Federal Register

Friday,
April 16, 2010

Part III

Department of Energy

10 CFR Part 430

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

DEPARTMENT OF ENERGY

10 CFR Part 430

[Docket Number EE–2006–BT–STD–0129]

RIN 1904–AA90

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

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

ACTION: 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 base-line installed price** *$*	Average in-stalled price increase *$*	Average life-cycle cost savings*** *$*	Median pay-back 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 con-servation standard* *AFUE (%)*	Average base-line installed price** *$*	Average in-stalled price increase *$*	Average life-cycle cost savings*** *$*	Median pay-back 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 * 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 × 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.