also contains DOE's discussion about the impacts of amended energy conservation standards on small business manufacturers.

3. National Net Present Value of Consumer Costs and Benefits and National Employment Impacts

The NPV analysis estimates the cumulative benefits or costs to the Nation of total heating product consumer costs and savings that would result from particular standard levels. The NPV analysis estimates the national economic impacts of each such level relative to the base case. In accordance with the OMB Circular A–4, DOE calculated the NPV using both a 7-percent and a 3-percent real discount rate. Table VI.38 through Table VI.40 show the consumer NPV results for each TSL DOE considered for the three types of heating products. See chapter 10 of the December 2009 NOPR TSD for more detailed NPV results.

TABLE VI.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	TSL 8
	billion 2009 dollars							
Discounted at 3%:								
Gas-Fired Storage	2.72	3.13	3.13	3.13	2.38	2.78	3.13	−7.47
Electric Storage	1.35	2.10	3.46	3.96	5.84	5.84	19.80	32.24
Oil-Fired Storage	0.08	0.15	0.22	0.22	0.22	0.22	0.22	0.38
Gas-Fired Instantaneous.	0.24	0.24	0.24	0.24	0.24	0.24	0.24	−8.27
Total	4.39	5.62	7.05	7.55	8.67	9.08	23.39	16.87
Discounted at 7%:								
Gas-Fired Storage	0.59	0.22	0.22	0.22	0.27	−0.10	0.22	−9.95
Electric Storage	0.35	0.61	0.85	0.73	1.03	1.03	−0.52	3.25
Oil-Fired Storage	0.03	0.06	0.09	0.09	0.09	0.09	0.09	0.15
Gas-Fired Instantaneous.	−0.004	−0.004	−0.004	−0.004	−0.004	−0.004	−0.004	−5.02
Total	0.96	0.88	1.55	1.03	1.39	1.01	−0.22	−11.57

TABLE VI.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 2009 dollars					
Discounted at 3%:						
Gas Wall Fan	0.06	0.07	0.07	−0.01	0.06	−0.01
Gas Wall Gravity	0.04	0.04	0.07	0.07	−0.12	−0.12
Gas Floor	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Gas Room	0.01	0.02	0.03	0.03	0.20	0.20
Gas Hearth	1.21	1.21	1.21	−1.35	−1.35	−5.04
Total	1.32	1.34	1.39	−1.26	−1.22	−4.97
Discounted at 7%:						
Gas Wall Fan	0.02	0.03	0.03	−0.03	0.02	−0.03

TABLE VI.39—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR DIRECT HEATING EQUIPMENT—Continued

[Impacts for units sold from 2013 to 2043]

Product class	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Gas Wall Gravity	0.01	0.01	0.02	0.02	−0.14	−0.14
Gas Floor	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Gas Room	0.003	0.01	0.01	0.01	0.07	0.07
Gas Hearth	0.50	0.50	0.50	−1.19	−1.19	−4.28
Total	0.54	0.55	0.56	−1.19	−1.24	−4.38

TABLE VI.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 2009 dollars					
Discounted at 3%	0.10	0.10	−0.01	−0.15	−2.33	−4.57
Discounted at 7%	0.04	0.04	−0.06	−0.16	−1.39	−2.87

DOE also estimated for each TSL the indirect employment impact of standards—the impact on the economy in general—in addition to considering the direct employment impacts on manufacturers of products covered in this rulemaking as discussed in section IV.I.4. DOE expects that consumers will redirect the net monetary savings from standards to other forms of economic activity, and that these shifts in spending and economic activity will affect the demand for labor. As shown in Table VI.41, DOE estimates that net indirect employment impacts from energy conservation standards for water heaters would be positive, though very small relative to total national employment. These increases would likely be sufficient to offset fully any adverse impacts on employment that might occur in the water heater industry. The estimated impacts from the amended standards for DHE and pool heaters are much smaller. For details on the employment impact analysis methods and results, *see* TSD Chapter 14.

TABLE VI.41—INCREASE IN NATIONAL INDIRECT EMPLOYMENT UNDER WATER HEATER TSLS

Trial standard level	2015 thousands	2020 thousands	2030 thousands	2044 thousands
1	−0.40	0.44	1.56	2.06
2	−0.72	0.48	2.08	2.80
3	−0.83	1.04	3.54	4.60
4	−0.97	1.43	4.63	5.96
5	−0.85	3.07	8.34	10.41
6	−1.20	2.89	8.37	10.56
7	−3.89	12.70	34.97	43.46
8	−8.21	13.82	43.69	56.26

4. Impact on Utility or Performance of Products

As indicated in section III.D.1.d, DOE has concluded that the TSLs it considered for the three types of heating products would not lessen the utility or performance of those products. Manufacturers of these products currently offer heating products that meet or exceed the efficiency levels being considered and would not necessitate changes in product design that would reduce the overall utility or performance of the three types of heating products that are the subject of this rulemaking. Therefore, DOE has concluded that none of the TSLs presented in today's final rule would reduce the utility or performance of the products under consideration.

5. Impact of Any Lessening of Competition

As discussed in the December 2009 NOPR (74 FR 65852, 65863, 65956 (Dec. 11, 2009)) and in section III.D.1.e of this preamble, DOE considers any lessening of competition likely to result from standards; the Attorney General determines, in writing, the impact, if any, of any such lessening of competition. (42 U.S.C. 6295(o)(2)(B)(i)(V) and (ii)) The Attorney General's determination (DOJ determination) is summarized below, along with DOE's response, and it is also reprinted in its entirety at the end of this final rule.

After considering the NOPR, DOJ determined that DOE's proposed standards for water heaters, pool heaters, and gas hearth DHE are not likely to lead to a lessening of competition; however, DOJ expressed concern that the proposed standards could adversely affect competition in the traditional DHE product categories. DOJ noted that only three manufacturers currently market products for each of the four traditional DHE categories. DOJ stated that the proposed standards could require manufacturers, even those currently producing models that meet the proposed standards, to make a substantial capital investment to convert or expand their production facilities. DOJ also stated that it also appeared that each manufacturer would have to commit significant resources for research and development. DOJ believed these costs create a significant risk that no more than one or two DHE manufacturers would choose to continue to produce products in any one DHE category. DOJ asked DOE to consider the possible impact on competition in determining its final energy efficiency standards for DHE. (DOJ, No. 99 at p. 2)

DOE is also concerned about the impacts on competition in the traditional DHE market. For any new or amended energy conservation standard, DOE must consider the impacts on manufacturers and consumers of the products in addition to the impacts of any lessening of competition. (42 U.S.C. 6295(o)(2)(B)(i)) DOE notes that the potential impacts on small business manufacturers factored heavily in DOE's proposed standard. 74 FR 65852, 65972–73 (Dec. 11, 2009).

DOE has carefully considered the potential adverse impacts on traditional DHE manufacturers in setting the amended energy conservation standards (*see* section VI.D.3). In total, DOE estimates that it will take approximately $4.6 million for the traditional DHE industry to upgrade all of it products to meet the amended energy conservation standards. Despite including the conversion costs for the additional product lines that were released since the December 2009 NOPR analysis was completed, the total conversion costs estimated by the industry to upgrade all products that do not meet the amended energy conservation standards is down $1.8 million from the $6.4 million total estimated for the proposed standards in the December 2009 NOPR. The conversion costs have been revised downward for gas wall gravity DHE due to the changes in the engineering analysis and a new TSL structure for gas wall gravity DHE that resulted in AFUE requirements that were 5 percentage points less stringent than the level proposed in the December 2009 NOPR. Finally, for other product categories, setting a lower TSL than proposed in the December 2009 NOPR also resulted in fewer product lines across the industry that need to be upgraded to meet the level established by today's final rule.

For the amended energy conservation standards for traditional DHE, one major manufacturer has a total of 3 product lines (7 models) that do not meet the amended energy conservation standards in the two smallest categories (gas floor and gas room DHE) but has a majority of product lines and models that meet the amended standards in the two largest product categories (gas wall fan and gas wall gravity). The other two major manufacturers have existing product lines that meet the amended energy conservation standards in all 4 product categories. Therefore, without incurring any conversion costs, at least two manufacturers already have existing products in all four product categories. In the most important gas wall gravity category, 57 percent of the existing models and 71 percent of the existing product lines identified by DOE already meet the amended energy conservation standards. One manufacturer indicated in written comments that the important gas wall gravity products that meet the amended energy conservation standard represent a small portion of total sales. However, DOE believes it has addressed the concerns of this manufacturer by setting an amended energy conservation standard that would require much less substantial changes than those proposed in the December 2009 NOPR (a two percentage point improvement in AFUE versus the six percentage point improvement in AFUE proposed in the December 2009 NOPR). While the $4.6 million in total conversion costs to upgrade all product lines that do not meet the amended energy conservation standards is substantial, DOE believes that a combination of products that meet the amended energy conservation standards and selectively upgrading popular product lines that fall below the standards will allow all three traditional DHE manufacturers to maintain a viable production volume. Because DOE has fully addressed the comments raised about the impacts on traditional DHE manufacturers, has considered the potential impacts on small business manufacturers of traditional DHE, and has adopted a less stringent standard than originally proposed for these products, DOE believes it has taken the potential impacts on competition in the traditional DHE market into consideration for today's final rule.

DOE also prepared a final regulatory flexibility analysis (FRFA) for direct heating equipment pursuant to the Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*). In particular, the FRFA carefully considers the impacts of the rule on the two manufacturers in the traditional DHE market that are small businesses. DOE's FRFA is found in section VII.B of today's final rule.

Several comments on the December 2009 NOPR raised issues related to competitive impacts. These comments and DOE's response are discussed below. In both its written submission and comments at the NOPR public meeting, Empire expressed concern about the potential for amended standards to create monopolies in certain DHE product categories. (Empire, Public Meeting Transcript, No. 57.4 at p. 300; Empire, No. 100 at p. 1) In addition, Empire stated that in order to increase efficiency, the industry would need to spend millions of dollars. With the small number of shipments and the shrinking market for traditional DHE, Empire opined that manufacturers would likely eliminate product categories. For those few categories where only one manufacturer meets the minimums (*e.g.,* floor furnaces), a monopoly would be created. (Empire, No. 100 at p. 2)

In response and as noted above, DOE is concerned about the impacts on competition in the traditional DHE market and has considered these impacts for today's final rule. In response to the concern that the amended energy conservation standards could create a monopoly in the floor furnace category, DOE notes that two of the major manufacturers currently offer products in the AHRI certification database that meet the required efficiencies, which implies that the creation of a monopoly is unlikely to result due to amended energy conservation standards. Additionally, DOE also recognizes that the traditional DHE market is mostly a replacement market. Even if only one manufacturer offered floor furnaces, for example, in response to the energy conservation standards, all other DHE categories are also potential substitutes. Finally, DOE has included the conversion costs for manufacturers to convert all existing products that do not meet the required efficiencies. While manufacturers currently in the industry would likely upgrade their most popular products that did not meet the standards, DOE notes that these conversion costs could also be made by manufacturers that are not currently in the market (*i.e.,* new entrants to the market).

Rheem stated that the U.S. residential water heater market currently has little or no presence of max-tech systems. Rheem commented that as a current manufacturer of conventional storage water heater products, it would be competitively disadvantaged by a standard at TSL 5 or higher in the December 2009 NOPR, as compared to companies that do not manufacture conventional technology. (Rheem, No. 89 at p. 9)

In response, DOE does not believe offering conventional technology would place a manufacturer at a disadvantage if DOE selected a TSL that used advanced technology. While TSL 5 or higher would drive a market for the advanced technology, full-line manufacturers that offer commercial condensing products, for example, could actually be in a better position because of their experience with the condensing technology. Most water heaters sales are made on a replacement basis. The large installed base of existing manufacturers could make it more difficult for new entrants to gain market share if customers look for a similar replacement. Also, the major manufacturers have very established brands. In short, there are too many factors to conclude that manufacturers who produce conventional storage water heaters would be placed at a competitive disadvantage.

Bock claimed that the proposed amended energy conservation standards for oil-fired water heaters would lessen competition. Bock stated that many manufacturers have exited the market since the last water heater rulemaking in the 1990s (Bock, No. 101 at p. 3)

In response, DOE notes that whether a given manufacturer chooses to exit the residential oil-fired water heater market will depend on a variety of internal and external factors, and DOE also believes that the decision of any manufacturer to exit the market would not necessarily result in a lessening of competition. Consumers today have a number of fuel sources that could be substituted for oil-fired products if any decrease in competition resulted in higher prices for consumers. Furthermore, any increase in prices could also attract new entrants to the market. While there are only two manufacturers that have a significant market share in the residential oil-fired water heater market, there are a number of manufacturers that offer lower volumes of residential oil-fired water heaters, commercial oil-fired water heaters, and oil-fired boilers. Any of these manufacturers could find it attractive to enter this market or expand production, if other manufacturers exited the residential oil-fired water heater market. Finally, as noted above, DOJ did not express concern about the potential lessening of competition in the oil-fired water heater market at the proposed standard level. (DOJ, No. 99 at pp. 1–2)

6. Need of the Nation To Conserve Energy

Improving the energy efficiency of heating products, where economically justified, would likely improve the security of the Nation's energy system by reducing overall demand for energy, thereby reducing the Nation's reliance on foreign sources of energy. Reduced electricity demand may also improve the reliability of the electricity system, particularly during peak-load periods. As a measure of this reduced demand, DOE expects the energy savings from today's standards for the three types of heating products to eliminate the need for approximately 0.857 gigawatts (GW) of generating capacity by 2045.

As discussed in section IV.K.1, DOE analyzed the potential impact on natural gas prices resulting from amended standards on water heaters and the associated benefits for all natural gas users in all sectors of the economy. DOE also analyzed the potential impact on electricity prices resulting from amended standards on water heaters and the associated benefits for all electricity users in all sectors of the economy. The estimated present value of the benefits to consumers are presented in chapter 13 of the TSD.

As discussed in section IV.K.1, DOE believes that there is uncertainty about the extent to which the calculated impacts from reduced energy prices are a benefits transfer from energy producers to energy consumers. Therefore, DOE has concluded that, at present, it should not give a heavy weight to this factor in its consideration of the economic justification of standards on heating products. DOE is continuing to investigate the extent to which benefits associated with change in energy prices projected to result from standards represents a net gain to society.

Enhanced energy efficiency also produces environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases associated with energy production. Table VI.42 and Table VI.43 provide DOE's estimate of cumulative CO_2, NO_X, and Hg emissions reductions expected to result from the TSLs considered in this rulemaking. The estimated cumulative CO_2, NO_X, and Hg emissions reductions for the standards in today's rule are 164 Mt for CO_2, 125 kt for NO_X, and 0.54 tons for Hg. The expected energy savings from these standards may also reduce the cost of maintaining nationwide emissions standards and constraints. In the environmental assessment (chapter 16 of the TSD), DOE reports estimated annual changes in CO_2, NO_X, and Hg emissions attributable to each TSL.

TABLE VI.42—SUMMARY OF EMISSIONS REDUCTIONS UNDER WATER HEATER TSLS

[Cumulative for products sold from 2015 to 2045]

Emission type	TSL							
	1	2	3	4	5	6	7	8
CO_2 (Mt)	74.3	122	131	137	154	209	609	1,001
NO_X (kt)	57.5	94.3	101	106	116	159	456	755
Hg (t)	0.056	0.090	0.103	0.113	0.553	0.704	2.32	3.59

TABLE VI.43—SUMMARY OF EMISSIONS REDUCTIONS UNDER DIRECT HEATING EQUIPMENT AND POOL HEATER TSLS

[Cumulative for products sold from 2013 to 2043]

Emission type	TSL					
	1	2	3	4	5	6
Direct Heating Equipment						
CO_2 (Mt)	8.3	8.8	9.3	17.9	20.2	49.9
NO_X (kt)	7.5	8.1	8.5	16.4	18.6	46.0
Hg (t)	(0.01)	(0.01)	(0.01)	0.03	0.03	0.08
Pool Heaters						
CO_2 (Mt)	0.41	0.75	1.72	2.38	3.61	8.89

TABLE VI.43—SUMMARY OF EMISSIONS REDUCTIONS UNDER DIRECT HEATING EQUIPMENT AND POOL HEATER TSLS—Continued

[Cumulative for products sold from 2013 to 2043]

Emission type	TSL					
	1	2	3	4	5	6
NO_X (kt)	0.37	0.67	1.53	2.10	3.18	7.84
Hg (t)	0.00	0.00	0.00	0.00	0.00	0.00

As noted in section IV.L of this final rule, DOE does not report SO_2 emissions reductions from power plants because DOE is uncertain that an energy conservation standard would affect the overall level of U.S. SO_2 emissions due to 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 likely not affect the overall level of NO_X emissions in those States due to the emissions caps mandated by CAIR.

It should be noted that, for DHE, DOE estimates a very small increase in Hg emissions under the adopted 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 *AEO* Reference Case, which leads to higher emissions. For CO_2 and NO_X, the higher emissions from the power sector are more than canceled out by lower household emissions from gas combustion, such that total emissions decrease under the considered TSLs. For Hg, this is not the case because there are no offsetting household emissions.

In the December 2009 NOPR, DOE investigated and considered the potential monetary benefit of reduced CO_2 emissions that could result from the TSLs it considered. 74 FR 65852, 65924–28 (Dec. 11, 2009). DOE valued the potential global benefits resulting from such reductions at the interim values of $5, $10, $20, $34, and $57 per metric ton in 2007 (in 2008$), and also valued the domestic benefits at approximately $1 per metric ton. For today's final rule, DOE has updated its analysis to reflect the outcome of the most recent interagency process regarding the social cost of carbon dioxide emissions (SCC). *See* section IV.M for a full discussion. The four values of CO_2 emissions reductions resulting from that process (expressed in 2007$) are $4.70/ton (the average value from a distribution that uses a 5-percent discount rate), $21.40/ton (the average value from a distribution that uses a 3-percent discount rate), $35.10/ton (the average value from a distribution that uses a 2.5-percent discount rate), and $64.90/ton (the 95th-percentile value from a distribution that uses a 3-percent discount rate). These values correspond to the value of emission reductions in 2010; the values for later years are higher due to increasing damages as the magnitude of climate change increases. Table VI.44, Table VI.45, and Table VI.46 present the global values of emissions reductions at each TSL. For each of the four cases, DOE calculated a present value of the stream of annual values using the same discount rate as was used in the studies upon which the dollar-per-ton values are based. DOE calculated domestic values as a range from 7 percent to 23 percent of the global values, and these results are presented in Table VI.47, Table VI.48, and Table VI.49.

TABLE VI.44—ESTIMATES OF GLOBAL PRESENT VALUE OF CO_2 EMISSIONS REDUCTIONS FOR THE PERIOD 2015–2045 UNDER WATER HEATER TRIAL STANDARD LEVELS

TSL	Cumulative CO_2 emission reductions, *Mt*	Global Value of CO_2 Emission Reductions, *Million 2009$*			
		5% discount rate, average*	3% discount rate, average*	2.5% discount rate, average*	3% discount rate, 95th percentile*
1	74.3	266	1,351	2,285	4,122
2	122	436	2,213	3,742	6,750
3	131	468	2,374	4,014	7,242
4	137	492	2,496	4,220	7,614
5	154	524	2,682	4,545	8,179
6	209	714	3,653	6,190	11,142
7	609	2,060	10,560	17,898	32,204
8	1,001	3,399	17,411	29,505	53,098

* Columns are labeled by the discount rate used to calculate the SCC and whether it is an average value or drawn from a different part of the distribution. Values presented in the table are based on escalating 2007$ to 2009$ for consistency with other values presented in this notice, and incorporate the escalation of the SCC with each year.

TABLE VI.45—ESTIMATES OF GLOBAL PRESENT VALUE OF CO_2 EMISSIONS REDUCTIONS FOR THE PERIOD 2013–2043 UNDER DIRECT HEATING EQUIPMENT TRIAL STANDARD LEVELS

TSL	Cumulative CO_2 emission reductions, *Mt*	Global value of CO_2 emission reductions, *million 2009$*			
		5% discount rate, average*	3% discount rate, average*	2.5% discount rate, average*	3% discount rate, 95th percentile*
1	8.2	31	154	259	470
2	8.8	33	165	278	503
3	9.3	35	174	293	530
4	17.9	67	335	565	1,023
5	20.2	76	378	637	1,154
6	49.9	187	933	1,572	2,849

* Columns are labeled by the discount rate used to calculate the SCC and whether it is an average value or drawn from a different part of the distribution. Values presented in the table are based on escalating 2007$ to 2009$ for consistency with other values presented in this notice, and incorporate the escalation of the SCC with each year.

TABLE VI.46—ESTIMATES OF GLOBAL PRESENT VALUE OF CO_2 EMISSIONS REDUCTIONS FOR THE PERIOD 2013–2043 UNDER POOL HEATER TRIAL STANDARD LEVELS

TSL	Cumulative CO_2 emission reductions, *Mt*	Global value of CO_2 emission reductions, *million 2009$*			
		5% discount rate, average*	3% discount rate, average*	2.5% discount rate, average*	3% discount rate, 95th percentile*
1	0.4	2	8	13	24
2	0.8	3	14	24	43
3	1.7	6	32	54	99
4	2.4	9	45	75	136
5	3.6	14	68	114	206
6	8.9	33	167	281	509

* Columns are labeled by the discount rate used to calculate the SCC and whether it is an average value or drawn from a different part of the distribution. Values presented in the table are based on escalating 2007$ to 2009$ for consistency with other values presented in this notice, and incorporate the escalation of the SCC with each year.

TABLE VI.47—ESTIMATES OF DOMESTIC PRESENT VALUE OF CO_2 EMISSIONS REDUCTIONS FOR THE PERIOD 2015–2045 UNDER WATER HEATER TRIAL STANDARD LEVELS

TSL	Domestic value of CO_2 emission reductions, *million 2009$* *			
	5% discount rate, average**	3% discount rate, average**	2.5% discount rate, average**	3% discount rate, 95th percentile**
1	18.6 to 61.3	94.6 to 311	160 to 526	289 to 948.
2	30.5 to 100	155 to 509	262 to 861	473 to 1,553.
3	32.8 to 108	166 to 546	281 to 923	507 to 1,666.
4	34.4 to 113	175 to 574	295 to 971	533 to 1,751.
5	36.7 to 120	188 to 617	318 to 1,045	573 to 1,881.
6	50.0 to 164	256 to 840	433 to 1,424	780 to 2,563.
7	144 to 474	739 to 2,429	1,253 to 4,117	2,254 to 7,407.
8	248 to 782	1,219 to 4,005	2,065 to 6,786	3,717 to 12,212.

* Domestic values are presented as a range between 7% and 23% of the global values.
** Columns are labeled by the discount rate used to calculate the SCC and whether it is an average value or drawn from a different part of the distribution. Values presented in the table are based on escalating 2007$ to 2009$ for consistency with other values presented in this notice, and incorporate the escalation of the SCC with each year.

TABLE VI.48—ESTIMATES OF DOMESTIC PRESENT VALUE OF CO_2 EMISSIONS REDUCTIONS FOR THE PERIOD 2013–2043 UNDER DIRECT HEATING EQUIPMENT TRIAL STANDARD LEVELS

TSL	Domestic value of CO_2 emission reductions, *million 2009$* *			
	5% discount rate, average**	3% discount rate, average**	2.5% discount rate, average**	3% discount rate, 95th percentile**
1	2.2 to 7.1	10.8 to 35.4	18.2 to 59.6	32.9 to 108.0.
2	2.3 to 7.6	11.5 to 37.9	19.5 to 63.9	35.2 to 115.8.
3	2.4 to 8.0	12.2 to 39.9	20.5 to 67.3	37.1 to 121.9.
4	4.7 to 15.4	23.5 to 77.1	39.5 to 129.9	71.6 to 235.4.
5	5.3 to 17.4	26.5 to 87.0	44.6 to 146.6	80.8 to 265.5.
6	13.1 to 43.0	65.3 to 214.7	110.1 to 361.7	199.4 to 655.2.

* Domestic values are presented as a range between 7% and 23% of the global values.

** Columns are labeled by the discount rate used to calculate SCC and whether it is an average value or drawn from a different part of the distribution. Values presented in the table are based on escalating 2007$ to 2009$ for consistency with other values presented in this notice, and incorporate the escalation of the SCC with each year.

TABLE VI.49—ESTIMATES OF DOMESTIC PRESENT VALUE OF CO_2 EMISSIONS REDUCTIONS FOR THE PERIOD 2013–2043 UNDER POOL HEATERS TRIAL STANDARD LEVELS

TSL	Domestic value of CO_2 emission reductions, *million 2009$* *			
	5% discount rate, average**	3% discount rate, average**	2.5% discount rate, average**	3% discount rate, 95th percentile**
1	0.1 to 0.4	0.5 to 1.8	0.9 to 3.0	1.7 to 5.5.
2	0.2 to 0.7	1.0 to 3.2	1.7 to 5.4	3.0 to 9.9.
3	0.5 to 1.5	2.3 to 7.4	3.8 to 12.5	6.9 to 22.7.
4	0.6 to 2.1	3.1 to 10.3	5.3 to 17.3	9.5 to 31.4.
5	1.0 to 3.1	4.7 to 15.5	8.0 to 26.2	14.4 to 47.5.
6	2.3 to 7.7	11.7 to 38.3	19.6 to 64.6	35.6 to 117.0.

* Domestic values are presented as a range between 7% and 23% of the global values.
** Columns are labeled by the discount rate used to calculate the SCC and whether it is an average value or drawn from a different part of the distribution. Values presented in the table are based on escalating 2007$ to 2009$ for consistency with other values presented in this notice, and incorporate the escalation of the SCC with each year.

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

DOE also estimated a range for the cumulative monetary value of the economic benefits associated with NO_X emissions reductions anticipated to result from amended standards for heating products. The dollar-per-ton values that DOE used are discussed in section IV.M of this final rule. Table VI.50 through Table VI.55 present the estimates calculated using seven-percent and three-percent discount rates, respectively.

TABLE VI.50—ESTIMATES OF VALUE OF REDUCTIONS OF NO_X EMISSIONS UNDER WATER HEATER TRIAL STANDARD LEVELS AT A SEVEN-PERCENT DISCOUNT RATE

TSL	Cumulative NO_X emission reductions, kt	Value of NO_X emission reductions, million 2009$
1	57.5	6.6 to 67.8.
2	94.3	10.8 to 111.
3	101	11.6 to 119.
4	106	12.1 to 125.
5	116	11.0 to 113.
6	159	15.2 to 157.
7	456	42.6 to 438.
8	755	71.4 to 734.

TABLE VI.51—ESTIMATES OF VALUE OF REDUCTIONS OF NO_X EMISSIONS UNDER WATER HEATER TRIAL STANDARD LEVELS AT A THREE-PERCENT DISCOUNT RATE

TSL	Cumulative NO_X emission reductions, kt	Value of NO_X emission reductions, million 2009$
1	57.5	13.7 to 141.
2	94.3	22.5 to 231.
3	101	24.0 to 247.
4	106	25.2 to 259.
5	116	25.4 to 261.
6	159	34.9 to 358.
7	456	99.1 to 1,018.
8	755	165 to 1,694.

TABLE VI.52—ESTIMATES OF VALUE OF REDUCTIONS OF NO_X EMISSIONS UNDER DIRECT HEATING EQUIPMENT TRIAL STANDARD LEVELS AT A SEVEN-PERCENT DISCOUNT RATE

TSL	Cumulative NO_X emission reductions, kt	Value of NO_X emission reductions, million 2009$
1	7.5	1.0 to 10.2.
2	8.1	1.1 to 10.9.
3	8.5	1.1 to 11.4.
4	16.4	2.2 to 22.3.
5	18.6	2.5 to 25.3.
6	46.0	6.1 to 62.5.

TABLE VI.53—ESTIMATES OF VALUE OF REDUCTIONS OF NO_X EMISSIONS UNDER DIRECT HEATING EQUIPMENT TRIAL STANDARD LEVELS AT A THREE-PERCENT DISCOUNT RATE

TSL	Cumulative NO_X emission reductions, kt	Value of NO_X emission reductions, million 2009$
1	7.5	1.9 to 19.6.
2	8.1	2.0 to 21.0.
3	8.5	2.1 to 22.1.
4	16.4	4.2 to 42.9.
5	18.6	4.7 to 48.7.
6	46.0	11.7 to 120.2.

TABLE VI.54—ESTIMATES OF VALUE OF REDUCTIONS OF NO_X EMISSIONS UNDER POOL HEATER TRIAL STANDARD LEVELS AT A SEVEN-PERCENT DISCOUNT RATE

TSL	Cumulative NO_X emission reductions, kt	Value of NO_X emission reductions, million 2009$
1	0.4	0.1 to 0.5.
2	0.7	0.1 to 0.9.
3	1.5	0.2 to 2.2.
4	2.1	0.3 to 2.9.
5	3.2	0.4 to 4.5.
6	7.8	1.1 to 11.0.

TABLE VI.55—ESTIMATES OF VALUE OF REDUCTIONS OF NO_X EMISSIONS UNDER POOL HEATER TRIAL STANDARD LEVELS AT A THREE-PERCENT DISCOUNT RATE

TSL	Cumulative NO_X emission reductions, kt	Value of NO_X emission reductions, million 2009$
1	0.4	0.1 to 1.0.
2	0.7	0.2 to 1.8.
3	1.5	0.4 to 4.1.
4	2.1	0.5 to 5.6.
5	3.2	0.8 to 8.4.
6	7.8	2.0 to 20.8.

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 VI.57 through Table VI.62 present the NPV values for heating products that would result if DOE were to add the estimates of the potential economic benefits resulting from reduced CO_2 and NO_X emissions in each of four valuation scenarios to the NPV of consumer savings calculated for each TSL considered in this rulemaking, at both a seven-percent and three-percent discount rate. The CO_2 values used in the columns of each table correspond to the four scenarios for the valuation of CO_2 emission reductions presented in section IV.M. Table VI.56 shows an example of the calculation of the NPV including benefits from emissions reductions for the case of TSL 5 for water heaters.

Although adding the value of consumer savings to the values of emission reductions provides a valuable perspective, the following should be considered: (1) The national consumer savings are domestic U.S. consumer monetary savings found in market transactions, while the values of emissions reductions are based on estimates of marginal social costs, which, in the case of CO_2, are based on a global value; (2) The assessments of consumer savings and emission-related benefits are performed with different computer models, leading to different timeframes for analysis. For heating products, the present value of national consumer savings is measured for the period in which units shipped (2015 to 2045 for water heaters, and 2013 to 2043 for DHE and pool heaters) continue to operate. However, the time frames of the benefits associated with the emission reductions differ. For example, the value of CO_2 emissions reductions reflects the present value of all future climate-related impacts due to emitting a ton of carbon dioxide in that year, out to 2300.

TABLE VI.56—ESTIMATE OF ADDING NET PRESENT VALUE OF CONSUMER SAVINGS TO PRESENT VALUE OF MONETIZED BENEFITS FROM CO_2 AND NO_X EMISSIONS REDUCTIONS AT TSL 5 FOR WATER HEATERS

Category	Present value billion 2009$	Discount rate (percent)
Benefits		
Operating Cost Savings	12.4	7
	29.2	3
CO_2 Monetized Value (at $4.7/Metric Ton)*	0.5	5
CO_2 Monetized Value (at $21.4/Metric Ton)*	2.7	3
CO_2 Monetized Value (at $35.1/Metric Ton)*	4.5	2.5
CO_2 Monetized Value (at $64.9/Metric Ton)*	8.2	3
NO_X Monetized Value (at $2,437/Metric Ton)	0.1	7
	0.1	3
Total Monetary Benefits **	15.2	7
	32.1	3
Costs		
Total Monetary Costs	−11.1	7
	−20.6	3
Net Benefits/Costs		
Including CO_2 and NO_X**	4.1	7
	11.5	3

* These values represent global values (in 2007$) of the social cost of CO_2 emissions in 2010 under several scenarios. The values of $4.7, $21.4, and $35.1 per ton are the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The value of $64.9 per ton represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. *See* section IV.M for details.
** Total Monetary Benefits for both the 3% and 7% cases utilize the central estimate of social cost of CO_2 emissions calculated at a 3% discount rate (averaged across three IAMs), which is equal to $21.4/ton in 2010 (in 2007$).

TABLE VI.57—ESTIMATES OF ADDING NET PRESENT VALUE OF CONSUMER SAVINGS (AT 7% DISCOUNT RATE) TO NET PRESENT VALUE OF LOW, CENTRAL, AND HIGH-END MONETIZED BENEFITS FROM CO_2 AND NO_X EMISSIONS REDUCTIONS AT TRIAL STANDARD LEVELS FOR WATER HEATERS

TSL	Consumer NPV at 7% discount rate added with:			
	CO_2 value of $4.7/metric ton CO_2* and Low value for NO_X** *billion 2009$*	CO_2 value of $21.4/metric ton CO_2* and Medium value for NO_X*** *billion 2009$*	CO_2 Value of $35.1/metric ton CO_2* and Medium value for NO_X*** *billion 2009$*	CO_2 value of $64.9/metric ton CO_2* and high value for NO_X**** *billion 2009$*
1	1.24	2.35	3.29	5.15
2	1.33	3.16	4.69	7.74
3	1.63	3.59	5.23	8.52
4	1.54	3.60	5.32	8.77
5	1.92	4.13	5.99	9.68
6	1.74	4.75	7.29	12.31
7	1.89	10.59	17.92	32.43
8	(8.10)	6.24	18.34	42.26

* These label values per ton represent the global SCC of CO_2 in 2010, in 2007$. Their present values have been calculated with scenario-consistent discount rates. *See* section IV.M for a full discussion of the derivation of these values.
** Low values correspond to $447 per ton of NO_X emissions.
*** Medium values correspond to $2,519 per ton of NO_X emissions.
**** High values correspond to $4,591 per ton of NO_X emissions.

TABLE VI.58—ESTIMATES OF ADDING NET PRESENT VALUE OF CONSUMER SAVINGS (AT 3% DISCOUNT RATE) TO NET PRESENT VALUE OF LOW, CENTRAL, AND HIGH-END MONETIZED BENEFITS FROM CO_2 AND NO_X EMISSIONS REDUCTIONS AT TRIAL STANDARD LEVELS FOR WATER HEATERS

TSL	Consumer NPV at 3% Discount Rate added with:			
	CO_2 value of $4.7/metric ton CO_2* and Low value for NO_X** *billion 2009$*	CO_2 value of $21.4/metric ton CO_2* and Medium value for NO_X*** *billion 2009$*	CO_2 value of $35.1/metric ton CO_2* and Medium value for NO_X*** *billion 2009$*	CO_2 value of $64.9/metric ton CO_2* and High value for NO_X**** *billion 2009$*
1	4.67	5.82	6.75	8.65
2	6.08	7.96	9.49	12.60
3	7.54	9.56	11.20	14.54
4	8.07	10.19	11.91	15.42
5	9.22	11.50	13.36	17.11
6	9.83	12.93	15.47	20.58
7	25.55	34.51	41.84	56.61
8	20.44	35.21	47.31	71.67

* These label values per ton represent the global SCC of CO_2 in 2010, in 2007$. Their present values have been calculated with scenario-consistent discount rates. *See* section IV.M for a full discussion of the derivation of these values.
** Low value corresponds to $447 per ton of NO_X emissions.
*** Medium value corresponds to $2,519 per ton of NO_X emissions.
**** High value corresponds to $4,591 per ton of NO_X emissions.

TABLE VI.59—ESTIMATES OF ADDING NET PRESENT VALUE OF CONSUMER SAVINGS (AT 7% DISCOUNT RATE) TO NET PRESENT VALUE OF LOW, CENTRAL, AND HIGH-END MONETIZED BENEFITS FROM CO_2 AND NO_X EMISSIONS REDUCTIONS AT TRIAL STANDARD LEVELS FOR DIRECT HEATING EQUIPMENT

TSL	Consumer NPV at 7% discount rate added with:			
	CO_2 value of $4.7/metric ton CO_2* and low value for NO_X** *billion 2009$*	CO_2 value of $21.4/metric ton CO_2* and medium value for NO_X*** *billion 2009$*	CO_2 value of $35.1/metric ton CO_2* and medium value for NO_X*** *billion 2009$*	CO_2 value of $64.9/metric ton CO_2* and high value for NO_X**** *billion 2009$*
1	0.58	0.70	0.81	1.02
2	0.61	0.74	0.86	1.09
3	0.60	0.74	0.86	1.10
4	(1.12)	(0.84)	(0.61)	(0.14)
5	(1.16)	(0.85)	(0.59)	(0.06)
6	(4.18)	(3.41)	(2.77)	(1.47)

* These label values per ton represent the global SCC of CO_2 in 2010, in 2007$. Their present values have been calculated with scenario-consistent discount rates. *See* section IV.M for a full discussion of the derivation of these values.
** Low value corresponds to $447 per ton of NO_X emissions.
*** Medium value corresponds to $2,519 per ton of NO_X emissions.
**** High value corresponds to $4,591 per ton of NO_X emissions.
Parentheses indicate negative (−) values.

TABLE VI.60—ESTIMATES OF ADDING NET PRESENT VALUE OF CONSUMER SAVINGS (AT 3% DISCOUNT RATE) TO NET PRESENT VALUE OF LOW, CENTRAL, AND HIGH-END MONETIZED BENEFITS FROM CO_2 AND NO_X EMISSIONS REDUCTIONS AT TRIAL STANDARD LEVELS FOR DIRECT HEATING EQUIPMENT

TSL	Consumer NPV at 3% discount rate added with:			
	CO_2 value of $4.7/metric ton CO_2* and low value for NO_X** *billion 2009$*	CO_2 value of $21.4/metric ton CO_2* and medium value for NO_X*** *billion 2009$*	CO_2 value of $35.1/metric ton CO_2* and medium value for NO_X*** *billion 2009$*	CO_2 value of $64.9/metric ton CO_2* and high value for NO_X**** *billion 2009$*
1	1.35	1.48	1.59	1.80
2	1.42	1.56	1.68	1.91
3	1.43	1.58	1.70	1.94
4	(1.18)	(0.90)	(0.67)	(0.19)
5	(1.14)	(0.81)	(0.55)	(0.02)
6	(4.77)	(3.97)	(3.33)	(2.00)

* These label values per ton represent the global SCC of CO_2 in 2010, in 2007$. Their present values have been calculated with scenario-consistent discount rates. *See* section IV.M for a full discussion of the derivation of these values.
** Low value corresponds to $447 per ton of NO_X emissions.
*** Medium value corresponds to $2,519 per ton of NO_X emissions.
**** High value corresponds to $4,591 per ton of NO_X emissions.
Parentheses indicate negative (−) values.

TABLE VI.61—ESTIMATES OF ADDING NET PRESENT VALUE OF CONSUMER SAVINGS (AT 7% DISCOUNT RATE) TO NET PRESENT VALUE OF LOW, CENTRAL, AND HIGH-END MONETIZED BENEFITS FROM CO_2 AND NO_X EMISSIONS REDUCTIONS AT TRIAL STANDARD LEVELS FOR POOL HEATERS

TSL	Consumer NPV at 7% discount rate added with:			
	CO_2 value of $4.7/metric ton CO_2* and low value for NO_X** *billion 2009$*	CO_2 value of $21.4/metric ton CO_2* and medium value for NO_X*** *billion 2009$*	CO_2 value of $35.1/metric ton CO_2* and medium value for NO_X*** *billion 2009$*	CO_2 value of $64.9/metric ton CO_2* and high value for NO_X**** *billion 2009$*
1	0.05	0.05	0.06	0.07
2	0.04	0.05	0.06	0.08
3	(0.05)	(0.03)	(0.00)	0.04
4	(0.15)	(0.11)	(0.08)	(0.02)
5	(1.38)	(1.32)	(1.28)	(1.18)
6	(2.84)	(2.70)	(2.59)	(2.35)

* These label values per ton represent the global SCC of CO_2 in 2010, in 2007$. Their present values have been calculated with scenario-consistent discount rates. *See* section IV.M for a full discussion of the derivation of these values.
** Low value corresponds to $447 per ton of NO_X emissions.
*** Medium value corresponds to $2,519 per ton of NO_X emissions.
**** High value corresponds to $4,591 per ton of NO_X emissions.
Parentheses indicate negative (−) values.

TABLE VI.62—ESTIMATES OF ADDING NET PRESENT VALUE OF CONSUMER SAVINGS (AT 3% DISCOUNT RATE) TO NET PRESENT VALUE OF LOW, CENTRAL, AND HIGH-END MONETIZED BENEFITS FROM CO_2 AND NO_X EMISSIONS REDUCTIONS AT TRIAL STANDARD LEVELS FOR POOL HEATERS

TSL	Consumer NPV at 3% discount rate added with:			
	CO_2 value of $4.7/metric ton CO_2* and low value for NO_X** *billion 2009$*	CO_2 value of $21.4/metric ton CO_2* and medium value for NO_X*** *billion 2009$*	CO_2 value of $35.1/metric ton CO_2* and medium value for NO_X*** *billion 2009$*	CO_2 value of $64.9/metric ton CO_2* and high value for NO_X**** *billion 2009$*
1	0.10	0.11	0.11	0.12
2	0.11	0.12	0.13	0.15
3	(0.01)	0.02	0.04	0.09
4	(0.14)	(0.10)	(0.07)	(0.01)
5	(2.31)	(2.26)	(2.21)	(2.11)
6	(4.53)	(4.39)	(4.28)	(4.04)

* These label values per ton represent the SCC of CO_2 in 2010, in 2007$. Their present values have been calculated with scenario-consistent discount rates. *See* section IV.M for a full discussion of the derivation of these values.
** Low value corresponds to $447 per ton of NO_X emissions.
*** Medium value corresponds to $2,519 per ton of NO_X emissions.
**** High value corresponds to $4,591 per ton of NO_X emissions.
Parentheses indicate negative (−) values.

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 VI.C.1.b above. DOE also believes that uncertainties associated with the heat pump water heater market (*e.g.,* product availability, servicing, and manufacturability) are relevant to consider as described in section VI.D.2 below. Lastly, DOE believes that another relevant consideration is the potential safety concerns surrounding gas-fired storage water heaters that are atmospherically vented with high recovery efficiencies that potentially may be installed with improper venting in certain installations, which are also discussed in section VI.D.2 below.

D. Conclusion

1. Overview

As discussed above, EPCA contains a number of criteria and other provisions which must be followed when prescribing new or amended energy conservation standards. Specifically, the statute provides that any such standard for any type (or class) of covered product must be designed to achieve the maximum improvement in energy efficiency that the Secretary determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) In determining whether a standard is economically justified, the Secretary must determine whether the benefits of the standard exceed its burdens. (42 U.S.C. 6295(o)(2)(B)(i)) DOE must do so after receiving public 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 the manufacturers and consumers of the products subject to such standard;

2. The savings in operating costs throughout the estimated average life of the covered product in the type (or class) compared to any increase in the price of, initial charges for, or maintenance expenses of the covered

products likely to result from imposition of the standard;

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

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

5. The impact of any lessening of competition, as determined in writing by the Attorney General, likely to result from 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))

A determination of whether a standard level is economically justified is not based on any one factor in isolation. The Secretary must weigh each of these seven factors in total. In addition, the Secretary may not establish any standard if such standard would not result in "significant conservation of energy" or "is not technologically feasible or economically justified." (42 U.S.C. 6295(o)(3)(B)) Furthermore, EPCA's "anti-backsliding" provision prohibits 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))

In selecting today's energy conservation standards for the three heating products, DOE started by examining whether the maximum technologically feasible levels were economically justified. Upon finding that the maximum technologically feasible levels were not economically justified, DOE analyzed the next lower TSL to determine whether that level was economically justified. DOE follows this procedure until it: (1) Identifies a TSL that is both technologically feasible and economically justified, and saves a significant amount of energy; or (2) determines that no TSL is economically justified.

Tables in each section below for each of the three types of heating products summarize DOE's quantitative analytical results for each TSL it considered for this final rule. These tables will aid the reader in understanding the costs and benefits of each TSL that DOE considered in adopting standards in this final rule.

2. Water Heaters

Table VI.63 summarizes the results of DOE's quantitative analysis for each TSL it considered for this final rule for water heaters.

TABLE VI.63—SUMMARY OF ANALYTICAL RESULTS FOR WATER HEATERS

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8
National Energy Savings (quads)	1.07	1.66	2.05	2.35	2.58	3.06	10.16	16.73
NPV of Consumer Benefits (2009$ billion)								
3% discount rate	4.39	5.62	7.05	7.55	8.67	9.08	23.39	16.87
7% discount rate	0.96	0.88	1.15	1.03	1.39	1.01	(0.22)	(11.57)
Industry Impacts								
Gas-Fired and Electric Storage:								
Industry NPV (2009$ million)	(4.9)–(14.2)	(4.3)–(31.4)	(5.2)–(38.3)	(4.8)–(89.4)	(25.9)–(122.6)	(23.6)–(134.6)	(10.5)–(350.2)	79.2–(647.0)
Industry NPV (% change)	(0.6)–(1.6)	(0.5)–(3.6)	(0.6)–(4.3)	(0.5)–(10.2)	(2.9)–(13.9)	(2.7)–(15.3)	(1.2)–(39.8)	9.0–(73.5)
Oil-Fired Storage:								
Industry NPV (2009$ million)	(0.2)–(0.4)	(0.2)–(0.3)	(0.2)–(0.4)	(0.2)–(0.4)	(0.2)–(0.4)	(0.2)–(0.4)	(0.2)–(0.4)	(1.4)–(3.8)
Industry NPV (% change)	(2.0)–(3.9)	(1.8)–(3.6)	(2.0)–(4.2)	(2.0)–(4.2)	(2.0)–(4.2)	(2.0)–(4.2)	(2.0)–(4.2)	(15.4)–(41.4)
Gas-Fired Instantaneous:								
Industry NPV (2009$ million)	2.3–(1.2)	2.3–(1.2)	2.3–(1.2)	2.3–(1.2)	2.3–(1.2)	2.3–(1.2)	2.3–(1.2)	91.4–(57.6)
Industry NPV (% change)	0.4–(0.2)	0.4–(0.2)	0.4–(0.2)	0.4–(0.2)	0.4–(0.2)	0.4–(0.2)	0.4–(0.2)	14.1–(8.9)
Cumulative Emissions Reduction								
CO_2 (Mt)	74.3	122	131	137	154	209	609	1,001
NO_X (kt)	57.5	94.3	101	106	116	159	456	755
Hg (t)	0.056	0.090	0.103	0.113	0.553	0.704	2.32	3.59
Value of Cumulative Emissions Reduction (2009$ million) [††]								
CO_2	266 to 4,122	436 to 6,750	468 to 7,242	492 to 7,614	524 to 8,179	714 to 11,142	2,060 to 32,204	3,399 to 53,098
NO_X—3% discount rate	13.7 to 141	22.5 to 231	24 to 247	25 to 259	25 to 261	35 to 358	99 to 1,019	165 to 1,694
NO_X—7% discount rate	6.6 to 67.9	10.8 to 111	11.6 to 119	12.2 to 125	11.0 to 113	15.2 to 157	42.6 to 438	71.5 to 734
Mean LCC Savings * (2009$)								
Gas-Fired Storage	16	7	7	7	18	9	(218)	(195)
Electric Storage	5	11	18	18	64	64	112	171
Oil-Fired Storage	101	203	295	295	295	295	295	495
Gas-Fired Instantaneous	9	9	9	9	9	9	9	(259)

TABLE VI.63—SUMMARY OF ANALYTICAL RESULTS FOR WATER HEATERS—Continued

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8
Median PBP (years)								
Gas-Fired Storage	2.0	4.5	4.5	4.5	2.3	4.7	21.5	15.6
Electric Storage	4.0	4.0	5.0	6.7	6.8	6.8	9.4	9.0
Oil-Fired Storage	0.9	0.3	0.5	0.5	0.5	0.5	0.5	1.9
Gas-Fired Instantaneous	14.8	14.8	14.8	14.8	14.8	14.8	14.8	38.7
Distribution of Consumer LCC Impacts								
Gas-Fired Storage:								
Net Cost (%)	25	32	32	32	27	34	70	70
No Impact (%)	36	22	22	22	33	21	6	1
Net Benefit (%)	39	45	45	45	40	46	23	28
Electric Storage:								
Net Cost (%)	11	12	21	32	33	33	50	50
No Impact (%)	44	39	17	10	9	9	5	1
Net Benefit (%)	45	48	62	59	58	58	45	49
Oil-Fired Storage:								
Net Cost (%)	0	0	0	0	0	0	0	0
No Impact (%)	76	54	47	47	47	47	47	17
Net Benefit (%)	24	46	53	53	53	53	53	83
Gas-Fired Instantaneous:								
Net Cost (%)	5	5	5	5	5	5	5	77
No Impact (%)	91	91	91	91	91	91	91	12
Net Benefit (%)	4	4	4	4	4	4	4	11
Generation Capacity Change (GW in 2045)	(0.168)	(0.270)	(0.309)	(0.339)	(0.829)	(1.05)	(3.49)	(5.39)
Employment Impacts								
Total Potential Changes in Domestic Production Workers in 2015:								
Gas-Fired and Electric Storage	(3,610)–55	(3,610)–128	(3,610)–168	(3,610)–256	(3,610)–439	(3,610)–500	(3,610)–3,253	(3,610)–6,313
Oil-Fired storage	(37)–0	(37)–0	(37)–1	(37)–1	(37)–1	(37)–1	(37)–1	(37)–18
Gas-Fired Instantaneous	Not Applicable †††							
Net Change in National Indirect Employment in 2044 thousands) ††††	2.1	2.8	4.6	6.0	10.4	10.6	43.5	56.3

Parentheses indicate negative (−) values.
* For LCCs, a negative value means an increase in LCC by the amount indicated.
†† Range of the economic value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions.
††† The industry for gas-fired instantaneous water heaters is international.
†††† National Indirect Employment Impacts exclude direct impacts.

DOE first considered TSL 8, which represents the max-tech efficiency levels for all four product classes. TSL 8 includes a national standard effectively requiring the use of condensing technology for gas-fired storage and instantaneous water heaters, a national standard effectively requiring the use of heat pump water heater technology for electric storage water heaters, and a national standard effectively requiring the use of a multi-flue design for oil-fired water heaters. TSL 8 would save 16.7 quads of energy, an amount DOE considers significant. TSL 8 would result in a NPV of consumer cost of $11.6 billion, using a discount rate of 7 percent, and consumer benefit of $16.9 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 8 are 1,001 Mt of CO_2, 755 kt of NO_X, and 3.6 t of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 8 is $3,399 million to $53,098 million. Total electricity generating capacity in 2045 is estimated to decrease by 5.39 gigawatts (GW) under TSL 8.

At TSL 8, DOE projects that the average LCC impact for consumers is a loss of $195 for gas-fired storage water heaters, a gain of $171 for electric storage water heaters, a gain of $495 for oil-fired storage water heaters, and a loss of $259 for gas-fired instantaneous water heaters. The median payback period is 15.6 years for gas-fired storage water heaters, 9.0 years for electric storage water heaters, 1.9 years for oil-fired storage water heaters, and 38.7 years for gas-fired instantaneous water heaters (which is substantially longer than the mean lifetime of the product). At TSL 8, the fraction of consumers experiencing an LCC benefit is 28 percent for gas-fired storage water heaters, 49 percent for electric storage water heaters, 83 percent for oil-fired storage water heaters, and 11percent for gas-fired instantaneous water heaters. The fraction of consumers experiencing an LCC cost is 70 percent for gas-fired storage water heaters, 50 percent for electric storage water heaters, 0 percent for oil-fired storage water heaters, and

77 percent for gas-fired instantaneous water heaters.

At TSL 8, the average LCC savings are negative for all of the considered consumer subgroups for gas-fired storage water heaters, and a majority of the households in each subgroup experience a net cost. In the case of electric storage water heaters, the average LCC savings are negative for senior-only and multi-family households, but positive for low-income and manufactured home households. In all cases, however, a majority of the households in each subgroup experience a net cost.

At TSL 8, the projected change in the INPV is estimated to decrease up to $647 million for gas-fired and electric storage water heaters, a decrease of up to $3.8 million for residential oil-fired storage water heaters, and a decrease of up to $58 million for gas-fired instantaneous water waters, in 2009$. For gas-fired 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 8, 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 8, 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 8 could result in a net loss of 73.5 percent in INPV for gas-fired and electric storage water heaters, a net loss of 41.4 percent in INPV for oil-fired storage water heaters, and a net loss of 8.9 percent in INPV for gas-fired instantaneous water heaters.

For gas-fired storage and instantaneous water heaters at TSL 8, condensing operation would be required. As further described in the December 2009 NOPR, DOE outlined several concerns related to the condensing gas-fired storage water heater market. 74 FR 65852, 65963–64 (Dec. 11, 2009). The main concerns included the ability for the industry to produce condensing gas-fired storage water heaters and provide installation and servicing on a scale necessary to serve the entire volume of the market (*i.e.,* approximately, 4.6 million units annually). TSL 8 also includes an efficiency level for electric storage water heaters that would require the use of heat pump technology. The substantial average savings for customers estimated by DOE's analysis for TSL 8 are primarily driven by the results for heat pump water heaters. However, DOE outlined a handful of concerns in the December 2009 NOPR with the current heat pump water heater market that may prevent heat pump technology from being ready for full-scale implementation for all consumers. 74 FR 65852, 65965 (Dec. 11, 2009). These included manufacturability, serviceability, the ability to retrofit existing installations, and potential impacts on the space conditioning loads in the house. All four major storage water heater manufacturers within the industry echoed these concerns regarding the max-tech efficiency level products.

Therefore, the Secretary has concluded that at TSL 8, the benefits of energy savings, positive NPV of consumer benefits (at 3-percent discount rate), generating capacity reductions, and emission reductions are 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 concluded that TSL 8 is not economically justified.

Next, DOE considered TSL 7. The efficiency levels in TSL 7 include the ENERGY STAR program level for electric storage water heaters, which effectively requires the use of heat pump water heating technologies. However, TSL 7 allows the use of atmospherically-vented gas-fired storage water heaters. TSL 7 would save 10.16 quads of energy, an amount DOE considers significant. TSL 7 would result in a negative consumer NPV of $0.22 billion, using a discount rate of 7 percent, and a consumer NPV benefit of $23.4 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 7 are 609 Mt of CO_2, 456 kt of NO_X, and 2.32 t of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 7 is $2,060 million to $32,204 million. Total generating capacity in 2045 is estimated to decrease by 3.49 GW under TSL 7.

At TSL 7, DOE projects that the average LCC impact is a loss of $218 for gas-fired storage water heaters, a gain of $112 for electric storage water heaters, a gain of $295 for oil-fired storage water heaters, and a gain of $9 for gas-fired instantaneous water heaters. The median payback period is 21.5 years for gas-fired storage water heaters, 9.4 years for electric storage water heaters, 0.5 years for oil-fired storage water heaters, and 14.8 years for gas-fired instantaneous water heaters. At TSL 7, the fraction of consumers experiencing an LCC benefit is 23 percent for gas-fired storage water heaters, 45 percent for electric storage water heaters, 53 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 70 percent for gas-fired storage water heaters, 50 percent for electric storage water heaters, 0 percent for oil-fired storage water heaters, and 5 percent for gas-fired instantaneous water heaters.

At TSL 7, the estimated average LCC savings are negative for all of the considered consumer subgroups for gas-fired storage water heaters, and a majority of the households in each subgroup experience a net cost. In the case of electric storage water heaters, the average LCC savings are negative for senior-only and multi-family households, but positive for low-income and manufactured home households. In all cases, however, a majority of the households in each subgroup experience a net cost.

At TSL 7, the projected change in INPV ranges from a decrease of up to $350.2 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 $1.2 million for gas-fired instantaneous water heaters, in 2009$. 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 7 could result in a net loss of 39.8 percent in INPV for gas-fired and electric storage water heaters, a net loss of 4.2 percent in INPV for oil-fired storage water heaters, and a net loss of 0.2 percent in INPV for gas-fired instantaneous water heaters.

TSL 7 includes efficiency levels for the entire market of 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. As with TSL 8, the average savings for electric water heater customers estimated by DOE's analysis for TSL 7 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 outlined a number of concerns regarding the manufacturability and the market for heat pump water heaters in the December 2009 NOPR. 74 FR 65852, 65965 (Dec. 11, 2009). These included manufacturability, serviceability, the ability to retrofit existing installations, and potential impacts on the space conditioning loads in the house.

DOE further researched the heat pump water heater market for the final rule. Since the analysis was conducted for the December 2009 NOPR, several heat pump water heater models have been introduced into the market by major manufacturers. DOE's engineering analysis for the final rule confirmed that the use of heat pump water heaters adds dramatically to the MSP estimates, increasing the MSP more than $588 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 $915 for heat pump water heaters compared to traditional electric storage water heaters that use electric resistance heating elements.

In the December 2009 NOPR, DOE posed a series of questions for interested parties regarding the manufacturability of heat pump water heaters to meet the demands of the entire market (*i.e.,* approximately 5.8 million units). Even though DOE acknowledged in the December 2009 NOPR that 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 begun to offer a heat pump water heater model for sale, DOE questioned whether it was possible for manufacturers to convert all of their existing product lines over to produce heat pump water heaters within 5 years. 74 FR 65852, 65965 (Dec. 11, 2009). In response to DOE's question in the December 2009 NOPR, A.O. Smith, Rheem, and Bradford White all agreed that producing heat pump water heaters in the volumes necessary to service the market would be quite a transformation and investment for manufacturers. DOE estimates that it would take a total of $76 million in capital conversion costs and an additional $55 million in product conversion costs for the industry to offer exclusively HPWHs. In addition, the significantly higher production costs would require an additional $273 million in working capital to purchase 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 $404 million in an electric storage market valued at approximately $301 million. Furthermore, manufacturers would find it extremely difficult to create a service structure for over five million electric storage water heaters that use a relatively new technology by the compliance date of the final rule. Finally, DOE believes it is unlikely that manufacturers 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. Even with the ENERGY STAR incentive program, DOE's only projects the market penetration of heat pump water heaters will be 5 percent in 2015.

In the December 2009 NOPR, DOE questioned whether the service industry would be capable of providing the same level of service for heat pump water heaters that consumers are accustomed to receiving from a typical installer or repair person. 74 FR 65852, 65965 (Dec. 11, 2009). DOE sought input from commenters about whether reliable installation and servicing could be achieved on the scale needed by the compliance date of the amended standard. *Id.* As further detailed in section IV.B.2.b, DOE received comments supporting both sides of the arguments. Some manufacturers believe the training of service technicians and infrastructure needed to provide service to the heat pump water heating industry is not adequate and would not be available by the compliance date of the standard to serve the needs of the entire market. Others, including a manufacturer of heat pump water heaters, asserted that a nationwide network for heat pump water heater product service currently exists to service the limited heat pump water heater market today. Also, this manufacturer is currently developing a nationwide installation base to ensure that its consumers can readily purchase, install, and repair their heat pump water heaters. Other commenters pointed out that the skills needed to service heat pump water heaters are similar to the skill set of technicians in the residential refrigerator industry, which has an extensive servicing base.

While DOE believes that heat pump water heaters could require different servicing needs compared to traditional electric resistance storage water heaters, DOE also believes that the service industry will adapt to provide reliable installation, repair, and maintenance for heat pump water heaters by the compliance date of amended energy conservation standards for a subset of the entire market. Heat pump water heaters will require additional servicing needs for the sealed system portion of the unit. This includes handling a working refrigerant in addition to the typical plumbing type issues associated with residential water heaters. Even though DOE believes this additional servicing requirement can be adequately handled by a national servicing network of appliance technicians, DOE questions whether this can be done in the near-term at a level necessary to service the entire market.

In the December 2009 NOPR, DOE also questioned whether heat pump water heaters were capable of being installed in all types of installations currently serviced by the residential electric storage water heating market. 74 FR 65852, 65965 (Dec. 11, 2009). 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. In some indoor installations, the consumer needs to address space constraints issues, a requirement for sufficient air volume to maintain adequate operation of the water heater, and the impact of the water heater cooling off the space during the heating season. *Id.* DOE stated in the December 2009 NOPR that according to DOE's estimates, 12 percent of electric storage water heater consumers would experience an increase of more than $500 in their LCC compared to the base case. 74 FR 65852, 65965 (Dec. 11, 2009).

DOE strongly considered TSL 7 as the standard level for residential water heaters. Even though the commenters provided useful insight regarding the potential manufacturability, serviceability, and capabilities of these units to be installed in similar types of installations where current electric storage water heaters are located, DOE is still concerned about some of the issues identified in the December 2009 NOPR and outlined above regarding a national heat pump water heater standard. Specifically, DOE is still concerned about the ability for manufacturers to ramp up production in time to meet the demand by the compliance date of amended standards, the potentially large increases in total installed cost to certain consumers, the potential impacts on multi-family households, and the potential impacts on the heating and cooling load of the residence. Consequently, for today's final rule, the Secretary has concluded that at TSL 7, the benefits of energy savings, positive consumer NPV (at 3-percent discount rate), 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 significant fraction of consumers due to the large increases in total installed 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.

Next, DOE considered TSL 6, 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 to potentially save additional energy. Specifically, TSL 6 would effectively require heat pump technology for electric storage water heaters with a rated storage volume greater than 55 gallons and condensing technology for gas-fired storage water heaters with a rated storage volume greater than 55 gallons. For electric storage water heaters at TSL 6, DOE considered efficiency level 6 (*i.e.,* the lowest efficiency level DOE analyzed effectively requiring heat pump technology), instead of the max-tech efficiency level 7 for large water heaters, because at the time of the analysis, only one manufacturer had demonstrated the capability of reaching the efficiencies required by the max-tech energy efficiency equation for electric storage water heaters. Under this slightly lower efficiency level, manufacturers can better maintain design flexibility, and it encourages competition in the heat pump water heater market. DOE believes this level represents an efficiency level that is likely to result in efficient heat pump technologies, yet also maintains maximum flexibility regarding specific heat pump water heater designs. For electric storage water heaters with a rated storage volume of 55 gallons or less, TSL 6 also includes requirements which continue to allow the use of electric resistance elements. TSL 6 also includes requirements allowing atmospherically-vented gas-fired storage water heaters with a rated storage volume at or below 55 gallons. As an example, a gas-fired water heater with a rated storage volume of 40 gallons would be required to meet a 0.63 EF under TSL 6. As described above and further detailed below, this efficiency level, which is pushing the limits of atmospherically-vented gas-fired storage water heaters is where DOE has concerns over consumer safety for units with high recovery efficiencies in certain installations. These concerns are further described below.

TSL 6 would save 3.06 quads of energy, an amount DOE considers significant. Under TSL 6, the NPV of consumer benefit would be $1.01 billion, using a discount rate of 7 percent, and $9.08 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 6 are 209 Mt of CO_2, 159 kt of NO_X, and 0.704 t of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 6 is $714 million to $11,142 million. Total generating capacity in 2045 is estimated to decrease by 1.05 GW under TSL 6.

At TSL 6, DOE projects that the average LCC impact is a gain (consumer cost savings) of $9 for gas-fired storage water heaters, a gain of $64 for electric storage water heaters, a gain of $295 for oil-fired storage water heaters, and a gain of $9 for gas-fired instantaneous water heaters. The median payback period is 4.7 years for gas-fired storage water heaters, 6.8 years for electric storage water heaters, 0.5 years for oil-fired storage water heaters, and 14.8 years for gas-fired instantaneous water heaters. At TSL 6, the fraction of consumers experiencing an LCC benefit is 46 percent for gas-fired storage water heaters, 58 percent for electric storage water heaters, 53 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 34 percent for gas-fired storage water heaters, 33 percent for electric storage water heaters, 0 percent for oil-fired storage water heaters, and 5 percent for gas-fired instantaneous water heaters.

At TSL 6, the estimated average LCC savings for gas-fired storage water heaters are negative for multi-family households and manufactured home households, slightly negative for low-income households, and slightly positive for senior-only households. In the case of electric storage water heaters, the average LCC savings are positive for senior-only and low-income households, slightly negative for multi-family households, and negative for manufactured home households. In all cases except manufactured home households, a majority of the households in each subgroup experience a net benefit.

At TSL 6, the projected change in INPV ranges from a decrease of up to $134.6 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 $1.2 million for gas-fired instantaneous water heaters, in 2009$. 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 6 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 6 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 6 do not require substantial changes to the existing operations for some manufacturers. The significant changes to 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 6 could result in a net loss of 15.3 percent in INPV for gas-fired and electric storage water heaters, a net loss of 4.2 percent in INPV for oil-fired storage water heaters, and a net loss of 0.2 percent in INPV for gas-fired instantaneous water heaters.

DOE believes TSL 6 would provide an effective mechanism for increasing the market penetration for advanced-technology water heaters. Given DOE's concerns with TSL 7 (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 adopting TSL 6. TSL 6 results in positive NPV of consumer benefit for both electric and gas-fired storage water heaters, while also providing considerable 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 6 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 6 division. Compared to TSL 7, TSL 6 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 structural 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 LCC savings and shorter 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 8), TSL 6 requires condensing technology for a relatively small fraction of the gas-fired storage water heater market, reduces the number of installations that require significant building modifications due to the size of condensing gas-fired water heaters, and results in higher average LCC savings and shorter median payback period.

Although DOE has identified a number of benefits associated with TSL 6, DOE is aware that there are multiple issues associated with promulgating an amended energy conservation standard at this level. Potential issues with TSL 6 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. DOE fully discusses each of these in great detail in the December 2009 NOPR. 74 FR 65852, 65966–67 (Dec. 11, 2009). The lack of clarity on many of these issues contributed to DOE's tentative conclusion at the NOPR stage that a determination could not be made that NOPR TSL 5 (which contained different standards based upon the 55-gallon capacity division) is economically justified. However, comments and other information on these issues in response to the NOPR allowed DOE to make a more informed decision for the final rule.

As far as consumer acceptance, DOE questioned whether consumers may elect not to buy the larger-volume water heaters for a number of reasons (*e.g.,* including increases in first costs, unfamiliarity with the product, or space-constraint issues) and instead buy multiple water heaters that are under the capacity limit in the December 2009 NOPR. 74 FR 65852, 65967 (Dec. 11, 2009). In the final rule, DOE has now accounted for the equipment switching to lower rated storage volume water heaters in its analysis. DOE believes it has captured any potential impacts from that fraction of consumers who might elect to install one or two smaller water heaters. DOE derived the fraction of households which could switch from a large water heater to two smaller water heaters by comparing the total installed costs. DOE also considered the feasibility of switching a large water heater to a smaller water heater based on hot water needs of the household. DOE also took into consideration other factors such as whether some households would account for the operating cost advantages, need for emergency replacement, and avoiding costly venting system modifications when also installing a condensing gas furnace. *See* section IV.G.2.d for additional details.

As far as the reliable installation, servicing, and repair network that would be needed to service the market, DOE believes TSL 6 mitigates these problems for the reasons that follow. Because TSL 6 only impacts at most 9 percent of the electric storage water heater market, DOE believes the service industry will be able to provide adequate service to this subset of consumers. In addition, DOE believes that with the ENERGY STAR program and major water heater manufacturers continuing to introduce products into the market, the service industry will also continue to evolve. Given that this standard level does not impact the entire market and with the 5-year lead time, DOE believes the service industry will be able to properly train technicians and provide a nationwide network, which includes plumbers and refrigeration technicians to properly service heat pump water heaters by 2015.

As far as manufacturability, DOE estimates that it would take a total of $14.2 million and $26.1 million in capital conversion costs and product conversion costs for the industry to offer condensing products and heat pump water heaters for units with rated storage volumes above 55-gallons, respectively. While the total required investments (including working capital) to manufacture exclusively HPWHs greatly exceed the total industry value, the total conversion costs for converting only products with rated storage volumes above 55-gallons represent just 2.4 percent and 8.7 percent of the total value of the gas-fired and electric storage markets, respectively. Additionally, TSL 6 requires far less investment in working capital than TSL 7. Specifically, as compared to the $273 million required by TSL 7 for electric storage water heaters, TSL 6 would necessitate an investment of $45 million. Similarly, for gas-fired storage water heaters, TSL 8 requires an increase of $177 million in working capital needs, while TSL 6 requires an increase of $20 million. These much higher investments at TSL 7 and TSL 8, relative to TSL 6, are reflected in the mitigated INPV impacts shown in the MIA results.

DOE also believes that manufacturers would be better able to make the technological changes required at TSL 6 than TSL 7 before the compliance date, due, in part, to the experience of all three major manufacturers in producing large-volume condensing products for the commercial sector. DOE believes manufacturers can rely on this experience to adapt to TSL 6 to an extent they could not at TSL 8, at which smaller-volume products would also have to be converted. Furthermore, two of the three major manufacturers have some experience in manufacturing heat pump water heaters for the residential sector. The efficiency requirements for products only above 55-gallons rated storage volume would not require manufacturers to greatly alter most of their existing production lines. DOE believes that manufactures would create separate production lines for these products, which would be less disruptive to current facilities. In addition, five years should offer enough lead time for the product development and capital changes for these larger-rated-volume products. Lastly, DOE believes that manufacturers would be more likely to maintain an historic level of return on investment on large-volume products, relative to small-volume products, because that market contains a greater mix of high-end consumers.

DOE strongly considered TSL 6 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, TSL 6 also includes a level for gas-fired storage water heaters with rated storage volumes at or below 55 gallons that has caused DOE some reservations related to consumer safety. These concerns came to light during the course of DOE's consideration of public comments on the NOPR. Specifically, TSL 6 for smaller-volume gas-fired storage water heaters effectively continues to allow the use of atmospherically-vented technology. DOE reviewed the current market at 40 gallons rated storage volume and two current designs offered at a 0.63 EF: (1) An atmospherically-vented unit and (2) a fan-assisted unit. Over 50 percent of these models have corresponding recovery efficiencies at or above 78 percent.

The efficiency of a gas-fired water heater is characterized by a number of factors, including the energy factor, the first hour rating, and the recovery efficiency. For atmospherically-vented gas-fired storage water heaters, manufacturers primarily modify either the insulation thickness to increase the energy factor or the baffling to increase the recovery efficiency. The recovery efficiency characterizes how efficiently the heat from the energy source is transferred to the water. For each design and energy factor analyzed by DOE, manufacturers offer units in a range of recovery efficiencies. As the recovery efficiency increases, the risk for condensation to occur in the vent increases. Recovery efficiencies at or above 78 percent present a potential safety risk if condensation occurs in certain installations and the proper venting has not been installed in the residence, thereby potentially allowing carbon monoxide to enter and build up in the living space.

As explained in section IV.F.2.a above, DOE's analysis assumed that installations with water heaters with recovery efficiency of 78 percent or higher (which accounted for 57 percent of installations at TSL 6) would use stainless steel vent connectors. Without such vent connectors, there is a potential for corrosion of the vent due to condensation of flue gases. At present, however, the National Fuel Gas Code venting tables that are used as guidelines for installation are based on assumed recovery efficiencies of 76 percent, and they do not mention use of stainless steel vent connectors. Therefore, there is a possibility that some installations could occur without use of stainless steel vent connectors.

DOE found that there are several 40-gallon gas-fired water heater models corresponding to TSL 6 efficiency levels that are currently available to consumers and that do not utilize power venting. These models do not have any venting or installation instructions directing installers to use special venting (other than what is already required by the National Fuel Gas Code and/or local codes) for these products, and it is unclear why the concerns raised have not been an issue for these products currently available on the market.

However, in considering the adoption of a minimum standard for gas-fired water heaters at TSL 6 with rated storage volumes at or below 55 gallons, DOE believes there may be an increased risk of potential safety concerns due to improper installation of units with high recovery efficiencies. While DOE realizes there are units with recovery efficiencies offered in a range of energy factors, DOE also believes this risks increases as the limits of atmospherically-vented technology are reached.

Ideally, DOE believes the National Fuel Gas Code venting tables should be modified to properly address condensation-related issues for the units on the market with recovery efficiencies at or above 76 percent. This would include a recommendation to use stainless steel vent connectors at these recovery efficiencies regardless of energy factor and in order to mitigate most of the safety concerns for atmospherically-vented units. However, DOE cannot be certain whether such changes would occur before the compliance date of amended energy conservation standards for water heaters. Thus, in practice, there remains the possibility that some installations of TSL 6 gas-fired water heaters with recovery efficiencies at or above 78 percent would not use stainless steel vent connectors, which could result in safety problems in a likely small, but uncertain, number of cases.

Therefore, for today's final rule, the Secretary tentatively concludes that at TSL 6, the benefits of energy savings, positive consumer NPV, generating capacity reductions, economic savings for most consumers, and emission reductions would be outweighed the large capital conversion costs that could result in a large reduction in INPV for the manufacturers, the negative impacts on some consumer groups, and the safety concerns due to the corrosive condensate forming in the venting system of specific installations.

Next, DOE considered TSL 5, which is very similar to TSL 6 except that it considers a lower efficiency level for gas-fired storage water heaters with rated storage volumes less than or equal to 55 gallons. TSL 5 still pairs 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 to potentially save additional energy. Specifically, TSL 5 would effectively require heat pump technology for electric storage water heaters with rated storage volumes greater than 55 gallons and condensing technology for gas-fired storage water heaters with rated storage volumes greater than 55 gallons. For gas-fired water heaters at TSL 5, DOE analyzed energy efficiency level 1 for small-volume units due to the potential safety concerns with corrosive condensate formation.

TSL 5 would save 2.58 quads of energy, an amount DOE considers significant. Under TSL 5, the NPV of consumer benefit would be $1.39 billion, using a discount rate of 7 percent, and $8.67 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 5 are 154 Mt of CO_2, 116 kt of NO_X, and 0.553 t of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 5 is $524 million to $8,179 million. Total generating capacity in 2045 is estimated to decrease by 0.83 GW under TSL 5.

At TSL 5, DOE projects that the average LCC impact is a gain (consumer cost savings) of $18 for gas-fired storage water heaters, a gain of $64 for electric storage water heaters, a gain of $295 for oil-fired storage water heaters, and a gain of $9 for gas-fired instantaneous water heaters. The median payback period is 2.3 years for gas-fired storage water heaters, 6.8 years for electric storage water heaters, 0.5 years for oil-fired storage water heaters, and 14.8 years for gas-fired instantaneous water heaters. At TSL 5, the fraction of consumers experiencing an LCC benefit is 40 percent for gas-fired storage water heaters, 58 percent for electric storage water heaters, 53 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 27 percent for gas-fired storage water heaters, 33 percent for electric storage water heaters, 0 percent for oil-fired storage water heaters, and 5 percent for gas-fired instantaneous water heaters.

At TSL 5, the estimated average LCC savings for gas-fired storage water heaters are slightly negative for multi-family households and manufactured home households, and slightly positive for senior-only households and low-income households. For all of the subgroups, a higher share of households have a net benefit than have a net cost. In the case of electric storage water heaters, the average LCC savings are positive for senior-only and low-income households, slightly negative for multi-family households, and negative for manufactured home households. In all cases except manufactured home households, a majority of the households in each subgroup experience a net benefit.

At TSL 5, the projected change in INPV ranges from a decrease of up to $122.6 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 $1.2 million for gas-fired instantaneous water heaters, in 2009$. 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 gallons 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 to 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 13.9 percent in INPV for gas-fired and electric storage water heaters, a net loss of 4.2 percent in INPV for oil-fired storage water heaters, and a net loss of 0.2 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 7 (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 adopting TSL 5. TSL 5 results in positive NPV of consumer benefit for both electric and gas-fired storage water heaters, and provides substantial energy and carbon savings, while mitigating some of the issues associated with a national heat pump water heater standard (TSL 7). Moreover, TSL 5 also reduces the risk of safety concerns for small-volume gas-fired storage water heaters by providing manufacturers with additional flexibility in reaching TSL 5 efficiency levels.

Therefore, for today's final rule, the Secretary has concluded that at TSL 5, the benefits of energy savings, positive consumer NPV, generating capacity reductions, economic savings for most consumers, and emission reductions (both in physical quantities and the monetized value of those emissions) outweigh the large capital conversion costs that could result in a large reduction in INPV for the manufacturers and the negative impacts on some consumer subgroups. Further, global benefits from carbon dioxide reductions (at a central value of $21.4 per ton for emissions in 2010) would have a present value of $2.7 billion. These benefits from carbon dioxide emission reductions, when considered in conjunction with the consumer savings NPV and other factors described above, support DOE's conclusion that TSL 5 is economically justified. Consequently, DOE is adopting TSL 5 for residential water heaters. Table VI.64 shows the standard levels DOE is adopting today for residential water heaters.

TABLE VI.64—AMENDED ENERGY CONSERVATION STANDARDS FOR RESIDENTIAL WATER HEATERS

Residential Water Heaters		
Product Class	Standard Level	
Gas-fired Storage	For tanks with a Rated Storage Volume at or below 55 gallons: EF = 0.675 − (0.0015 × Rated Storage Volume in gallons).	For tanks with a Rated Storage Volume above 55 gallons: EF = 0.8012 − (0.00078 × Rated Storage Volume in gallons)
Electric Storage	For tanks with a Rated Storage Volume at or below 55 gallons: EF = 0.960 − (0.0003 × Rated Storage Volume in gallons).	For tanks with a Rated Storage Volume above 55 gallons: EF = 2.057 − (0.00113 × 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)	

3. Direct Heating Equipment

Table VI.65 summarizes the results of DOE's quantitative analysis for each TSL it considered for this final rule for direct heating equipment.

TABLE VI.65—SUMMARY OF ANALYTICAL RESULTS FOR DIRECT HEATING EQUIPMENT

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
National Energy Savings (quads)	0.20	0.21	0.23	0.43	0.48	1.26
NPV of Consumer Benefits (2009$ billion)						
3% discount rate	1.32	1.34	1.39	(1.26)	(1.22)	(4.97)

TABLE VI.65—SUMMARY OF ANALYTICAL RESULTS FOR DIRECT HEATING EQUIPMENT—Continued

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
7% discount rate	0.54	0.55	0.56	(1.19)	(1.24)	(4.38)
Industry Impacts:						
Traditional Direct Heating Equipment:.						
Industry NPV (2009$ million)	(0.9)–(2.5)	(1.2)–(3.9)	(1.9)–(7.0)	(1.9)–(8.8)	(3.8)–(10.4)	(3.9)–(13.4)
Industry NPV (% change)	(5.2)–(14.9)	(7.2)–(23.6)	(11.3)–(42.4)	(11.6)–(53.1)	(22.7)–(64.2)	(23.6)–(80.8)
Gas Hearth Direct Heating Equipment:.						
Industry NPV (2009$ million)	(0.2)–(0.9)	(0.2)–(0.9)	(0.2)–(0.9)	1.6–(13.2)	1.6–(13.2)	8.6–(53.6)
Industry NPV (% change)	(0.3)–(1.2)	(0.3)–(1.2)	(0.3)–(1.2)	2.0–(17.1)	2.0–(17.1)	11.1–(69.5)
Cumulative Emissions Reduction*:						
CO_2 (Mt)	8.2	8.8	9.3	17.9	20.2	49.9
NO_X (kt)	7.5	8.1	8.5	16.4	18.6	46.0
Value of Cumulative Emissions Reduction (2009$ million) ††:						
CO_2	31–470	33–503	35–530	67–1,023	76–1,154	187–2,849
NO_X–3% discount rate	1.9–19.6	2.0–21.0	2.1–22.1	4.2–42.9	4.7–48.7	11.7–120
NO_X–7% discount rate	0.99–10.2	1.06–10.9	1.1–11.4	2.2–22.3	2.5–25.3	6.1–62.5
Mean LCC Savings ** (2009$):						
Gas Wall Fan	83	102	114	43	83	43
Gas Wall Gravity	21	21	64	64	(56)	(56)
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	2.7	3.2	5.0	12.2	2.7	12.2
Gas Wall Gravity	7.5	7.5	11.0	11.0	16.5	16.5
Gas Floor	10.7	10.7	10.7	10.7	10.7	10.7
Gas Room	6.7	4.5	4.8	4.8	6.9	6.9
Gas Hearth	0	0	0	17.1	17.1	26.8
Distribution of Consumer LCC Impacts:						
Gas Wall Fan:.						
Net Cost (%)	0	3	19	53	0	53
No Impact (%)	60	53	26	7	60	7
Net Benefit (%)	40	44	55	40	40	40
Gas Wall Gravity:						
Net Cost (%)	10	10	33	33	70	70
No Impact (%)	75	75	37	37	0	0
Net Benefit (%)	15	15	30	30	30	30
Gas Floor:						
Net Cost (%)	25	25	25	25	25	25
No Impact (%)	18	18	18	18	18	18
Net Benefit (%)	57	57	57	57	57	57
Gas Room:						
Net Cost (%)	19	19	20	20	26	26
No Impact (%)	31	56	55	55	49	49
Net Benefit (%)	50	25	25	25	25	25
Gas Hearth:						
Net Cost (%)	9	9	9	69	69	81
No Impact (%)	40	40	40	17	17	19
Net Benefit (%)	51	51	51	13	13	0
Generation Capacity Change (GW in 2042)	0.024	0.026	0.028	0.036	0.041	0.103
Employment Impacts:						
Total Potential Changes in Domestic Production Workers in 2013:.						
Traditional Direct Heating Equipment	(275)–4	(275)–6	(275)–33	(275)–37	(275)–35	(275)–44
Gas Hearth Direct Heating Equipment	(1,280)–6	(1,280)–6	(1,280)–6	(1,280)–448	(1,280)–448	(1,280)–770
Net Change in National Indirect Employment in 2042 (thousands) †††	0.21	0.22	0.23	0.16	0.19	0.51

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.
†† Range of the economic value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions.
††† National Indirect Employment Impacts exclude direct impacts.

DOE first considered TSL 6, the max-tech level. TSL 6 would save 1.26 quads of energy, an amount DOE considers significant. TSL 6 would decrease consumer NPV by $4.38 billion, using a discount rate of 7 percent, and by $4.97 billion, using a discount rate of 3 percent.

The emissions reductions at TSL 6 are 49.9 Mt of CO_2 and 46.0 kt of NO_X. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 6 is $187 million to $2,849 million. Total generating capacity in 2042 is estimated to increase slightly under TSL 6.

At TSL 6, DOE projects that the average LCC impact for consumers is a gain of $43 for gas wall fan DHE, a loss of $56 for gas wall gravity DHE, a gain of $13 for gas floor DHE, a gain of $646 for gas room DHE, and a loss of $253 for gas hearth DHE. The median payback period is 12.2 years for gas wall fan DHE, 16.5 years for gas wall gravity DHE, 10.7 years for gas floor DHE, 6.9 years for gas room DHE, and 26.8 years 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 40 percent for gas wall fan DHE, 30 percent for gas wall gravity DHE, 57 percent for gas floor DHE, 25 percent for gas room DHE, and 0 percent for gas hearth DHE. The fraction of consumers experiencing an LCC cost is 53 percent for gas wall fan DHE, 70 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.

With respect to consumer subgroups, DOE estimated that the impacts of TSL 6 would be approximately the same for the senior-only and low-income subgroups as they are for the full household sample.

At TSL 6, the projected change in INPV ranges from a decrease of up to $13.4 million for traditional DHE and a decrease of up to $53.6 million for gas hearth DHE, in 2009$. 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 80.8 percent in INPV for traditional DHE and a net loss of 69.5 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 business manufacturers in both the traditional and gas hearth DHE market. The conversion costs could cause many of these small business manufacturers to exit the market.

Therefore, the Secretary concludes that at TSL 6, the benefits of energy savings 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 business manufacturers. Consequently, the Secretary has concluded that TSL 6 is not economically justified.

Next, DOE considered TSL 5. TSL 5 would save 0.48 quads of energy, an amount DOE considers significant. TSL 5 would decrease consumer NPV by $1.24 billion, using a discount rate of 7 percent, and by $1.22 billion, using a discount rate of 3 percent.

The emissions reductions at TSL 5 are 20.2 Mt of CO_2 and 18.6 kt of NO_X. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 5 is $76 million to $1,154 million. Total generating capacity in 2042 is estimated to increase slightly under TSL 5.

At TSL 5, DOE projects that the average LCC impact for consumers is a gain of $83 for gas wall fan DHE, a loss of $56 for gas wall gravity DHE, a gain of $13 for gas floor DHE, a gain of $646 for gas room DHE, and a loss of $70 for gas hearth DHE. The median payback period is 2.7 years for gas wall fan DHE, 16.5 years for gas wall gravity DHE, 10.7 years for gas floor DHE, 6.9 years for gas room DHE, and 17.1 years for gas hearth DHE. At TSL 5, the fraction of consumers experiencing an LCC benefit is 40 percent for gas wall fan DHE, 30 percent for gas wall gravity DHE, 57 percent for gas floor DHE, 25 percent for gas room DHE, and 13 percent for gas hearth DHE. The fraction of consumers experiencing an LCC cost is 0 percent for gas wall fan DHE, 70 percent for gas wall gravity DHE, 25 percent for gas floor DHE, 26 percent for gas room DHE, and 69 percent for gas hearth DHE.

With respect to consumer subgroups, DOE estimated that the impacts of TSL 5 would be approximately the same for the senior-only and low-income subgroups as they are for the full household sample.

At TSL 5, the projected change in INPV ranges from a decrease of up to $10.4 million for traditional DHE and a decrease of up to $13.2 million for gas hearth DHE, in 2009$. 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 62.4 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 business manufacturers 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.

Therefore, the Secretary concludes that at trial standard level 5, the benefits of energy savings 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 business manufacturers to have to reduce or discontinue a significant number of their product lines. Consequently, the Secretary has concluded that trial standard level 5 is not economically justified.

Next, DOE considered TSL 4. TSL 4 would save 0.43 quads of energy, an amount DOE considers significant. TSL 4 would decrease consumer NPV by $1.19 billion, using a discount rate of 7 percent, and $1.26 billion, using a discount rate of 3 percent.

The emissions reductions at TSL 4 are 17.9 Mt of CO_2 and 16.4 kt of NO_X. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 4 is $67 million to $1,023 million. Total generating capacity in 2042 is estimated to increase slightly under TSL 4.

At TSL 4, DOE projects that the average LCC impact for consumers is a gain of $43 for gas wall fan DHE, a gain of $64 for gas wall gravity DHE, a gain of $13 for gas floor DHE, a gain of $143 for gas room DHE, and a loss of $70 for gas hearth DHE. The median payback period is 12.2 years for gas wall fan DHE, 11.0 years for gas wall gravity DHE, 10.7 years for gas floor DHE, 4.8 years for gas room DHE, and 17.1 years for gas hearth DHE. At TSL 4, the fraction of consumers experiencing an LCC benefit is 40 percent for gas wall fan DHE, 30 percent for gas wall gravity DHE, 57 percent for gas floor DHE, 57 percent for gas room DHE, and 13 percent for gas hearth DHE. The fraction of consumers experiencing an LCC cost is 53 percent for gas wall fan DHE, 33 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.

With respect to consumer subgroups, DOE estimated that the impacts of TSL 4 would be approximately the same for the senior-only and low-income subgroups as they are for the full household sample.

At TSL 4, the projected change in INPV ranges from a decrease of up to $8.8 million for traditional DHE and decrease of up to $13.2 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 53.1 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 business manufacturers in both the traditional and gas hearth DHE market. These manufacturers could be forced to reduce their product offerings to remain competitive.

Therefore, the Secretary concludes that at trial standard level 4, the benefits of energy savings 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 business manufacturers of DHE to have to reduce their product offerings. Consequently, the Secretary has concluded that trial standard level 4 is not economically justified.

Next, DOE considered TSL 3. TSL 3 would save 0.23 quads of energy, an amount DOE considers significant. TSL 3 would provide an NPV of consumer benefit of $0.56 billion, using a discount rate of 7 percent, and $1.39 billion, using a discount rate of 3 percent.

The emissions reductions at TSL 3 are 9.3 Mt of CO_2 and 8.5 kt of NO_X. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 3 is $35 million to $530 million. Total electric generating capacity in 2042 is estimated to increase slightly under TSL 3.

At TSL 3, DOE projects that the average LCC impact for consumers is a gain of $114 for gas wall fan DHE, a gain of $64 for gas wall gravity DHE, a gain of $13 for gas floor DHE, a gain of $143 for gas room DHE, and a gain of $96 for gas hearth DHE. The median payback period is 5.0 years for gas wall fan DHE, 11.0 years for gas wall gravity DHE, 10.7 years for gas floor DHE, 4.8 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 55 percent for gas wall fan DHE, 30 percent for gas wall gravity DHE, 57 percent for gas floor DHE, 25 percent for gas room DHE, and 51 percent for gas hearth DHE. The fraction of consumers experiencing an LCC cost is 19 percent for gas wall fan DHE, 33 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.

With respect to consumer subgroups, DOE estimated that the impacts of TSL 3 would be approximately the same for the senior-only and low-income subgroups as they are for the full household sample.

At TSL 3, the projected change in INPV ranges from a decrease of up to $7 million for traditional DHE and decrease of up to $0.9 million for gas hearth DHE. If the high end of the range of impacts is reached, TSL 3 could result in a net loss of 42.4 percent in INPV for traditional DHE and a net loss of 1.2 percent in INPV for gas hearth DHE. The impacts on gas hearth DHE 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.

For traditional direct heating equipment, however, not all manufacturers have a substantial number of existing products that meet the efficiencies required at TSL 3. The industry has consolidated significantly over the last decade due to a steady decline in shipments. The three competitors that account for nearly 100 percent of the market have survived by consolidating a variety of legacy brands and products and providing them in replacement situations. Thus, each of the three competitors, two of which are small business manufacturers, would face the prospect of significantly upgrading several low-volume product lines. For the most part, manufacturers do not have significant volume over which to spread the capital conversion costs required by TSL 3, meaning that margins will likely be pressured unless consumers accept large increases in product price. As a whole, DOE expects the industry would be required to invest $8.0 million to convert its product lines to meet TSL 3, or roughly half of the industry value. Because shipments are expected to remain flat or continue to decline, there may be limited opportunity for all manufacturers to recoup the investment necessary at TSL 3 to upgrade their product lines.

At TSL 3, the impacts on small business manufacturers are even more harmful than to the industry as a whole. For example, the typical small business manufacturer in the industry would require investment equal to 426 percent of its annual earnings before interest and taxes. With these prospects, it is likely manufacturers would drop a number of product lines or exit the market entirely. The small business manufacturers would likely be disproportionately affected by TSL 3 because they would need to spread the product development costs, including R&D, over lower volumes. Finally, in the important gas wall gravity category, small business manufacturers have a limited number of products that meet the required efficiencies. The two small business manufacturers with significant market shares have a total of 6 models that meet the required efficiencies out of a total of 29 models for gas wall gravity DHE. Based on the public comments of these small manufacturers, these products also represent a small percentage of total sales. To offer a full range of the most popular replacements, a typical small manufacturer would have to convert over 70 percent of its gas wall gravity product lines, including multiple modifications to their most popular products.

Therefore, the Secretary concludes that at TSL 3, the benefits of energy savings, emission reductions, and consumer NPV benefits would be outweighed by the economic burden on some consumers, the large capital conversion costs that could result in a large reduction in INPV for the manufacturers of traditional DHE, and the potential for small business manufacturers of DHE to reduce their product offerings or to be forced to exit the market completely, thereby reducing competition in the traditional DHE market. Consequently, the Secretary has concluded that TSL 3 is not economically justified.

Next, DOE considered TSL 2. TSL 2 would save 0.21 quads of energy, an amount DOE considers significant. TSL 2 would provide a NPV of consumer benefit of $0.55 billion, using a discount rate of 7 percent, and $1.34 billion, using a discount rate of 3 percent.

The emissions reductions at TSL 2 are 8.8 Mt of CO_2 and 8.1 kt of NO_X. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 2 is $33 million to $503 million. Total electric generating capacity in 2042 is estimated to increase slightly under TSL 2.

At TSL 2, DOE projects that the average LCC impact for consumers is a gain of $102 for gas wall fan DHE, a gain of $21 for gas wall gravity DHE, a gain of $13 for gas floor DHE, a gain of $96 for gas room DHE, and a gain of $96 for gas hearth DHE. The median payback period is 3.2 years for gas wall fan DHE, 7.5 years for gas wall gravity DHE, 10.7 years for gas floor DHE, 4.5 years for gas room DHE, and 0.0 years for gas hearth DHE. At TSL 2, the fraction of consumers experiencing an LCC benefit is 44 percent for gas wall fan DHE, 15 percent for gas wall gravity DHE, 57 percent for gas floor DHE, 25 percent for gas room DHE, and 51 percent for gas hearth DHE. The fraction of consumers experiencing an LCC cost is 3 percent for gas wall fan DHE, 10 percent for gas wall gravity DHE, 25 percent for gas floor DHE, 19 percent for gas room DHE, and 9 percent for gas hearth DHE.

With respect to consumer subgroups, DOE estimated that the impacts of TSL 2 would be approximately the same for the senior-only and low-income subgroups as they are for the full household sample.

At TSL 2, the projected change in INPV ranges from a decrease of up to $3.9 million for traditional DHE and decrease of up to $0.9 million for gas hearth DHE. The impacts on gas hearth DHE manufacturers are less significant at TSL 2 because manufacturers offer a wide range of product lines that meet the required efficiencies at TSL 2, and most products that do not meet TSL 2 could be upgraded with inexpensive purchased parts at fairly small conversion costs. If the high end of the range of impacts is reached, TSL 2 could result in a net loss of 23.6 percent in INPV for traditional DHE and a net loss of 1.2 percent in INPV for gas hearth DHE. In addition, the required capital and product conversion costs faced by small business manufacturers at this level decrease substantially, thereby mitigating the potential harm to a significant number of small business manufacturers.

In total, DOE estimates that it will take approximately $4.6 million for the industry to upgrade all of it products to meet the amended energy conservation standards. Despite including the conversion costs for the additional product lines that were released since the NOPR analysis was completed, the total conversion costs estimated by the industry to upgrade all products that do not meet the amended energy conservation standards is down $1.8 million from the $6.4 million total estimated for the proposed standards in the December 2009 NOPR, given the change in the standard level DOE has ultimately decided to adopt. For the amended energy conservation standards, one major manufacturer has a total of 3 product lines (7 models) that do not meet the amended energy conservation standards in the two smallest categories (gas floor and gas room DHE) but has a majority of product lines and models that meet the amended standards in the two largest product categories (gas wall fan and gas wall gravity). The other two major manufacturers have existing product lines that meet the amended energy conservation standards in all 4 product categories. Therefore, without spending any conversion costs, at least two manufacturers already have existing products in all four product categories. In the most important gas wall gravity category, 57 percent of the existing models and 71 percent of the existing product lines identified by DOE meet the amended energy conservation standards. One manufacturer indicated in written comments that the important gas wall gravity products that meet the amended energy conversation standard represent a small portion of total sales. However, DOE believes it has addressed the concerns of this manufacturer by setting an amended energy conservation standard that would require much less substantial changes than those proposed in the NOPR (a two percentage point improvement in AFUE versus the six percentage point improvement proposed in the NOPR). While the $4.6 million in total conversion costs to upgrade all product lines that do not meet the amended energy conservation standards is substantial, DOE believes that a combination of products that meet the amended energy conservation standards and selectively upgrading popular product lines that fall below the standards will allow all three traditional DHE manufacturers to maintain a viable production volume.

After considering the analysis, comments on the December 2009 NOPR, and the benefits and burdens of TSL 2, the Secretary 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, global benefits from carbon dioxide reductions (at a central value of $21.4 for emissions in 2010) would have a present value of $165 million. These benefits from carbon dioxide emission reductions (both in physical reductions and the monetized value of those reductions), when considered in conjunction with the consumer savings NPV and other factors described above, outweigh the potential reduction in INPV for manufacturers and support DOE's conclusion that trial standard level 2 is economically justified. Therefore, the Department today adopts the energy conservation standards for direct heating equipment at TSL 2, as shown in Table VI.66.

TABLE VI.66—AMENDED ENERGY CONSERVATION STANDARDS FOR DIRECT HEATING EQUIPMENT

Direct heating equipment	
Product class	Standard level
Gas wall fan type up to 42,000 Btu/h	AFUE = 75%.
Gas wall fan type over 42,000 Btu/h	AFUE = 76%.
Gas wall gravity type up to 27,000 Btu/h	AFUE = 65%.
Gas wall gravity type over 27,000 Btu/h up to 46,000 Btu/h	AFUE = 66%.
Gas wall gravity type over 46,000 Btu/h	AFUE = 67%.

TABLE VI.66—AMENDED ENERGY CONSERVATION STANDARDS FOR DIRECT HEATING EQUIPMENT—Continued

Direct heating equipment	
Product class	Standard level
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 = 61%.
Gas room over 20,000 Btu/h up to 27,000 Btu/h	AFUE = 66%.
Gas room over 27,000 Btu/h up to 46,000 Btu/h	AFUE = 67%.
Gas room over 46,000 Btu/h	AFUE = 68%.
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%.

4. Pool Heaters

Table VI.67 summarizes the results of DOE's quantitative analysis for each TSL it considered for this final rule for pool heaters.

TABLE VI.67—SUMMARY OF ANALYTICAL RESULTS FOR POOL HEATERS

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
National Energy Savings (quads)	0.01	0.02	0.04	0.06	0.09	0.22
NPV of Consumer Benefits (2009$ billion)						
3% discount rate	0.10	0.10	(0.01)	(0.15)	(2.32)	(4.56)
7% discount rate	0.04	0.04	(0.06)	(0.16)	(1.39)	(2.87)
Industry Impacts						
Industry NPV (2009$ million)	0.0–(0.1)	0.3–(0.8)	(0.8)–(5.0)	(0.3)–(6.6)	0.8–(17.2)	7.3–(38.3)
Industry NPV (% change)	0.1–(0.2)	0.5–(1.7)	(1.7)–(10.2)	(0.6)–(13.5)	1.6–(35.0)	14.9–(78.0)
Cumulative Emissions Reduction *						
CO_2 (Mt)	0.41	0.75	1.72	2.38	3.61	8.89
NO_X (kt)	0.37	0.67	1.53	2.10	3.18	7.84
Value of Cumulative Emissions Reduction (2009$ million) ††						
CO_2	2 to 24	3 to 43	6 to 99	9 to 136	14 to 206	33 to 509
NO_X—3% discount rate	0.1 to 1.0	0. 2 to 1.8	0.4 to 4.1	0.5 to 5.6	0.8 to 8.4	2.0 to 20.77
NO_X—7% discount rate	0.1 to 0.5	0.1 to 0.9	0.2 to 2.2	0.29 to 2.9	0.4 to 4.5	1.1 to 11.0
Mean LCC Savings ** (2009$).	25	22	(6)	(52)	(632)	(1,361)
Median PBP (years)	2.7	8.6	18.2	19.2	38.1	33.2
Distribution of Consumer LCC Impacts						
Net Cost (%)	5	27	60	64	88	95
No Impact (%)	72	51	23	21	9	1
Net Benefit (%)	23	22	17	15	3	4
Generation Capacity Change (GW in 2042).	0.00	0.00	0.00	+0.01	+0.01	+0.03
Employment Impacts						
Total Potential Changes in Domestic Production Workers in 2013.	(512)–7	(512)–19	(512)–58	(512)–81	(512)–135	(512)–268
Net Change in National Indirect Employment in 2042 (thousands) †††.	0.01	0.02	0.02	0.02	0.04	(0.07)

Parentheses indicate negative (−) values.
* The impacts for Hg emissions are negligible.
** For LCCs, a negative value means an increase in LCC by the amount indicated.
†† Range of the economic value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions.
††† National Indirect Employment Impacts exclude direct impacts.

DOE first considered TSL 6, the max-tech level. TSL 6 would save 0.22 quads of energy, an amount DOE considers significant. TSL 6 would decrease consumer NPV by $2.87 billion, using a discount rate of 7 percent, and by $4.56 billion, using a discount rate of 3 percent.

The emissions reductions at TSL 6 are 8.89 Mt of CO_2 and 7.84 kt of NO_X. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 6 is $33 million to $509 million, using a discount rate of 7 percent. Total generating capacity in 2042 is estimated to increase slightly under TSL 6.

At TSL 6, DOE projects that the average LCC impact for consumers is a loss of $1,361. The median payback period is 33.2 years (which is substantially longer than the mean lifetime of the product). At TSL 6, the fraction of consumers experiencing an LCC benefit is 4 percent. The fraction of consumers experiencing an LCC cost is 95 percent.

At TSL 6, the INPV is projected to decrease by up to $38.3 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 78 percent in INPV for gas-fired pool heaters.

Therefore, the Secretary has concluded that at TSL 6, the benefits of energy savings and emission reductions would be outweighed by the negative impacts on consumer NPV, 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 concluded that TSL 6 is not economically justified.

Next, DOE considered TSL 5. TSL 5 would save 0.09 quads of energy, an amount DOE considers significant. TSL 5 would decrease consumer NPV by $1.39 billion, using a discount rate of 7 percent, and by $2.32 billion, using a discount rate of 3 percent.

The emissions reductions at TSL 5 are 3.6 Mt of CO_2 and 3.2 kt of NO_X. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 5 is $14 million to $206 million. Total generating capacity in 2042 is estimated to increase slightly under TSL 5.

At TSL 5, DOE projects that the average LCC impact for consumers is a loss of $632. The median payback period is 38.1 years (which is substantially longer than the mean lifetime of the product). At TSL 5, the fraction of consumers experiencing an LCC benefit is 3 percent. The fraction of consumers experiencing an LCC cost is 88 percent.

At TSL 5, the projected change in INPV is a decrease of up to $17.2 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 35 percent in INPV for gas-fired pool heaters.

Therefore, the Secretary has concluded that at TSL 5, the benefits of energy savings and emission reductions would be outweighed by the negative impacts on consumer NPV, the economic burden on some consumers, and the large capital conversion costs that could result in a large reduction in INPV for the manufacturers. Consequently, the Secretary has concluded that TSL 5 is not economically justified.

Next, DOE considered TSL 4. TSL 4 would save 0.06 quads of energy, an amount DOE considers significant. TSL 4 would decrease consumer NPV by $0.16 billion, using a discount rate of 7 percent, and by $0.15 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 4 are 2.38 Mt of CO_2 and 2.10 kt of NO_X. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 4 is $9 million to $136 million. Total generating capacity in 2042 is estimated to increase slightly under TSL 4.

At TSL 4, DOE projects that the average LCC impact for consumers is a loss of $52. The median payback period is 19.2 years (which is substantially longer than the mean lifetime of the product). At TSL 4, the fraction of consumers experiencing an LCC benefit is 15 percent. The fraction of consumers experiencing an LCC cost is 64 percent.

At TSL 4, DOE projects that INPV decreases by up to $6.6 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 13.5 percent in INPV for gas-fired pool heaters.

Therefore, the Secretary has concluded that at TSL 4, the benefits of energy savings and emission reductions would be outweighed by the negative impacts on consumer NPV, the economic burden on some consumers, and the large capital conversion costs that could result in a large reduction in INPV for the manufacturers. Consequently, the Secretary has concluded that TSL 4 is not economically justified.

Next, DOE considered TSL 3. TSL 3 would save 0.04 quads of energy, an amount DOE considers significant. TSL 3 would decrease consumer NPV by $0.06 billion, using a discount rate of 7 percent, and by $0.01 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 3 are 1.72 Mt of CO_2 and 1.53 kt of NO_X. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 3 is $6 million to $99 million. Total generating capacity in 2042 is estimated to stay the same under TSL 3.

At TSL 3, DOE projects that the average LCC impact for consumers is a loss of $6. The median payback period is 18.2 years (which is substantially longer than the mean lifetime of the product). At TSL 3, the fraction of consumers experiencing an LCC benefit is 17 percent. The fraction of consumers experiencing an LCC cost is 60 percent.

At TSL 3, DOE projects that INPV decreases by up to $5 million for gas-fired pool heaters. At TSL 3, 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, as with TSL 4. If the high end of the range of impacts is reached as DOE expects, TSL 3 could result in a net loss of 10 percent in INPV for gas-fired pool heaters.

Therefore, the Secretary has concluded that at TSL 3, the benefits of energy savings and emission reductions would be outweighed by the negative impacts on consumer NPV, the economic burden on some consumers, and the large capital conversion costs that could result in a large reduction in INPV for the manufacturers. Consequently, the Secretary has concluded that TSL 3 is not economically justified.

Next, DOE considered TSL 2. TSL 2 would save 0.02 quads of energy, an amount DOE considers significant. TSL 2 would increase consumer NPV by $0.04 billion, using a discount rate of 7 percent, and by $0.10 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 2 are 0.75 Mt of CO_2 and 0.67 kt of NO_X. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 2 is $3 million to $43 million. Total generating capacity in 2042 is estimated to stay the same under TSL 2.

At TSL 2, DOE projects that the average LCC impact for consumers is a savings of $22. The median payback period is 8.6 years. At TSL 2, the fraction of consumers experiencing an LCC benefit is 22 percent. The fraction of consumers experiencing an LCC cost is 27 percent.

At TSL 2, DOE projects that INPV decreases by up to $0.8 million for gas-fired pool heaters. At TSL 2, 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, as with TSL 3 and 4. If the high end of the range of impacts is reached as DOE expects, TSL 2 could result in a net loss of 2 percent in INPV for gas-fired pool heaters.

After considering the analysis and the benefits and burdens of TSL 2, the Secretary has concluded 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, global benefits from carbon dioxide reductions (at a central value of $21.4 for emissions in 2010) have a present value of $14 million. These benefits from carbon dioxide emission reductions (in both physical reductions and the monetized value of those reductions), when considered in conjunction with the consumer savings NPV and other factors described above, outweigh the potential reduction in INPV for manufacturers and support DOE's conclusion that trial standard level 2 is economically justified. Therefore, the Department today adopts the energy conservation standards for pool heaters at TSL 2, which requires a thermal efficiency of 82 percent for gas-fired pool heaters as shown in Table VI.68.

TABLE VI.68—AMENDED ENERGY CONSERVATION STANDARD FOR POOL HEATERS

Product class	Minimum thermal efficiency %
Gas-fired Pool Heaters	82

VII. 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 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 rule and that the Office of Information and Regulatory Affairs (OIRA) in the Office of Management and Budget (OMB) review this rule. DOE presented to OIRA for review the draft rule and other documents prepared for this rulemaking, including the RIA, and has included these documents in the rulemaking record. 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 a.m. and 4 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) specific national impacts of the 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 standards in today's 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 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 regulatory action (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 today's rule. Table VII.1 through Table VII.5 show the results for energy savings and consumer NPV.

TABLE VII.1—IMPACTS OF NON-REGULATORY ALTERNATIVES FOR GAS-FIRED STORAGE WATER HEATERS THAT MEET THE STANDARD (TSL 5)

Policy alternative	Primary energy savings quads	Net present value* billion 2009$	
		7% discount rate	3% discount rate
No New Regulatory Action	0.00	0.00	0.00
Consumer Rebates	0.21	0.05	0.55
Consumer Tax Credits	0.12	0.03	0.33
Manufacturer Tax Credits	0.06	0.01	0.17
Voluntary Energy Efficiency Targets	0.12	0.05	0.38
Early Replacement	0.001	−0.03	−0.05
Bulk Government Purchases	0.003	0.004	0.01
Energy Conservation Standard	0.81	0.27	2.37

* DOE determined the NPV of consumer benefit for product shipments from 2015 to 2045.

TABLE VII.2—IMPACTS OF NON-REGULATORY ALTERNATIVES FOR ELECTRIC STORAGE WATER HEATERS THAT MEET THE STANDARD (TSL 5)

Policy alternative	Primary energy savings quads	Net present value* billion 2009$	
		7% discount rate	3% discount rate
No New Regulatory Action	0.00	0.00	0.00
Consumer Rebates	0.53	0.19	1.50
Consumer Tax Credits	0.32	0.12	0.90
Manufacturer Tax Credits	0.16	0.06	0.45
Voluntary Energy Efficiency Targets	0.17	0.29	0.99
Early Replacement	0.003	−0.05	−0.08
Bulk Government Purchases	0.003	0.004	0.01
Energy Conservation Standard	1.67	1.03	5.84

* DOE determined the NPV of consumer benefit for product shipments from 2015 to 2045.

TABLE VII.3—IMPACTS OF NON-REGULATORY ALTERNATIVES FOR GAS WALL FAN DHE THAT MEET THE STANDARD (TSL 2)

Policy alternative	Primary energy savings quads	Net present value* billion 2009$	
		7% discount rate	3% discount rate
No New Regulatory Action	0.00	0.00	0.00
Consumer Rebates	0.004	0.007	0.018
Consumer Tax Credits	0.002	0.004	0.011
Manufacturer Tax Credits	0.001	0.002	0.005
Voluntary Energy Efficiency Targets	0.001	0.003	0.007
Early Replacement	<0.0001	0.000	0.000
Bulk Government Purchases †	NA	NA	NA
Energy Conservation Standard	0.01	0.03	0.07

* DOE determined the NPV of consumer benefit for product shipments 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 VII.4—IMPACTS OF NON-REGULATORY ALTERNATIVES FOR GAS HEARTH DHE THAT MEET THE STANDARD (TSL 2)

Policy alternative	Primary energy savings quads	Net present value* billion 2009$	
		7% discount rate	3% discount rate
No New Regulatory Action	0.00	0.00	0.00
Consumer Rebates	0.04	0.10	0.23
Consumer Tax Credits	0.02	0.06	0.14
Manufacturer Tax Credits	0.01	0.03	0.07
Voluntary Energy Efficiency Targets	0.02	0.05	0.14
Early Replacement	<0.001	0.000	0.000
Bulk Government Purchases†	NA	NA	NA
Energy Conservation Standard	0.19	0.50	1.21

* DOE determined the NPV of consumer benefit for product shipments 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 VII.5—IMPACTS OF NON-REGULATORY ALTERNATIVES FOR POOL HEATERS THAT MEET THE STANDARD (TSL 2)

Policy alternative	Primary energy savings quads	Net present value* billion 2009$	
		7% discount rate	3% discount rate
No New Regulatory Action	0.00	0.00	0.00
Consumer Rebates	0.006	0.01	0.03
Consumer Tax Credits	0.003	0.006	0.02
Manufacturer Tax Credits	0.002	0.003	0.01
Voluntary Energy Efficiency Targets	0.002	0.004	0.01
Early Replacement	<0.001	0.000	0.000
Bulk Government Purchases †	NA	NA	NA
Energy Conservation Standard	0.02	0.04	0.11

* DOE determined the NPV of consumer benefit for product shipments 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 VII.1 through Table VII.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 VII.1 through Table VII.5. (*See* the regulatory impact analysis in the final rule TSD for details.) For comparison with the results reported below for the non-regulatory policies, the combined impacts of the standards for all product classes considered in this rulemaking are projected to result in 2.81 quads of national energy savings and an NPV of consumer benefit of $1.98 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.

Consumer 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 standards, the number of consumers buying a more-efficient water heater, pool heater, or DHE would increase relative to the base case. For example, as a result of the consumer rebates, DOE's analysis suggests that the market share of water heaters meeting the standard level would increase from 35 percent (in the base case) to 62 percent for gas-fired storage products, and from 9 percent (in the base case) to 48 percent for electric storage products. 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 0.79 quads of national energy savings and an NPV of consumer benefit of $0.36 billion (at a 7-percent discount rate) for the five considered product classes. Although DOE estimated that rebates would provide national benefits, they would be much smaller than the benefits resulting from the 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 standards, DOE's analysis 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. For example, as a result of the consumer tax credit, the market share of water heaters meeting the standard level would increase from 35 percent (in the base case) to 51 percent for gas-fired storage products and from 9 percent (in the base case) to 31 percent for electric storage products. 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 0.47 quads of national energy savings and an NPV of consumer benefit of $0.22 billion (at a seven-percent discount rate) for the five considered products. Hence, DOE estimated that consumer tax credits would yield a fraction of the benefits that consumer rebates would provide.

Manufacturer Tax Credits. DOE estimates that 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 standards. Because these tax credits would go to manufacturers instead of consumers, DOE assumed that fewer consumers would be aware of this program than would be aware of 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. For example, as a result of the manufacturer tax credit, the market share of water heaters meeting the standard would increase from 35 percent (in the base case) to 43 percent for gas-fired storage products and from 9 percent (in the base case) to 20 percent for electric storage products. 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 0.23 quads of national energy savings and an NPV of consumer benefit of $0.1 billion (at a seven-percent discount rate) for the five 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. Some equipment purchases that result from the ENERGY STAR program already are reflected in DOE's base-case scenario for gas-fired and electric storage water heaters. DOE evaluated the potential impacts of increased marketing efforts by ENERGY STAR that would encourage the purchase of water heaters meeting the standard. For direct heating equipment and pool heaters, DOE evaluated a hypothetical ENERGY STAR program for these products with market impacts comparable to the impacts of existing ENERGY STAR programs for similar products. DOE modeled the voluntary efficiency program based on these scenarios. DOE estimated that the enhanced effectiveness of voluntary energy efficiency targets would provide 0.31 quads of national energy savings and an NPV of consumer benefit of $0.40 billion (at a 7-percent discount rate) for the five considered products. Although this would provide national benefits, they would be much smaller than the benefits resulting from the 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 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 for such an early replacement program, the national energy savings benefits would be negligible in comparison with the benefits resulting from the 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 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 water heaters meeting the efficiency levels of the 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 and NPV for the considered products, benefits that would be much smaller than those estimated for the national standards.

Energy Conservation Standards. DOE is adopting the energy conservation standards listed in section VI.D. As indicated in the paragraphs above, none of the alternatives DOE examined would save as much energy as today's 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 from requiring 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).

DOE estimated that a policy that would allow States to require that some electric storage water heaters installed in new homes have an efficiency level higher than the Federal standard would provide 2.18 quads of national energy savings and an NPV of consumer benefit of $1.23 billion (at a 7-percent discount rate). The energy savings from this State building code requirement for new homes would be greater than the savings from today's energy conservation standard for electric storage water heaters. This contrasts with the non-regulatory policy alternatives discussed above, whose savings are lower than those of the considered standards.

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, and a final regulatory flexibility analysis (FRFA) for any such rule that an agency adopts as a final rule, 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.energy.gov/*). DOE reviewed the December 2009 NOPR and today's final rule under the provisions of the Regulatory Flexibility Act and the procedure and policies published on February 19, 2003.

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 (Sept. 5, 2000) and codified at 13 CFR part 121.The size standards are listed by North American Industry Classification System (NAICS) code and industry description and are available at *http://www.sba.gov/idc/groups/public/documents/sba_homepage/serv_sstd_tablepdf.pdf.* Residential water heater manufacturing is classified under NAICS 335228—"Other Major Household Appliance Manufacturing." DHE and pool heater manufacturing are 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 VII.6.

TABLE VII.6—SBA AND NAICS CLASSIFICATION OF SMALL BUSINESS MANUFACTURERS POTENTIALLY AFFECTED BY THIS RULE [26]

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	333414

In the December 2009 NOPR, 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. 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 manufacturers. 74 FR 65852, 65984–86 (Dec. 11, 2009). DOE concluded that the proposed standards for residential water heaters and gas-fired pool heaters set forth in the proposed rule, if promulgated, would not have a significant economic impact on a substantial number of small entities. DOE also sought comment on the impacts of the proposed amended energy conservation standards on small business manufacturers of residential water heaters and the impacts of the proposed amended energy conservation standards on small business manufacturers of gas-fired residential pool heaters. DOE received no comments on the certification or its additional requests for comment on small business impacts in response to the December 2009 NOPR for residential water heaters and gas-fired pool heaters. Comments related to the economic impacts of the proposed rule generally are discussed elsewhere in the preamble, and no changes were made to the certification as a result of these comments. Thus, DOE reaffirms the certification and has not prepared a FRFA for this final rule for those products.

DOE determined, however, that it could not certify that the proposed standards, if promulgated, would not have significant impact on a substantial number of small entities in the direct heating equipment industry. DOE made the determination that small business manufacturers of both traditional and gas hearth DHE could be negatively impacted by the standards proposed in the December 2009 NOPR. 74 FR 65852, 65985–86 (Dec. 11, 2009). Because of the potential impacts on small DHE manufacturers, DOE prepared an IRFA for DHE during the NOPR stage of this rulemaking. DOE provided the IRFA in its entirety in the December 2009 NOPR. 74 FR 65852, 65984–92 (Dec. 11, 2009). Chapter 12 of the TSD contains more information about the impact of this rulemaking on manufacturers. DOE presents the FRFA conducted for this rulemaking in the following discussion. Comments received in response to the IRFA are also presented below.

DOE's determination that the rule may have a significant economic impact on a substantial number of small entities results from the large number of small DHE manufacturers and the expected impact of the standards on these small businesses. As presented and discussed below, the FRFA describes potential impacts on small business DHE manufacturers associated with the required capital and product conversion costs at each TSL and discusses alternatives that could minimize these impacts.

Succinct Statement of the Need for, and Objectives of, the Rule

The statement of the need for and objectives of the rule is set forth elsewhere in the preamble and is not repeated here.

Description and Estimated Number of Small Entities Regulated

After examining structure of the DHE industry, DOE determined it was 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 FRFA presents the results for traditional DHE and gas hearth DHE separately to be consistent with the MIA results in section VI.C.2 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).

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 business manufacturers. One of the small business manufacturers 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 small business manufacturer produces all five products classes of DHE, including gas hearth DHE. DOE identified a third small business manufacturer 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.

Gas Hearth Direct Heating Equipment

DOE identified 10 small business manufacturers of gas hearth DHE. 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.

Significant Issues Raised by Public Comments

A number of interested parties commented on the appropriateness of the proposed standard level for traditional DHE, given the impacts DOE calculated in the MIA, and urged DOE to reconsider the traditional DHE standards for the final rule. See section V.A.2 for a summary of these comments, and see section VI.D.3 for a discussion of DOE's conclusion about the final amended energy conservation standard for traditional DHE in light of these and other comments.

DOE also received a number of comments from industry groups and

[26] In the December 2009 NOPR, DOE mistakenly listed gas-fired pool heater manufacturing under NAICS code 335228. 74 FR 65852, 65984 (Dec. 11, 2009). The correct classification for pool heater manufacturing is 333414. Both NAICS categories have the same 500 employee limit.

manufacturers, including two small business manufacturers, about the potential of the proposed standards to have a tremendous impact on direct employment in the traditional DHE market. *See* section IV.I.4 for a discussion of these comments. Interested parties also commented on the MIA scenarios and profitability in the traditional DHE market after the compliance date of the amended energy conservation standards (section IV.I.2). Another issue raised by interested parties that could impact small business manufacturers and the industry in general is securing the funding for the conversion costs estimated by DOE (*see* section IV.I.5).

Several comments argued that TSL 3, as presented in the December 2009 NOPR, presented a very negative business case for traditional DHE manufacturers, especially small business manufacturers. In general, AHRI and the small business manufacturers argued that the market for traditional DHE would not support the sales volume necessary to recoup the investments in R&D and capital equipment required by TSL 3. Essentially, two factors drive this argument: (1) The costs required by amended standards; and (2) revenues that follow the standards. On the cost side, AHRI stated that manufacturers cannot afford the necessary investment for product development and redesign for nearly all of their models; the retooling and changing of their production lines; and the testing of those redesigned models to certify compliance with the applicable safety standards. On the revenue side, AHRI and manufacturers attributed the lack of volume necessary to recoup these costs to three factors: (1) The market has already been in steady decline in the base case; (2) there would be fewer retrofits—the products' primary market—because of space constraints and the increased size associated with higher-efficiency products; and (3) higher first costs, including higher installation costs, would further reduce demand. (Williams, No. 96 at p. 1; Empire, Public Meeting Transcript, No. 57.4 at pp. 298–300; AHRI, No. 91 at p. 10) AHRI and the manufacturers argued that the prospect of declining sales and the aforementioned costs would force those manufacturers to either drop product lines or exit the market entirely. (AHRI, No. 91 at p. 10; LTS, Public Meeting Transcript, No. 57.4 at p. 25) As a result, some segments of the traditional DHE market may shrink to only one or two manufacturers. (AHRI, No. 91 at p. 10) As mentioned in section VI.C.5, DOJ expressed concern that the proposed standards could adversely affect competition in the traditional DHE product categories. (DOJ, No. 99 at p. 2)

DOE also received comments specific to the small business analysis presented in the IRFA section of the December 2009 NOPR. LTS agreed that most manufacturers have existing products that meet the required efficiencies in three out of the four product types of traditional DHE, but said that that statement is misleading because only 15 percent of LTS' total sales come from products that meet the proposed standards. LTS stated its belief that its competitors similarly derive only a small portion of total revenue from products that would meet the proposed standards. (LTS, No. 56.7 at p. 2; Public Meeting Transcript, No. 57.4 at p. 22) LTS also disagreed with DOE's statement in the December 2009 NOPR that small business manufacturers would be left with a viable number of product lines that meet the new standards, particularly for the gravity wall category which represents 60 percent of their business. Because only one manufacturer has two gas wall gravity models that would meet the proposed standard (which represent 5 percent of sales and only have lower input ratings less than 25,000 BTU), LTS stated that these few products do not lead to maintaining a viable number of product offerings. (LTS, No. 56.7 at p. 3; LTS, Public Meeting Transcript, No. 57.4 at pp. 23–24; 286–287) Therefore, LTS did not agree with DOE's conclusion that manufacturers would have a viable number of product lines at TSL 3 to maintain a sufficient production volume and remain in the market. (LTS, No. 56.7 at p. 2)

DOE acknowledges that, according to the AHRI database, LTS produces only a few gas wall gravity DHE models that would meet the standards being adopted in this final rule. According to the AHRI directory, LTS has certified four models that meet the proposed gas wall gravity standard in the 2009 NOPR. These four models are two basic products that are listed twice in the directory (once for using natural gas as a fuel source and once for using propane gas as a fuel source). DOE also understands that these products currently reflect a small share of the market and that few of LTS's current products in other categories would meet the standards proposed in the December 2009 NOPR. To clarify, in the December 2009 NOPR, DOE concluded that a combination of existing product lines that currently meet the standard and other select product lines—which would have to be upgraded—would allow manufacturers to offer a viable number of product lines after the compliance date of the amended energy conservation standard. DOE did and does not assume that only products that meet the current standard will be sufficient to support manufacturers after compliance with the amended standards is required.

For these reasons, in the IRFA, DOE accounted for the costs the industry would incur to upgrade all of its other gas wall gravity product lines at the proposed standard. For the final rule, DOE used the AHRI database to update the number of product lines manufacturers currently have, and continued to use this methodology to estimate its capital conversion costs. DOE recognizes that its conversion costs may, therefore, be conservative because manufacturers may choose not to upgrade all of their current product lines. However, DOE assumed manufacturers would have to invest to maintain the shipment volumes forecasted in the NIA. See chapter 12 of the TSD for more details on DOE's product line analysis.

AHRI stated that because manufacturers in the traditional DHE market provide products of every type, the total shipments of traditional DHE must be considered since that is the true base of manufacturers' business. According to the commenter, DOE must reconsider its analysis for traditional DHE, both relative to the impacts on manufacturers and on national energy savings, given that total future shipments are expected to continue to decrease. (AHRI, No. 91 at p. 11) AHRI stated that, to date, the traditional DHE manufacturers have survived by offering replacements. Dropping product lines or dropping categories would hurt manufacturers because they would no longer be able to offer all replacements for all products, which could cause a complete exit from the market rather than upgrading some product lines. (AHRI, Public Meeting Transcript, No. 57.4 at pp. 297–298) Williams stated that offering a range of products is critical to traditional DHE manufacturers, arguing that in a small, niche category, part of viability is being able to offer a breadth of products. Williams commented that it needs to be able to be able to offer like replacements, including units without electricity. (Williams, Public Meeting Transcript, No. 57.4 at pp. 301–302)

DOE agrees with AHRI and Williams that total sales and offering a broad range of products are critical to traditional DHE manufacturers. In the December 2009 NOPR, DOE noted that the wide range of product offerings by manufacturers is a legacy of a once 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 maintaining a sufficiently broad product line is so critical to traditional DHE manufacturers, DOE conducted its small business impact analysis by examining how the conversion costs to convert all product lines would impact small business manufacturers. Because each product line is manufactured in relatively 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. 74 FR 65852, 65986 (Dec. 11, 2009).

DOE notes that the comments it received on the IRFA pertain to the conclusion DOE drew from the results, rather than the methodology or results themselves. As such, DOE has maintained its methodology from the December 2009 NOPR (discussed in more detail in section IV.I) and believes it has appropriately captured the costs to traditional DHE manufacturers of upgrading all of their product lines to the TSLs. The cash flow impacts presented in section VI.C.2.b are reflective of this assumption. However, DOE recognizes the significant costs small business manufacturers could face in converting product lines. In light of these costs and the need to maintain a viable number of products to offer in the marketplace, DOE is adopting a different TSL for traditional DHE in today's final rule. Particularly in light of this change, DOE continues to believe that manufacturers, including the small business manufacturers, will be able to maintain a viable number of products after the compliance date of the amended energy conservation standards.

DOE did not receive any specific comments on the MIA for gas hearth DHE manufacturers. DOE also did not receive any comments on its request for comment on the characterization of a typical large and small business manufacturer of gas hearth DHE nor its request for comment on the potential impacts on small business manufacturers of gas hearth DHE.

Description and Estimate of Compliance Requirements

Traditional DHE

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 models offered by each manufacturer per product line. Again, the wide range of product offerings by manufacturers is a legacy of a once 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, so achieving manufacturing scale is 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 there must be a large enough volume to justify an added per-unit cost.

DOE calculated 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 does 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 business manufacturers could be differentially harmed, DOE compared the conversion costs for a typical large manufacturer and a typical small business manufacturer within the industry. To calculate the conversion costs for a typical small business manufacturer and a typical large manufacturer, DOE used publicly-available information to determine the average number of product lines that meet each efficiency level in each product category for a typical small business manufacturer and a typical large manufacturer of traditional DHE. DOE updated this information for the final rule, adding products that had been released since the December 2009 NOPR analysis. For both small business and large manufacturers, 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 VII.7 and Table VII.8 show DOE's estimates of the average number of product lines requiring conversion at each TSL for a typical small business manufacturer and a typical large manufacturer of traditional DHE, respectively.

TABLE VII.7—NUMBER OF PRODUCT LINES REQUIRING CONVERSION FOR A TYPICAL SMALL BUSINESS MANUFACTURER OF TRADITIONAL DIRECT HEATING EQUIPMENT*

	Number of gas wall fan product lines requiring conversion	Number of gas wall gravity product lines requiring conversion	Number of gas floor product lines requiring conversion	Number of gas room product lines requiring conversion	Total number of product lines requiring conversion	Total product lines that meet each or exceed each TSL
Baseline	0	0	0	0	0	13
TSL 1	2	2.5	0.5	1	6	7
TSL 2	2	2.5	0.5	1.5	6.5	6.5
TSL 3	3	4	0.5	2	9.5	3.5
TSL 4	3.5	4	0.5	2	10	3
TSL 5	2	4	0.5	2	8.5	4.5
TSL 6	3.5	4	0.5	2	10	3

* Fractions of product lines result from taking the average number of product lines from publicly-available information.

TABLE VII.8—NUMBER OF PRODUCT LINES REQUIRING CONVERSION FOR A TYPICAL LARGE MANUFACTURER OF TRADITIONAL DIRECT HEATING EQUIPMENT

	Number of gas wall fan product lines requiring conversion	Number of gas wall gravity product lines requiring conversion	Number of gas floor product lines requiring conversion	Number of gas room product lines requiring conversion	Total number of product lines requiring conversion	Total product lines that meet each or exceed each TSL
Baseline	0	0	0	0	0	18
TSL 1	1	0	1	1	3	15
TSL 2	2	0	1	1	4	14
TSL 3	4	3	1	2	10	8
TSL 4	7	3	1	2	13	5
TSL 5	1	6	1	3	11	7
TSL 6	7	6	1	3	17	1

Amended energy conservation standards have the potential to differentially affect the small business manufacturers, 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 business manufacturers would face higher product conversion costs at lower TSLs than their large competitor. Both large and small business 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, to produce a sufficiently large volume, the small business manufacturers would have to upgrade more product lines at lower TSLs than the large manufacturer at lower TSLs. As shown in Table VII.9 and Table VII.10, modifying facilities and developing new, more-efficient products would cause a typical small business manufacturer to incur higher conversion costs than a typical larger manufacturer for TSL 1 through TSL 3.

TABLE VII.9—TOTAL CONVERSION COSTS FOR A TYPICAL SMALL BUSINESS MANUFACTURER OF TRADITIONAL DIRECT HEATING EQUIPMENT

	Capital conversion costs for a typical small business manufacturer (2009$ millions)	Product conversion costs for a typical small business manufacturer (2009$ millions)	Total conversion costs for a typical small business manufacturer (2009$ millions)
Baseline	....	....	....
TSL 1	0.86	0.41	1.27
TSL 2	1.35	0.57	1.92
TSL 3	1.89	0.81	2.70
TSL 4	2.18	0.92	3.10
TSL 5	1.93	1.44	3.37
TSL 6	2.52	1.65	4.17

TABLE VII.10—TOTAL CONVERSION COSTS FOR A TYPICAL LARGE MANUFACTURER OF TRADITIONAL DIRECT HEATING EQUIPMENT

	Capital conversion costs for a typical large manufacturer (2009$ millions)	Product conversion costs for a typical large manufacturer (2009$ millions)	Total conversion costs for a typical large manufacturer (2009$ millions)
Baseline	....	....	....
TSL 1	0.23	0.14	0.38
TSL 2	0.54	0.25	0.79
TSL 3	1.81	0.79	2.60
TSL 4	2.59	1.11	3.70
TSL 5	2.90	2.13	5.03
TSL 6	4.08	2.61	6.69

Because the larger manufacturer offers more products at higher efficiencies, a typical small business manufacturer faces disproportionate costs at the lower TSLs in absolute terms at TSL 1 through TSL 3. Despite being similar in absolute terms, at these TSLs, the small business 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 business manufacturer using the financial parameters in the DHE GRIM. Comparing the conversion costs of a typical small business manufacturer to a typical large manufacturer with operating profit provides a rough estimate of how quickly the investments could be recouped. Table VII.11 and Table VII.12 show these comparisons.

TABLE VII.11—COMPARISON OF A TYPICAL SMALL BUSINESS MANUFACTURER'S CONVERSION COSTS TO ANNUAL EXPENSES, REVENUE, AND OPERATING PROFIT

	Capital conversion cost as a percentage of annual capital expenditures	Product conversion cost as a percentage of annual R&D expense	Total conversion cost as a percentage of annual revenue	Total conversion cost as a percentage of annual EBIT
Baseline	....	....	....	....
TSL 1	267	190	9	252
TSL 2	332	210	11	302
TSL 3	466	299	15	426
TSL 4	537	341	17	489
TSL 5	474	535	19	531
TSL 6	619	612	23	657

TABLE VII.12—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	Product conversion cost as a percentage of annual R&D expense	Total conversion cost as a percentage of annual revenue	Total conversion cost as a percentage of annual EBIT
Baseline	....	....	....	....
TSL 1	33	30	1	34
TSL 2	77	53	3	72
TSL 3	257	169	8	237
TSL 4	368	237	12	337
TSL 5	412	456	16	458
TSL 6	580	559	22	610

Table VII.11 and Table VII.12 illustrate that, although the investments required at each TSL can be considered substantial for all companies, the impacts could be relatively greater for a typical small business manufacturer, 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 business manufacturers would face increasingly difficult decisions on whether to: (1) Invest the capital required to be able to continue offering a full range of products; (2) cut product lines; (3) consolidate to maintain a large enough combined scale to spread the required conversion costs and operating expenses; or (4) exit the market altogether. Because of the high conversion costs at higher TSLs, manufacturers would likely eliminate their lower-volume product lines. Small business 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 revealed the potential for small businesses manufacturers to be disproportionately harmed by the proposed standard levels and higher TSLs. Additionally, DOE agrees with comments that small business traditional DHE 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 business 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 business 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 business manufacturers 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 manufacturers 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 business manufacturers.

Even though there is a potential for the small business manufacturers to be negatively impacted by today's final rule, DOE believes that manufacturers, including the small businesses, would be able to maintain a viable number of product offerings at TSL 2, the adopted standard level. A typical small business manufacturer of traditional DHE offers product families in the four product types that would meet or exceed the standard levels adopted in today's final rule. For example, over two-thirds of the product lines identified by DOE as currently on the market meet the standard established by today's final rule for gas wall gravity DHE, which comprise over 60 percent of the traditional DHE market. While recognizing that the product lines that currently meet the standard represent a minority of current revenue, the standard levels do not require manufacturers, including those that are small businesses, to completely redesign all their product lines. For those product lines that would need to be redesigned, DOE believes that small business manufacturers would offer fewer product lines in response to the amended energy conservation standards. However, DOE believes that the standards adopted in today's final rule will allow the small business manufacturers to selectively upgrade their existing product lines and maintain viable production volumes after the compliance date of the amended energy conservation standards.

Gas Hearth DHE

For gas hearth DHE in the IRFA, DOE used publicly-available information to estimate the conversion costs for a typical large and a typical small business manufacturer of gas hearth DHE as shown in the December 2009 NOPR. 74 FR 65852, 65984–92 (Dec. 11, 2009). DOE tentatively concluded that a typical small business manufacturer could be differentially impacted by amended energy conservation standards because of their smaller scale. However, DOE believed that a typical small business manufacturer would not face prohibitively large conversion costs and that the required changes would not require significant investments in product development. DOE tentatively concluded that because a typical manufacturer of gas hearth DHE already offers multiple product lines that meet and exceed the required efficiencies and because most product lines that did not meet the proposed standard could be upgraded with relatively minor changes, manufacturers, including the small business manufacturers, would be able to maintain a viable number of product offerings. 74 FR 65852, 65991 (Dec. 11, 2009). In this final rule, while DOE is adopting a different TSL for direct heating equipment (*i.e.,* TSL 2), the efficiency requirements are identical to the proposed amended energy conservation standard for gas hearth DHE. Additionally, because DOE did not receive any comments on the IRFA or the potential impacts on small business manufacturers of gas hearth DHE, DOE continues to believe that the analysis developed for the IRFA and presented in the December 2009 NOPR accurately presents the potential impacts on small business manufacturers of gas hearth DHE. (*See* 74 FR 65852, 65989–91 (Dec. 11, 2009) for additional details.) Therefore, for the FRFA detailed in today's final rule, DOE continues to believe that gas hearth DHE manufacturers, including the small business manufacturers, will be able to maintain a viable number of product offerings following the compliance date of the amended energy conservation standard.

Description of the Steps DOE Has Taken To Minimize the Significant Economic Impact on Small Entities Consistent With the Stated Objectives of Applicable Statutes

DOE acknowledges all the potential impacts highlighted by manufacturers and industry and updated its small business analysis for the impacts on traditional DHE manufacturers in light of these comments and additional information and analysis. The impacts on small business manufacturers of traditional DHE, as illustrated in public comments, contributed to DOE's ultimate determination that the TSL proposed in the December 2009 NOPR for traditional DHE (TSL 3) was not economically justified.

DOE discusses how it has considered the new information about the impacts on traditional DHE in section VI.D.3. Even though there is a potential for the small business manufacturers to be negatively impacted by today's final rule, DOE believes that manufacturers, including the small businesses, would be able to maintain a viable number of product offerings at TSL 2, the adopted standard level. For today's final rule, the small business manufacturers of traditional DHE have an average of 6.5 product lines out of 13 that already meet the required efficiencies. In total, 61 percent of the models offered by a typical small business manufacturer meet the amended energy conservation standards. DOE also reviewed the conversion costs required for each of the small business manufacturers to upgrade an average of approximately seven product lines for a capital cost totaling $1.35 million to offer replacements for all models that do not meet the standard. At the proposed standards in the December 2009 NOPR, DOE estimated small business manufacturers would be required to spend approximately 3.5 years worth of operating profit to convert every product line. For todays final rule, that estimate has fallen to 3.0 years despite changes to the analysis that lowered annual shipments and updates to the product line analysis to include new product lines. While DOE believes that this would still be a substantial undertaking, DOE has carefully reviewed the impact of the conversion costs on small business manufacturers and has carefully considered what would be required for these manufacturers to continue to offer a viable number of replacement models that are critical to their ability to remain in the market. In sum, DOE has concluded that adoption of a standard level at TSL 2 in this final rule (as compared to TSL 3 proposed in the NOPR) minimizes the impact on small business manufacturers to the extent possible, given EPCA's requirements for setting energy conservation standards.

Although the TSL lower than the adopted TSL would be expected to further 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, after considering a variety of factors. As explained earlier in the preamble, DOE rejected the lower TSL based on its analysis conducted pursuant to these EPCA requirements.

In addition to the other TSLs being considered, the December 2009 NOPR TSD included a regulatory impact analysis. For DHE, this report discusses the following policy alternatives: (1) No new regulatory action; (2) consumer rebates; (3) consumer tax credits; (4) manufacturer tax credits; (5) voluntary energy efficiency targets; (6) early replacement incentives; and (7) bulk government purchases. While these alternatives may mitigate the economic impacts on small entities compared to the adopted standards, the energy savings of these regulatory alternatives are significantly smaller than those expected to result from the adopted standard levels. Thus, DOE rejected these alternatives and is adopting the standards set forth in this rulemaking.

C. Review Under the Paperwork Reduction Act of 1995

This rule contains a collection-of-information requirement subject to the Paperwork Reduction Act of 1995 (PRA) which has been approved by OMB under control number 1910–1400. As described in the December 2009 NOPR, 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. 74 FR 65852, 65992 (Dec. 11, 2009). DOE did not receive any comments regarding this burden estimate, or any other aspect of this data collection in response to its proposals. DOE believes that the collection of information required by this final rule is the least burdensome method of meeting the statutory requirements.

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 prepared an environmental assessment (EA) of the impacts of today's final rule, pursuant to the National Environmental Policy Act of 1969 (NEPA) (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 NEPA (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 final EA has been incorporated into the final rule TSD at chapter 16. DOE found the environmental effects associated with today's standard levels for water heaters, direct heating equipment, and pool heaters to be insignificant. Therefore, DOE is issuing a finding of no significant impact (FONSI) as part of the final EA. The FONSI is available in the docket for this rulemaking.

E. Review Under Executive Order 13132

DOE reviewed this rule pursuant to Executive Order 13132, "Federalism," 64 FR 43255 (August 4, 1999), which 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 final 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 final rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297(d)) Therefore, no further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of Executive Order 12988, "Civil Justice Reform" (61 FR 4729 (Feb. 7, 1996)) imposes on Federal agencies the general duty to adhere to the following requirements: (1) Eliminate drafting errors and ambiguity; (2) write regulations to minimize litigation; and (3) provide a clear legal standard for affected conduct rather than a general standard and promote simplification and burden reduction. Section 3(b) of Executive Order 12988 specifically requires that Executive agencies make every reasonable effort to ensure that the regulation: (1) Clearly specifies the preemptive effect, if any; (2) clearly specifies any effect on existing Federal law or regulation; (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction; (4) specifies the retroactive effect, if any; (5) adequately defines key terms; and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of Executive Order 12988 requires Executive agencies to review regulations in light of applicable standards in section 3(a) and section 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, this final rule meets the relevant standards of Executive Order 12988.

G. Review Under the Unfunded Mandates Reform Act of 1995

As indicated in the December 2009 NOPR, DOE reviewed the proposed rule under Title II of the Unfunded Mandates Reform Act of 1995 (Pub. L. 104–4) (UMRA), which requires each Federal agency to assess the effects of their Federal regulatory actions on State, local, and Tribal governments and the private sector. *See* 74 FR 65852, 65992–93 (Dec. 11, 2009). 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 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 final rule does not contain a Federal intergovernmental mandate, it may impose expenditures of $100 million or more on the private sector.

DOE has concluded that this final rule would likely result in a final rule that could impose expenditures of $100 million or more between 2013 and 2045 in the private sector. For the final rule, DOE estimated annualized impacts for the final standards using the results of the national impacts analysis. The national impact analysis results, expressed as annualized values, range from $1.55–$2.03 billion (at a 7-percent discount rate) and $1.90–$2.38 billion (at a 3-percent discount rate) in total annualized benefits from the final rule. The NIA also reports $1.28 billion (at a 7-percent discount rate) and $1.25 billion (at a 3-percent discount rate) in annualized costs, and $0.27–$0.75 billion (at a 7-percent discount rate) and $0.65–$1.13 billion (at a 3-percent discount rate) in annualized net benefits. Details are provided in chapter 10 of the TSD. 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 energy conservation standards for residential water heaters, direct heating equipment, and pool heaters 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 discussion of the alternatives considered by DOE is presented in the "Regulatory Impact Analysis" section of the TSD for this final 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 final 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. In the December 2009 NOPR, DOE tentatively determined that this rulemaking would not have any impact on the autonomy or integrity of the family as an institution, and, accordingly, that it is not necessary to prepare a Family Policymaking Assessment. *See* 74 FR 65852, 65993 (Dec. 11, 2009). DOE received no comments concerning Section 654 in response to the December 2009 NOPR, and, therefore, has concluded that no further action is necessary in today's final rule with respect to this provision.

I. Review Under Executive Order 12630

DOE tentatively determined under Executive Order 12630, "Governmental Actions and Interference with Constitutionally Protected Property Rights," 53 FR 8859 (March 18, 1988), that this rule would not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution. 74 FR 65852, 65993 (Dec. 11, 2009). DOE received no comments concerning Executive Order 12630 in response to the December 2009 NOPR, and, therefore, has concluded that no further action is necessary in today's final rule with respect to this Executive Order.

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 final rule under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

Executive Order 13211, "Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use," 66 FR 28355 (May 22, 2001), requires Federal agencies to prepare and submit to the Office of Information and Regulatory Affairs (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 determined that today's rule, which sets energy conservation standards for residential water heaters, direct heating equipment, and pool heaters, is not a "significant energy action" within the meaning of Executive Order 13211, because the standards are not likely to have a significant adverse effect on the supply, distribution, or use of energy, nor has it been designated as such by the Administrator of OIRA. Accordingly, DOE has not prepared a Statement of Energy Effects.

L. Review Under the Information Quality Bulletin for Peer Review

In consultation with the Office of Science and Technology Policy (OSTP), OMB issued on December 16, 2004, 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 that 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.*

M. Congressional Notification

As required by 5 U.S.C. 801, DOE will submit to Congress a report regarding the issuance of today's final rule prior to the effective date set forth at the outset of this notice. The report will state that it has been determined that the rule is a "major rule" as defined by 5 U.S.C. 804(2). DOE also will submit the supporting analyses to the Comptroller General in the U.S. Government Accountability Office (GAO) and make them available to each House of Congress.

VIII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of today's final 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 March 22, 2010.

Cathy Zoi,

Assistant Secretary, Energy Efficiency and Renewable Energy.

■ For the reasons set forth in the preamble, DOE amends part 430 of chapter II, subchapter D, of title 10 of the Code of Federal Regulations, to read as set forth below:

PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

■ 1. The authority citation for part 430 continues to read as follows:

Authority: 42 U.S.C. 6291–6309; 28 U.S.C. 2461 note.

■ 2. In § 430.2, add the definitions "Direct heating equipment" and "Vented hearth heater," in alphabetical order and revise the definition "Vented home heating equipment," 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 appliance which simulates a solid fuel fireplace and is designed to furnish warm air, with or without duct connections, to the space in which it is installed. The circulation of heated room air may be by gravity or mechanical means. A vented hearth heater may be freestanding, recessed, zero clearance, or a gas fireplace insert or stove. Those heaters with a maximum input capacity less than or equal to 9,000 British thermal units per hour (Btu/h), as measured using DOE's test procedure for vented home heating equipment (10 CFR part 430, subpart B, appendix O), are considered purely decorative and are excluded from DOE's regulations.

Vented home heating equipment or *vented heater* means 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 except for vented hearth heaters, which may be with or without duct connections) and includes: vented wall furnace, vented floor furnace, vented room heater, and vented hearth heater.

* * * * *

■ 3. In § 430.32, revise 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 April 16, 2015
Gas-fired Water Heater	0.67 − (0.0019 × Rated Storage Volume in gallons).	For tanks with a Rated Storage Volume at or below 55 gallons: EF = 0.675 − (0.0015 × Rated Storage Volume in gallons). For tanks with a Rated Storage Volume above 55 gallons: EF = 0.8012 − (0.00078 × Rated Storage Volume in gallons).
Oil-fired Water Heater	0.59 − (0.0019 × Rated Storage Volume in gallons).	EF = 0.68 − (0.0019 × Rated Storage Volume in gallons).
Electric Water Heater	0.97 − (0.00132 × Rated Storage Volume in gallons).	For tanks with a Rated Storage Volume at or below 55 gallons: EF = 0.960 − (0.0003 × Rated Storage Volume in gallons). For tanks with a Rated Storage Volume above 55 gallons: EF = 2.057 − (0.00113 × Rated Storage Volume in gallons).
Tabletop Water Heater	0.93 − (0.00132 × Rated Storage Volume in gallons).	EF = 0.93 − (0.00132 × Rated Storage Volume in gallons).
Instantaneous Gas-fired Water Heater.	0.62 − (0.0019 × Rated Storage Volume in gallons).	EF = 0.82 − (0.0019 × Rated Storage Volume in gallons).
Instantaneous Electric Water Heater.	0.93 − (0.00132 × Rated Storage Volume in gallons).	EF = 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) Vented home heating equipment manufactured on or after January 1, 1990 and before April 16, 2013, 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

Product class	Annual fuel utilization efficiency, Jan. 1, 1990 (percent)
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) Vented home heating equipment manufactured on or after April 16, 2013, shall have an annual fuel utilization efficiency no less than:

Product class	Annual fuel utilization efficiency, April 16, 2013 (percent)
1. Gas wall fan type up to 42,000 Btu/h	75
2. Gas wall fan type over 42,000 Btu/h	76
3. Gas wall gravity type up to 27,000 Btu/h	65
4. Gas wall gravity type over 27,000 Btu/h up to 46,000 Btu/h	66
5. Gas wall gravity type over 46,000 Btu/h	67
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	61
9. Gas room over 20,000 Btu/h up to 27,000 Btu/h	66
10. Gas room over 27,000 Btu/h up to 46,000 Btu/h	67
11. Gas room over 46,000 Btu/h	68
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 April 16, 2013, shall have a thermal efficiency not less than 78%.

(2) Gas-fired pool heaters manufactured on or after April 16, 2013, shall have a thermal efficiency not less than 82%.

* * * * *

Appendix

[The following letter from the Department of Justice will not appear in the Code of Federal Regulations.]

DEPARTMENT OF JUSTICE, Antitrust Division

CHRISTINE A. VARNEY, Assistant Attorney General, Main Justice Building, 950 Pennsylvania Avenue, N.W., Washington, D.C 20530–0001, (202) 514–2401/(202) 616–2645 (Fax) E-mail: *antItrust.atr@usdoj.gov*, Web site: *http://www.usdoj.gov/atr*

February 12, 2010

Robert H. Edwards, Jr., Deputy General Counsel for Energy Policy, Department of Energy, Washington, DC 20585

Dear Deputy General Counsel Edwards:

I am responding to your letter seeking the views of the Attorney General about the potential impact on competition of proposed energy conservation standards for residential water heaters, direct heating equipment and pool heaters (collectively, residential heating products). Your request was submitted pursuant to Section 325(0)(2)(B)(i)(V) of the Energy Policy and Conservation Act, as amended, ("EPCA"), 42 U.S.C. § 6295(0)(B)(i)(V), which requires the Attorney General to make a determination of the impact of any lessening of competition that is likely to result from the imposition of proposed energy conservation standards. The Attorney General's responsibility for responding to requests from other departments about the effect of a program on competition has been delegated to the Assistant Attorney General for the Antitrust Division in 28 CFR § 0.40(g).

In conducting its analysis, the Antitrust Division examines whether a proposed standard may lessen competition, for example, by substantially limiting consumer choice, leaving consumers with fewer competitive alternatives, placing certain manufacturers of a product at an unjustified competitive disadvantage compared to other manufacturers, or by inducing avoidable inefficiencies in production or distribution of particular products.

We have reviewed the proposed standards contained in the Notice of Proposed Rulemaking ("NOPR") (74 Fed. Reg. 65852, December 11, 2009) and the supplementary information submitted to the Attorney General, and attended the January 7, 2010 public hearing on the proposed standards.

Based on this review, the Department of Justice does not believe that the proposed standard for residential hot water heaters or pool heaters would likely lead to a lessening of competition. Our review has focused upon the standards DOE has proposed adopting; we have not determined the impact on competition of more stringent standards than those proposed in the NOPR.

With respect to direct heating equipment (DHE), the Department does not see any competitive issue with gas hearth-heaters. The Department, however, is concerned that the proposed efficiency standards could adversely affect competition in the traditional DHE product categories: (1) gravity wall furnaces; (2) fan-forced wall furnaces; (3) floor furnaces; and (4) room heaters.

The Department notes that essentially only three manufacturers currently market products for each of these four traditional DHE categories. It appears from the record that meeting the proposed standards may require the manufacturers, even those currently producing models that meet the proposed standards, to make a substantial capital investment to convert or expand their production facilities. It also appears that each manufacturer will have to commit significant resources for research and development.

Based on our review, the proposed efficiency standards could affect competition by limiting the number of competitors in each category. Given the capital investments and research and development costs required to produce products meeting the standards, there is a significant risk that no more than one or two DHE manufacturers will choose to continue to produce products in anyone DHE category.

Although the Department of Justice is not in a position to judge whether manufacturers will be able to meet—or choose to make the capital expenditures to meet—the proposed standards, we ask the Department of Energy to take into account the possible impact on competition in determining its final energy efficiency standards for DHE.

Sincerely,

Christine A. Varney

[FR Doc. 2010–7611 Filed 4–15–10; 8:45 am]

BILLING CODE 6450–01–P