[6450-01-P]

DEPARTMENT OF ENERGY

10 CFR Part 430

[Docket Number EERE-2011-BT-STD-0011]

RIN: 1904–AC06

Energy Conservation Program: Energy Conservation Standards for Residential Furnaces and Residential Central Air Conditioners and Heat Pumps

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

ACTION: Direct final rule.

SUMMARY: The Energy Policy and Conservation Act of 1975 (EPCA), as amended, prescribes energy conservation standards for various consumer products and certain commercial and industrial equipment, including residential furnaces and residential central air conditioners and heat pumps. EPCA also requires the U.S. Department of Energy (DOE) to determine whether more-stringent, amended standards for these products would be technologically feasible and economically justified, and would save a significant amount of energy. In this direct final rule, DOE adopts amended energy conservation standards for residential furnaces and for residential central air conditioners and heat pumps. A notice of proposed rulemaking that proposes identical energy efficiency standards is published elsewhere in today's Federal Register. If DOE receives

adverse comment and determines that such comment may provide a reasonable basis for withdrawing the direct final rule, this final rule will be withdrawn, and DOE will proceed with the proposed rule.

DATES: The direct final rule is effective on **[INSERT DATE 120 DAYS FROM DATE OF PUBLICATION IN THE FEDERAL REGISTER]** unless adverse comment is received by **[INSERT DATE THAT IS 110 DAYS FROM PUBLICATION IN THE FEDERAL REGISTER]**. If adverse comments are received that DOE determines may provide a reasonable basis for withdrawal of the direct final rule, a timely withdrawal of this rule will be published in the Federal Register. If no such adverse comments are received, compliance with the standards in this final rule will be required on May 1, 2013 for non-weatherized gas furnaces, mobile home gas furnaces, and non-weatherized oil furnaces; and January 1, 2015 for weatherized gas furnaces and all central air conditioner and heat pump product classes.

ADDRESSES: Any comments submitted must identify the direct final rule for Energy Conservation Standards for Residential Furnaces, Central Air Conditioners, and Heat Pumps, and provide the docket number EERE-2011-BT-STD-0011 and/or regulatory information number (RIN) 1904-AC06. Comments may be submitted using any of the following methods:

1. Federal eRulemaking Portal: http://www.regulations.gov. Follow the instructions for submitting comments.

2. E-mail: ResFurnaceAC-2011-Std-0011@ee.doe.gov. Include Docket Numbers EERE-2011-BT-STD-0011 and/or RIN number1904-AC06 in the subject line of the message.

3. Mail: Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, Mailstop EE-2J, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. If possible, please submit all items on a CD, in which case it is not necessary to include printed copies.

4. Hand Delivery/Courier: Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, 950 L'Enfant Plaza, SW., Suite 600, Washington, DC, 20024. Telephone: (202) 586-2945. If possible, please submit all items on a CD, in which case it is not necessary to include printed copies.

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

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

A link to the docket web page can be found at: [This web page will contain a link to the docket for this notice on the regulations.gov site.] The www.regulations.gov web page contains simple instructions on how to access all documents, including public comments, in the docket. See section VII for further information on how to submit comments through www.regulations.gov.

For further information on how to submit or review public comments, or view hard copies of the docket in the Resource Room, contact Ms. Brenda Edwards at (202) 586-2945 or by email: Brenda.Edwards@ee.doe.gov.

FOR FURTHER INFORMATION CONTACT:

Mr. Mohammed Khan (furnaces) or Mr. Wesley Anderson (central air conditioners and heat pumps), U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, EE-2J, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. Telephone: (202) 586-7892 or (202) 586-7335. E -mail: Mohammed.Khan@ee.doe.gov or Wes.Anderson@ee.doe.gov.

Mr. Eric Stas or Ms. Jennifer Tiedeman, U.S. Department of Energy, Office of the General Counsel, GC-71, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. Telephone: (202) 586-9507 or (202) 287-6111. E-mail: Eric.Stas@hq.doe.gov or Jennifer.Tiedeman@hq.doe.gov.

SUPPLEMENTARY INFORMATION:

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I. Summary of the Direct Final Rule

A. The Energy Conservation Standard Levels

Title III, Part B[1] of the Energy Policy and Conservation Act of 1975 (EPCA or the Act), Pub. L. 94-163 (42 U.S.C. 6291-6309, as codified), established the Energy Conservation Program for Consumer Products Other Than Automobiles. Pursuant to EPCA, any new or amended energy conservation standard that DOE prescribes for certain products, such as the residential furnaces (furnaces) and residential central air conditioners and central air conditioning heat pumps (air conditioners and heat pumps)[2] that are the subject of this rulemaking, shall be designed to "achieve the maximum improvement in energy efficiency . . . which the Secretary determines is technologically feasible and economically justified." (42 U.S.C. 6295(o)(2)(A)) Furthermore, the new or amended standard must "result in significant conservation of energy." (42 U.S.C. 6295(o)(3)(B)) In accordance with these and other statutory provisions discussed in this notice, DOE adopts amended energy conservation standards for furnaces and central air conditioners and heat pumps. The standards for energy efficiency are shown in Table I.1, and the standards for standby mode and off mode[3] are shown in Table I.2. These standards apply to all products listed in Table I.1 and manufactured in, or imported into, the United States on or after May 1, 2013, for non-weatherized gas and oil-fired furnaces

[1] For editorial reasons, upon codification in the U.S. Code, Part B was redesignated Part A.
[2] "Residential central air conditioner" is a product that provides cooling only. It is often paired with a separate electric or gas furnace. "Residential central air conditioning heat pump" is a product that provides both cooling and heating, with the cooling provided in the same manner as a residential central air conditioner and the heating provided by a heat pump mechanism. In this document, "residential central air conditioners and central air conditioning heat pumps" are referred to collectively as "central air conditioners and heat pumps," and separately as "air conditioners" (cooling only) and "heat pumps" (both cooling and heating), respectively.
[3] In this rule, DOE is changing the nomenclature for the standby mode and off mode power consumption metrics for furnaces from those in the furnace and boiler test procedure final rule published on October 20, 2010. 75 FR 64621. DOE is renaming the P_{SB} and P_{OFF} metrics as $P_{W,SB}$ and $P_{W,OFF}$, respectively. However, the substance of these metrics remains unchanged.

and mobile home gas furnaces, and on or after January 1, 2015, for weatherized furnaces and central air conditioners and heat pumps.

Table I.1 Amended Energy Conservation Standards for Furnace, Central Air Conditioner, and Heat Pump Energy Efficiency

Residential Furnaces*		
Product Class	**National Standards**	**Northern Region** Standards**
Non-weatherized gas	AFUE = 80%	AFUE = 90%
Mobile home gas	AFUE = 80%	AFUE = 90%
Non-weatherized oil-fired	AFUE = 83%	AFUE = 83%
Weatherized gas	AFUE = 81%	AFUE = 81%
Mobile home oil-fired[‡‡]	AFUE = 75%	AFUE = 75%
Weatherized oil-fired[‡‡]	AFUE = 78%	AFUE = 78%
Electric[‡‡]	AFUE = 78%	AFUE = 78%

Central Air Conditioners and Heat Pumps[†]			
Product Class	**National Standards**	**Southeastern Region[††] Standards**	**Southwestern Region[‡] Standards**
Split-system air conditioners	SEER = 13	SEER = 14	SEER = 14 EER = 12.2 (for units with a rated cooling capacity less than 45,000 Btu/h) EER = 11.7 (for units with a rated cooling capacity equal to or greater than 45,000 Btu/h)
Split-system heat pumps	SEER = 14 HSPF = 8.2	SEER = 14 HSPF = 8.2	SEER = 14 HSPF = 8.2
Single-package air conditioners[‡‡]	SEER = 14	SEER = 14	SEER = 14 EER = 11.0
Single-package heat pumps	SEER = 14 HSPF = 8.0	SEER = 14 HSPF = 8.0	SEER = 14 HSPF = 8.0
Small-duct, high-velocity systems	SEER = 13 HSPF = 7.7	SEER = 13 HSPF = 7.7	SEER = 13 HSPF = 7.7
Space-constrained products – air conditioners[‡‡]	SEER = 12	SEER = 12	SEER = 12
Space-constrained products – heat pumps[‡‡]	SEER = 12 HSPF = 7.4	SEER = 12 HSPF = 7.4	SEER = 12 HSPF = 7.4

* AFUE is annual fuel utilization efficiency.

** The Northern region for furnaces contains the following States: Alaska, Colorado, Connecticut, Idaho, Illinois, Indiana, Iowa, Kansas, Maine, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Dakota, Ohio, Oregon, Pennsylvania, Rhode Island, South Dakota, Utah, Vermont, Washington, West Virginia, Wisconsin, and Wyoming.

† SEER is Seasonal Energy Efficiency Ratio; EER is Energy Efficiency Ratio; HSPF is Heating Seasonal Performance Factor; and Btu/h is British thermal units per hour.

†† The Southeastern region for central air conditioners and heat pumps contains the following States: Alabama, , Arkansas, Delaware, Florida, Georgia, Hawaii, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia, and the District of Columbia.

‡ The Southwestern region for central air conditioners and heat pumps contains the States of Arizona, California, Nevada, and New Mexico.

‡‡ DOE is not amending energy conservation standards for these product classes in this rule.

Table I.2 Amended Energy Conservation Standards for Furnace, Central Air Conditioner, and Heat Pump Standby Mode and Off Mode*

Residential Furnaces**	
Product Class	**Standby Mode and Off Mode Standard Levels**
Non-weatherized gas	$P_{W,SB}$ = 10 watts $P_{W,OFF}$ = 10 watts
Mobile home gas	$P_{W,SB}$ = 10 watts $P_{W,OFF}$ = 10 watts
Non-weatherized oil-fired	$P_{W,SB}$ = 11 watts $P_{W,OFF}$ = 11 watts
Mobile home oil-fired	$P_{W,SB}$ = 11 watts $P_{W,OFF}$ = 11 watts
Electric	$P_{W,SB}$ = 10 watts $P_{W,OFF}$ = 10 watts
Central Air Conditioners and Heat Pumps††	
Product Class	**Off Mode Standard Levels**††
Split-system air conditioners	$P_{W,OFF}$ = 30 watts
Split-system heat pumps	$P_{W,OFF}$ = 33 watts
Single-package air conditioners	$P_{W,OFF}$ = 30 watts
Single-package heat pumps	$P_{W,OFF}$ = 33watts
Small-duct, high-velocity systems	$P_{W,OFF}$ = 30 watts
Space-constrained air conditioners	$P_{W,OFF}$ = 30 watts
Space-constrained heat pumps	$P_{W,OFF}$ = 33 watts

*$P_{W,SB}$ is standby mode electrical power consumption, and $P_{W,OFF}$ is off mode electrical power consumption. For furnaces, DOE is proposing to change the nomenclature for the standby mode and off mode power consumption metrics for furnaces from those in the furnace and boiler test procedure final rule published on October 20, 2010. 75 FR 64621. DOE is renaming the P_{SB} and P_{OFF} metrics as $P_{W,SB}$ and $P_{W,OFF}$, respectively. However, the substance of these metrics remains unchanged.
** Standby mode and off mode energy consumption for weatherized gas and oil-fired furnaces is regulated as a part of single-package air conditioners and heat pumps, as discussed in section III.E.1.
† $P_{W,OFF}$ is off mode electrical power consumption for central air conditioners and heat pumps.
†† DOE is not adopting a separate standby mode standard level for central air conditioners and heat pumps, because standby mode power consumption for these products is already regulated by SEER and HSPF.

B. Benefits and Costs to Consumers

The projected economic impacts of today's standards on individual consumers are generally positive. For the standards on energy efficiency, the estimated average life-cycle cost (LCC)[4] savings for consumers are $155 for non-weatherized gas furnaces in

[4] The LCC is the total consumer expense over the life of a product, consisting of purchase and installation costs plus operating costs (expenses for energy use, maintenance, and repair). To compute the operating

the northern region, $419 for mobile home gas furnaces in the northern region, and $15 for non-weatherized oil-fired furnaces at a national level. (Today's standards on energy efficiency would have no impact for consumers of non-weatherized gas furnaces and mobile home gas furnaces in the southern region.) The estimated LCC savings for consumers are $93 and $107 for split system air conditioners (coil only) in the hot-humid and hot-dry regions,[5] respectively; $89 and $101 for split system air conditioners (blower coil) in the hot-humid and hot-dry regions, respectively; $102 and $175 for split system heat pumps in the hot-humid and hot-dry regions, respectively, and $4 for the rest of the country; $37 for single package air conditioners in the entire country; and $104 for single package heat pumps in the entire country.[6] For small-duct, high-velocity systems, no consumers would be impacted by today's standards.

For today's national standards on standby mode and off mode power, the estimated average LCC savings for consumers are $2 for non-weatherized gas furnaces, $0 for mobile home gas furnaces and electric furnaces, $1 for non-weatherized oil-fired furnaces, $84 for split system air conditioners (coil only), $40 for split system air conditioners (blower coil), $9 for split system heat pumps, $41 for single package air conditioners, $9 for single package heat pumps and $37 for small-duct, high-velocity (SDHV) systems.

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Comment [A1]: Footnote recommended by OIRA.

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costs, DOE discounts future operating costs to the time of purchase and sums them over the lifetime of the product.

[5] Throughout this notice, the terms "hot-humid" and "hot-dry" are used interchangeably with the terms "southeastern" and "southwestern," respectively, when referring to the two southern regions for central air conditioners and heat pumps.

[6] For single-package air conditioners and single-package heat pumps, DOE has analyzed the regional standards on a national basis because the standard would be identical in each region. Additionally, given the low level of shipments of these products, DOE determined that an analysis of regional standards would not produce significant differences in comparison to a single national standard.

C. Impact on Manufacturers

The industry net present value (INPV) is the sum of the discounted cash flows to the industry from the base year through the end of the analysis period (2010 through 2045). Using a real discount rate of 8.0 percent, DOE estimates that the INPV for manufacturers of furnaces, central air conditioners, and heat pumps in the base case (without amended standards) is $8.50 billion in 2009$. For today's standards on energy efficiency, DOE expects that manufacturers may lose 5.6 to 10.6 percent of their INPV, or approximately $0.48 billion to $0.90 billion. For today's standards on standby mode and off mode power, DOE expects that manufacturers may lose up to 2.9 percent of their INPV, or approximately $0.25 billion.

D. National Benefits

DOE's analyses indicate that today's standards for energy efficiency and standby mode and off mode power would save a significant amount of energy–an estimated 3.36 to 4.38 quads of cumulative energy in 2013–2045 for furnaces and in 2015-2045 for central air conditioners and heat pumps.[7] This amount is comprised of savings of 3.20 to 4.22 quads for today's standards on energy efficiency and 0.16 quads for today's standards on standby mode and off mode power. The total amount is approximately one-fifth of the amount of total energy used annually by the U.S. residential sector. In

[7] DOE has calculated the energy savings over a period that begins in the year in which compliance with the proposed standards would be required (as described in the text preceding Table I.1) and continues through 2045. DOE used the same end year (2045) for both types of products to be consistent with the end year that it used in analyzing other standard levels that it considered. See section IV.G of this notice for further discussion.

addition, DOE expects the energy savings from today's standards to eliminate the need for approximately 3.80 to 3.92 gigawatts (GW) of generating capacity by 2045.

The cumulative national net present value (NPV) of total consumer costs and savings of today's standards for products shipped in 2013–2045 for furnaces and in 2015-2045 for central air conditioners and heat pumps, in 2009$, ranges from $4.30 billion to $4.58 billion (at a 7-percent discount rate) to $15.9 billion to $18.7 billion (at a 3-percent discount rate).[8] This NPV is the estimated total value of future operating-cost savings during the analysis period, minus the estimated increased product costs (including installation), discounted to 2011.

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In addition, today's standards would have significant environmental benefits. The energy savings would result in cumulative greenhouse gas emission reductions of 113 million to 143 million metric tons (Mt)[9] of carbon dioxide (CO_2) in 2013–2045 for furnaces and in 2015-2045 for central air conditioners and heat pumps. During this period, today's standards would also result in emissions reductions of 97 to 124 thousand tons of nitrogen oxides (NO_X) and 0.143 to 0.169 ton of mercury (Hg).[10] DOE estimates the present monetary value of the total CO_2 emissions reductions is between $0.574 billion and $11.8 billion, expressed in 2009$ and discounted to 2011 using a range of

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[8] DOE uses discount rates of 7 and 3 percent based on guidance from the Office of Management and Budget (OMB Circular A-4, section E (Sept. 17, 2003)). See section IV.G of this notice for further information.

[9] A metric ton is equivalent to 1.1 short tons. Results for NO_X and Hg are presented in short tons.

[10] DOE calculates emissions reductions relative to the most recent version of the Annual Energy Outlook (AEO) Reference case forecast. As noted in section 15.2.4 of TSD chapter 15, this forecast accounts for regulatory emissions reductions through 2008, including the Clean Air Interstate Rule (CAIR, 70 FR 25162 (May 12, 2005)), but not the Clean Air Mercury Rule (CAMR, 70 FR 28606 (May 18, 2005)). Subsequent regulations, including the currently proposed CAIR replacement rule, the Clean Air Transport Rule (75 FR 45210 (Aug. 2, 2010)), do not appear in the forecast.

discount rates (see notes to Table I.3). DOE also estimates the present monetary value of the NO_X emissions reductions, expressed in 2009$ and discounted to 2011, is between $12.7 million and $169 million at a 7-percent discount rate, and between $30.7 million and $403 million at a 3-percent discount rate.[11]

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The benefits and costs of today's standards can also be expressed in terms of annualized values. The annualized monetary values are the sum of: (1) the annualized national economic value, expressed in 2009$, of the benefits from operating products that meet today's standards (consisting primarily of operating cost savings from using less energy, minus increases in equipment purchase costs, which is another way of representing consumer NPV), and (2) the monetary value of the benefits of emission reductions, including CO_2 emission reductions.[12] The value of the CO_2 reductions, otherwise known as the Social Cost of Carbon (SCC), is calculated using a range of values per metric ton of CO_2 developed by a recent interagency process. The monetary costs and benefits of cumulative emissions reductions are reported in 2009$ to permit comparisons with the other costs and benefits in the same dollar units. The derivation of the SCC values is discussed in further detail in section IV.M.

[11] DOE is aware of multiple agency efforts to determine the appropriate range of values used in evaluating the potential economic benefits of reduced Hg emissions. DOE has decided to await further guidance regarding consistent valuation and reporting of Hg emissions before it once again monetizes Hg emissions reductions in its rulemakings.

[12] DOE used a two-step calculation process to convert the time-series of costs and benefits into annualized values. First, DOE calculated a present value in 2011, the year used for discounting the NPV of total consumer costs and savings, for the time-series of costs and benefits using discount rates of three and seven percent for all costs and benefits except for the value of CO_2 reductions. For the latter, DOE used a range of discount rates, as shown in Table I.3. From the present value, DOE then calculated the fixed annual payment over a 32-year period, starting in 2011 that yields the same present value. The fixed annual payment is the annualized value. Although DOE calculated annualized values, this does not imply that the time-series of cost and benefits from which the annualized values were determined would be a steady stream of payments.

Although combining the values of operating savings and CO_2 emission reductions provides a useful perspective, two issues should be considered. First, the national operating savings are domestic U.S. consumer monetary savings that occur as a result of market transactions, whereas the value of CO_2 reductions is based on a global value. Second, the assessments of operating cost savings and CO_2 savings are performed with different methods that use quite different time frames for analysis. The national operating cost savings is measured for the lifetime of products shipped in 2013–2045 for furnaces and 2015-2045 for central air conditioners and heat pumps. The SCC values, on the other hand, reflect the present value of future climate-related impacts resulting from the emission of one metric ton of carbon dioxide in each year. These impacts continue well beyond 2100.

Estimates of annualized benefits and costs of today's standards for furnace, central air conditioner, and heat pump energy efficiency are shown in Table I.3. The results under the primary estimate are as follows. Using a 7-percent discount rate for consumer impacts and the SCC series that has a value of $22.1/ton in 2010 (in 2009$), the cost of the standards in today's rule is $527 million to $773 million per year in increased equipment costs, while the annualized benefits are $837 million to $1106 million per year in reduced equipment operating costs, $140 million to $178 million in CO_2 reductions, and $5.3 million to $6.9 million in reduced NO_X emissions. In this case, the net benefit amounts to $456 million to $517 million per year. DOE also calculated annualized net benefits using a range of potential electricity and equipment price trend

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forecasts. Given the range of modeled price trends, the range of net benefits in this case is from $295 million to $623 million per year. The low estimate in Table I.3 corresponds to a scenario with a low electricity price trend and a constant real price trend for equipment, while the high estimate reflects a high electricity price trend and a strong declining real price trend for equipment.

Comment [A2]: Change recommended by OIRA.

Using a 3-percent discount rate for consumer impacts and the SCC series that has a value of $22.1/ton in 2010 (in 2009$), the cost of the standards in today's rule is $566 million to $825 million per year in increased equipment costs, while the benefits are $1289 million to $1686 million per year in reduced operating costs, $140 million to $178 million in CO_2 reductions, and $7.9 million to $10.2 million in reduced NO_X emissions. In this case, the net benefit amounts to $871 million to $1049 million per year. DOE also calculated annualized net benefits using a range of potential electricity and equipment price trend forecasts. Given the range of modeled price trends, the range of net benefits in this case is from $601 million to $1,260 million per year. The low estimate corresponds to a scenario with a low electricity price trend and a constant real price trend for equipment, while the high estimate reflects a high electricity price trend and a strong declining real price trend for equipment.

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Comment [A3]: Change recommended by OIRA.

Table I.3 Annualized Benefits and Costs of Standards for Furnace and Central Air Conditioner and Heat Pump Energy Efficiency (TSL 4)*

	Discount Rate	Primary Estimate**	Low Estimate**	High Estimate**
		Monetized (million 2009$/year)		
Benefits				
Operating Cost Savings	7%	837 to 1,106	723 to 959	955 to 1,258
	3%	1,289 to 1,686	1,083 to 1,422	1,493 to 1,948
CO_2 Reduction at $4.9/t†	5%	34 to 43	34 to 43	34 to 43
CO_2 Reduction at $22.1/t†	3%	140 to 178	141 to 178	140 to 178
CO_2 Reduction at $36.3/t†	2.5%	224 to 284	225 to 285	224 to 284
CO_2 Reduction at $67.1/t†	3%	427 to 541	428 to 543	427 to 541
NO_X Reduction at $2,519/ton†	7%	5.3 to 6.9	5.3 to 7.0	5.3 to 6.9
	3%	7.9 to 10.2	7.9 to 10.3	7.9 to 10.2
Total††	7% plus CO_2 range	876 to 1,653	762 to 1,509	994 to 1,805
	7%	983 to 1,290	869 to 1,144	1,100 to 1,442
	3%	1,437 to 1,874	1,232 to 1,611	1,641 to 2,136
	3% plus CO_2 range	1,330 to 2,237	1,125 to 1,975	1,535 to 2,499
Costs				
Incremental Product Costs	7%	527 to 773	574 to 840	555 to 819
	3%	566 to 825	630 to 916	599 to 876
Net Benefits/Costs				
Total††	7% plus CO_2 range	349 to 880	188 to 669	438 to 986
	7%	456 to 517	295 to 305	545 to 623
	3%	871 to 1,049	601 to 695	1,042 to 1,260
	3% plus CO_2 range	764 to 1,412	494 to 1,059	935 to 1,623

* The benefits and costs are calculated for products shipped in 2013-2045 for the furnace standards and in 2015-2045 for the central air conditioner and heat pump standards.

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**The Primary, Low, and High Estimates utilize forecasts of energy prices and housing starts from the AEO2010 Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, the Low estimate uses incremental product costs that reflects constant prices (no learning rate) for product prices, and the High estimate uses incremental product costs that reflects a declining trend (high learning rate) for product prices. The derivation and application of learning rates for product prices is explained in section IV.F.1.

Comment [A4]: Change recommended by OIRA.

† The CO_2 values represent global monetized values (in 2009$) of the social cost of CO_2 emissions in 2010 under several scenarios. The values of $4.9, $22.1, and $36.3 per metric ton are the averages of SCC distributions calculated using 5-percent, 3-percent, and 2.5-percent discount rates, respectively. The value of $67.1 per ton represents the 95th percentile of the SCC distribution calculated using a 3-percent discount rate. The value for NO_X (in 2009$) is the average of the low and high values used in DOE's analysis.

†† Total Benefits for both the 3-percent and 7-percent cases are derived using the SCC value calculated at a 3-percent discount rate, which is $22.1/ton in 2010 (in 2009$). In the rows labeled as "7% plus CO_2 range" and "3% plus CO_2 range," the operating cost and NO_X benefits are calculated using the labeled discount rate, and those values are added to the full range of CO_2 values.

Estimates of annualized benefits and costs of today's standards for furnace, central air conditioner, and heat pump standby mode and off mode power are shown in Table I.4. The results under the primary estimate are as follows. Using a 7-percent discount rate and the SCC value of $22.1/ton in 2010 (in 2009$), the cost of the standards in today's rule is $16.4 million per year in increased equipment costs, while the annualized benefits are $46.5 million per year in reduced equipment operating costs, $12.4 million in CO_2 reductions, and $0.4 million in reduced NO_X emissions. In this case, the net benefit amounts to $42.8 million per year. Using a 3-percent discount rate and the SCC value of $22.10/ton in 2010 (in 2009$), the cost of the standards in today's rule is $19.1 million per year in increased equipment costs, while the benefits are $79.3 million per year in reduced operating costs, $12.4 million in CO_2 reductions, and $0.6 million in reduced NO_X emissions. In this case, the net benefit amounts to $73.2 million per year.

Table I.4 Annualized Benefits and Costs of Standards for Furnace, Central Air Conditioner, and Heat Pump Standby Mode and Off Mode (TSL 2)*

	Discount Rate	Primary Estimate**	Low Estimate**	High Estimate**
		Monetized (million 2009$/year)		
Benefits				
Operating Cost Savings	7%	46.5	40.4	52.8
	3%	79.3	67.9	90.8
CO_2 Reduction at $4.9/t†	5%	2.9	2.9	2.9
CO_2 Reduction at $22.1/t†	3%	12.4	12.4	12.4
CO_2 Reduction at $36.3/t†	2.5%	19.9	19.9	19.9
CO_2 Reduction at $67.1/t†	3%	37.6	37.6	37.6
NO_X Reduction at $2,519/ton†	7%	0.4	0.4	0.4
	3%	0.6	0.6	0.6
Total††	7% plus CO_2 range	49.7 to 84.5	43.6 to 78.4	56.1 to 90.8
	7%	59.2	53.1	65.5
	3%	92.3	80.9	103.8
	3% plus CO_2 range	82.8 to 117.5	71.4 to 106.2	94.3 to 129.1
Costs				
Incremental Product Costs	7%	16.4	15.2	17.7
	3%	19.1	17.6	20.6
Net Benefits/Costs				
Total††	7% plus CO_2 range	33.3 to 68.1	28.5 to 63.2	38.4 to 73.1
	7%	42.8	38.0	47.9
	3%	73.2	63.3	83.2
	3% plus CO_2 range	63.7 to 98.4	53.8 to 88.5	73.7 to 108.5

* The benefits and costs are calculated for products shipped in 2013-2045 for the furnace standards and in 2015-2045 for the central air conditioner and heat pump standards.

**The Primary, Low, and High Estimates utilize forecasts of energy prices and housing starts from the AEO2010 Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, the low estimate uses incremental product costs that reflects constant prices (no learning rate) for product prices, and the high estimate uses incremental product costs that reflects a declining trend (high learning rate) for product prices. The derivation and application of learning rates for product prices is explained in section IV.F.1.

Comment [A5]: Change recommended by OIRA.

† The CO_2 values represent global monetized values (in 2009$) of the social cost of CO_2 emissions in 2010 under several scenarios. The values of $4.9, $22.1, and $36.3 per metric ton are the averages of SCC distributions calculated using 5-percent, 3-percent, and 2.5-percent discount rates, respectively. The value of $67.1 per ton represents the 95th percentile of the SCC distribution calculated using a 3-percent discount rate. The value for NO_X (in 2009$) is the average of the low and high values used in DOE's analysis.

†† Total Benefits for both the 3-percent and 7-percent cases are derived using the SCC value calculated at a 3-percent discount rate, which is $22.1/ton in 2010 (in 2009$). In the rows labeled as "7% plus CO_2 range" and "3% plus CO_2 range," the operating cost and NO_X benefits are calculated using the labeled discount rate, and those values are added to the full range of CO_2 values.

E. Conclusion

Based on the analyses culminating in this rule, DOE has concluded that the benefits of today's standards (energy savings, positive NPV of consumer benefits, consumer LCC savings, and emission reductions) would outweigh the burdens (loss of INPV for manufacturers and LCC increases for some consumers). DOE has concluded that today's standards represent the maximum improvement in energy efficiency that is technologically feasible and economically justified, and would result in the significant conservation of energy. DOE further notes that products achieving these standard levels are already commercially available for all of the product classes covered by today's proposal.

II. Introduction

The following sections briefly discuss the statutory authority underlying today's direct final rule, as well as some of the relevant historical background related to the establishment of standards for residential furnaces and residential central air conditioners and heat pumps.

A. Authority

Title III, Part B of the Energy Policy and Conservation Act of 1975 (EPCA or the Act), Pub. L. 94-163 (42 U.S.C. 6291-6309, as codified) established the Energy Conservation Program for Consumer Products Other Than Automobiles,[13] a program covering most major household appliances (collectively referred to as "covered products"), which includes the types of residential central air conditioners and heat pumps and furnaces that are the subject of this rulemaking. (42 U.S.C. 6292(a)(3) and (5)) EPCA prescribed energy conservation standards for central air conditioners and heat pumps and directed DOE to conduct two cycles of rulemakings to determine whether to amend these standards. (42 U.S.C. 6295(d)(1)-(3)) The statute also prescribed standards for furnaces, except for "small" furnaces (i.e., those units with an input capacity less than 45,000 British thermal units per hour (Btu/h)), for which EPCA directed DOE to prescribe standards. (42 U.S.C. 6295(f)(1)-(2)) Finally, EPCA directed DOE to conduct rulemakings to determine whether to amend the standards for furnaces. (42 U.S.C. 6295(f)(4)(A)-(C)) As explained in further detail in section II.B, "Background," this rulemaking represents the second round of amendments to both the central air conditioner/heat pump and the furnaces standards, under the authority of 42 U.S.C. 6295(d)(3)(B) and (f)(4)(C), respectively.

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

DOE notes that this rulemaking is one of the required agency actions in two court orders. First, pursuant to the consolidated Consent Decree in State of New York, et al. v. Bodman et al., 05 Civ. 7807 (LAP), and Natural Resources Defense Council, et al. v. Bodman, et al., 05 Civ. 7808 (LAP), DOE is required to complete a final rule for amended energy conservation standards for residential central air conditioners and heat pumps that must be sent to the Federal Register by June 30, 2011. Second, pursuant to the Voluntary Remand in State of New York, et al. v. Department of Energy, et al., 08-0311-ag(L); 08-0312-ag(con), DOE agreed to complete a final rule to consider amendments to the energy conservation standards for residential furnaces which it anticipated would be sent to the Federal Register by May 1, 2011.

DOE further notes that under 42 U.S.C. 6295(m), the agency must periodically review its already established energy conservation standards for a covered product. Under this requirement, the next review that DOE would need to conduct must occur no later than six years from the issuance of a final rule establishing or amending a standard for a covered product.

Pursuant to EPCA, DOE's energy conservation program for covered products consists essentially of four parts: (1) testing; (2) labeling; (3) the establishment of Federal energy conservation standards; and (4) certification and enforcement procedures. The Federal Trade Commission (FTC) is primarily responsible for labeling, and DOE implements the remainder of the program. Subject to certain criteria and conditions, DOE is required to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating cost of each covered product. (42 U.S.C. 6293) Manufacturers of covered products must use the prescribed DOE test procedure as the basis for certifying to DOE that their products comply with the applicable energy conservation standards adopted under EPCA and when making representations to the public regarding the energy use or efficiency of those products. (42 U.S.C. 6293(c) and 6295(s)) Similarly, DOE must use these test procedures to determine whether the products comply with standards adopted pursuant to EPCA. Id. The DOE test procedures for central air conditioners and heat pumps, and for furnaces, appear at title 10 of the Code of Federal Regulations (CFR) part 430, subpart B, appendices M and N, respectively.

DOE must follow specific statutory criteria for prescribing amended standards for covered products. As indicated above, any amended standard for a covered product must be designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) Furthermore, DOE may not adopt any standard that would not result in the significant conservation of energy. (42 U.S.C. 6295(o)(3)) Moreover, DOE may not prescribe a standard: (1) for certain products, including both furnaces and central air conditioners and heat pumps, if no test procedure has been established for the product, or (2) if DOE determines by rule that the proposed standard is not technologically feasible or economically justified. (42 U.S.C. 6295(o)(3)(A)-(B)) In deciding whether a standard is economically justified, DOE must determine whether the benefits of the standard exceed its burdens. (42 U.S.C. 6295(o)(2)(B)(i)) DOE must make this determination after receiving comments on the proposed standard, and by considering, to the greatest extent practicable, the following seven factors:

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

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

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

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

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

6. The need for national energy and water conservation; and

7. Other factors the Secretary of Energy (the Secretary) considers relevant. (42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII))

The Energy Independence and Security Act of 2007 (EISA 2007; Pub. L. 110-140) amended EPCA, in relevant part, to grant DOE authority to issue a final rule (hereinafter referred to as a "direct final rule") establishing an energy conservation standard on receipt of a statement submitted jointly by interested persons that are fairly

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representative of relevant points of view (including representatives of manufacturers of covered products, States, and efficiency advocates), as determined by the Secretary, that contains recommendations with respect to an energy or water conservation standard that are in accordance with the provisions of 42 U.S.C. 6295(o). A notice of proposed rulemaking (NOPR) that proposes an identical energy efficiency standard must be published simultaneously with the final rule, and DOE must provide a public comment period of at least 110 days on this proposal. 42 U.S.C. 6295(p)(4). Not later than 120 days after issuance of the direct final rule, if one or more adverse comments or an alternative joint recommendation are received relating to the direct final rule, the Secretary must determine whether the comments or alternative recommendation may provide a reasonable basis for withdrawal under 42 U.S.C. 6295(o) or other applicable law. If the Secretary makes such a determination, DOE must withdraw the direct final rule and proceed with the simultaneously-published NOPR. DOE must publish in the Federal Register the reason why the direct final rule was withdrawn. Id.

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The Consent Decree in State of New York, et al. v. Bodman et al., described above, defines a "final rule" to have the same meaning as in 42 U.S.C. 6295(p)(4) and defines "final action" as a final decision by DOE. As this direct final rule is issued under authority at 42 U.S.C. 6295(p)(4) and constitutes a final decision by DOE which becomes legally effective 120 days after issuance, absent an adverse comment that leads the Secretary to withdraw the direct final rule, DOE asserts that issuance of this direct final rule on or before the date required by the court constitutes compliance with the Consent Decree in State of New York, et al. v. Bodman et al.

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

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

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

Under 42 U.S.C. 6295(o)(6), which was added by section 306(a) of the Energy Independence and Security Act of 2007 (EISA 2007; Pub. L. 110-140), DOE may consider the establishment of regional standards for furnaces (except boilers) and for central air conditioners and heat pumps. Specifically, in addition to a base national standard for a product, DOE may establish for furnaces a single more-restrictive regional standard, and for central air conditioners and heat pumps, DOE may establish one or two more-restrictive regional standards. (42 U.S.C. 6295(o)(6)(B)) The regions must include only contiguous States (with the exception of Alaska and Hawaii, which may be included in regions with which they are not contiguous), and each State may be placed in only one region (i.e., an entire State cannot simultaneously be placed in two regions, nor can it be divided between two regions). (42 U.S.C. 6295(o)(6)(C)) Further, DOE can establish the additional regional standards only: (1) where doing so would produce significant energy savings in comparison to a single national standard, (2) if the regional standards are economically justified, and (3) after considering the impact of these standards on consumers, manufacturers, and other market participants, including product distributors, dealers, contractors, and installers. (42 U.S.C. 6295(o)(6)(D))

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

Finally, pursuant to the amendments contained in section 310(3) of EISA 2007, any final rule for new or amended energy conservation standards promulgated after July 1, 2010 are required to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) Specifically, when DOE adopts a standard for a covered product after that date, it must, if justified by the criteria for adoption of standards under 42 U.S.C. 6295(o), incorporate standby mode and off mode energy use into the standard, if feasible, or, if that is not feasible, adopt a separate standard for such energy use for that product. (42 U.S.C. 6295(gg)(3)(A)-(B)) DOE's current energy conservation standards for furnaces are expressed in terms of minimum annual fuel utilization efficiencies (AFUE), and, for central air conditioners and heat pumps, they are expressed in terms of minimum seasonal energy efficiency ratios (SEER) for the cooling mode and heating seasonal performance factors (HSPF) for the heating mode.

DOE's current test procedures for furnaces have been updated to address standby mode and off mode energy use. 75 FR 64621 (Oct. 20, 2010). DOE is in the process of amending its test procedures for central air conditioners and heat pumps to address standby mode and off mode energy use. 75 FR 31224 (June 2, 2010). In this rulemaking, DOE is adopting provisions to comprehensively address such energy use. In addition, DOE is amending the test procedure for furnaces and boilers to specify that furnaces manufactured on or after May 1, 2013 (i.e., the compliance date of the standard) will be required to be tested for standby mode and off mode energy consumption for purposes of certifying compliance with the standard. As noted above, for central air conditioners and heat pumps, DOE is currently in the process of amending the test procedures. Accordingly, DOE is including language to specify that off mode testing does not need to be performed until the compliance date for the applicable off mode energy conservation standards resulting from this rule.

DOE has also reviewed this regulation pursuant to Executive Order 13563, issued on January 18, 2011 (76 FR 3281, Jan. 21, 2011). EO 13563 is supplemental to and explicitly reaffirms the principles, structures, and definitions governing regulatory review established in Executive Order 12866. To the extent permitted by law, agencies are required by Executive Order 13563 to: (1) propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify); (2) tailor regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations; (3) select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity); (4) to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt; and (5) identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public.

We emphasize as well that Executive Order 13563 requires agencies "to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible." In its guidance, the Office of Information and Regulatory Affairs has emphasized that such techniques may include "identifying changing future compliance costs that might result from technological innovation or anticipated behavioral changes." For the reasons stated in the preamble, DOE believes that today's direct final rule is consistent with these principles, including that, to the extent permitted by law, agencies adopt a regulation only upon a reasoned determination that its benefits justify its costs and select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits. Consistent with EO 13563, and the range of impacts analyzed in this rulemaking, the energy efficiency standard adopted herein by DOE achieves maximum net benefits.

Comment [A6]: Change recommended by OIRA.

B. Background

1. Current Standards

a. Furnaces

EPCA established the energy conservation standards that apply to most residential furnaces currently being manufactured, consisting of a minimum AFUE of 75 percent for mobile home furnaces and a minimum AFUE of 78 percent for all other furnaces, except "small" gas furnaces (those having an input rate of less than 45,000 Btu per hour), for which DOE was directed to prescribe a separate standard. (42 U.S.C. 6295(f)(1)-(2); 10 CFR 430.32(e)(1)(i)) The standard for mobile home furnaces has applied to products manufactured for sale in the United States, or imported into the United States, since September 1, 1990, and the standard for most other furnaces has applied to products manufactured or imported since January 1, 1992. Id. On November 17, 1989, DOE published a final rule in the Federal Register adopting the current standard for "small" gas furnaces, which consists of a minimum AFUE of 78 percent that has applied to products manufactured or imported since January 1, 1992. 54 FR 47916.

Pursuant to EPCA, DOE was required to conduct further rulemaking to consider amended energy conservation standards for furnaces. (42 U.S.C. 6295(f)(4)) For furnaces manufactured or imported on or after November 19, 2015, DOE published a final rule in the Federal Register on November 19, 2007 (the November 2007 Rule) that revised these standards for most furnaces, but left them in place for two product classes (i.e., mobile home oil-fired furnaces and weatherized oil-fired furnaces). 72 FR 65136. This rule completed the first of the two rulemakings required under 42 U.S.C.

6295(f)(4)(B)-(C) to consider amending the standards for furnaces. The energy conservation standards in the November 2007 Rule consist of a minimum AFUE level for each of the six classes of furnaces (10 CFR 430.32(e)(1)(ii)) and are set forth in Table II.1 below.

Table II.1 Energy Conservation Standards for Residential Furnaces Manufactured On or After November 19, 2015

Product Class	**AFUE (percent)**
Non-weatherized Gas Furnaces	80
Weatherized Gas Furnaces	81
Mobile Home Oil-Fired Furnaces	75
Non-weatherized Oil-Fired Furnaces	82
Weatherized Oil-Fired Furnaces	78

b. Central Air Conditioners and Heat Pumps

Congress initially prescribed statutory standard levels for residential central air conditioners and heat pumps. (42 U.S.C. 6295(d)(1)-(2)) DOE was required to subsequently conduct two rounds of rulemaking to consider amended standards for these products. (42 U.S.C. 6295(d)(3)) In a final rule published in the Federal Register on August 17, 2004 (the August 2004 Rule), DOE prescribed the current Federal energy conservation standards for central air conditioners and heat pumps manufactured or imported on or after January 23, 2006. 69 FR 50997. This rule completed the first of the two rulemakings required under 42 U.S.C. 6295(d)(3)(A) to consider amending the standards for these products. The standards consist of a minimum SEER for each class of air conditioner and a minimum SEER and HSPF for each class of heat pump (10 CFR 430.32(c)(2)). These standards are set forth in Table II.2 below.

Table II.2 Energy Conservation Standards for Central Air Conditioners and Heat Pumps Manufactured On or After January 23, 2006

Product Class	SEER	HSPF
Split-System Air Conditioners	13	-
Split-System Heat Pumps	13	7.7
Single-Package Air Conditioners	13	-
Single-Package Heat Pumps	13	7.7
Through-the-wall Air Conditioners and Heat Pumps – Split System*	10.9	7.1
Though-the-wall Air Conditioners and Heat Pumps – Single Package*	10.6	7.0
Small-Duct, High-Velocity Systems[14]	13	7.7
Space-Constrained Products – Air Conditioners	12	-
Space-Constrained Products – Heat Pumps	12	7.4

*As defined in 10 CFR 430.2, this product class applies to products manufactured prior to January 23, 2010.

2. History of Standards Rulemaking for Residential Furnaces, Central Air Conditioners, and Heat Pumps

a. Furnaces

Amendments to EPCA in the National Appliance Energy Conservation Act of 1987 (NAECA; Pub. L. 100-12) established EPCA's original energy conservation standards for furnaces, which are still in force, consisting of the minimum AFUE levels described above for mobile home furnaces and for all other furnaces except "small" gas furnaces. (42 U.S.C. 6295(f)(1)-(2)) Pursuant to 42 U.S.C. 6295(f)(1)(B), in November 1989, DOE adopted a mandatory minimum AFUE level for "small" furnaces. 54 FR 47916 (Nov. 17, 1989). DOE was required to conduct two more cycles of rulemakings to determine whether to amend all of the standards for furnaces. (42 U.S.C. 6295(f)(4)(B)-(C)) As discussed above, the November 2007 Rule completed the first cycle of required

[14] In 2004 and 2005, DOE's Office of Hearings and Appeals (OHA) granted exception relief from the standards for this class of products, under section 504 of the DOE Organization Act (42 U.S.C. 7194), to allow three manufacturers to sell such products so long as they had a SEER no less than 11 and an HSPF no less than 6.8. See Office of Hearings and Appeals case numbers TEE-0010 and TEE-0011, which were filed on May 24, 2004.

rulemaking to consider amendment of the standards for furnaces under 42 U.S.C. 6295(f)(4)(B).

Following DOE's adoption of the November 2007 Rule, however, several parties jointly sued DOE in the United States Court of Appeals for the Second Circuit to invalidate the rule. Petition for Review, State of New York, et al. v. Department of Energy, et al., Nos. 08-0311-ag(L); 08-0312-ag(con) (2d Cir. filed Jan. 17, 2008). The petitioners asserted that the standards for residential furnaces promulgated in the November 2007 Rule did not reflect the "maximum improvement in energy efficiency" that "is technologically feasible and economically justified," as required under 42 U.S.C. 6295(o)(2)(A). On April 16, 2009, DOE filed with the Court a motion for voluntary remand that the petitioners did not oppose. The motion did not state that the November 2007 Rule would be vacated, but indicated that DOE would revisit its initial conclusions outlined in the November 2007 Rule in a subsequent rulemaking action. Motion for Voluntary Remand, State of New York, et al. v. Department of Energy, et al., supra. The Court granted the voluntary remand on April 21, 2009. State of New York, et al. v. Department of Energy, et al., supra, (order granting motion). Under the remand agreement, DOE anticipated that it would issue a revised final rule amending the energy conservation standards for furnaces by May 1, 2011.[15] DOE also agreed that the final rule would address both regional standards for furnaces, as well as the effects of alternate

[15] The current rulemaking for furnaces is being conducted pursuant to authority under 42 U.S.C. 6295(f)(4)(C) and (o)(6). DOE notes that the second round of amended standards rulemaking called for under 42 U.S.C. 6295(f)(4)(C) applies to both furnaces and boilers. However, given the relatively recently prescribed boiler standards under 42 U.S.C. 6295(f)(3), with compliance required for products manufactured or imported on or after September 1, 2012, DOE has decided to consider amended standards for boilers under 42 U.S.C. 6295(f)(4)(C) in a future rulemaking.

standards on natural gas prices. Subsequently, the furnaces rulemaking was combined with the central air conditioners and heat pumps rulemaking because of the functional and analytical interplay of these types of products (see section III.A for more details). The petitioners and DOE agreed that the final rule for furnaces should be issued on June 30, 2011, to coincide with the date by which the central air conditioner and heat pump rulemaking is required to be issued.

DOE initiated the portion of this rulemaking that concerns furnaces on March 11, 2010, by publishing on the DOE website its "Energy Conservation Standards for Residential Furnaces Rulemaking Analysis Plan" (furnaces RAP). (The furnaces RAP is available at: http://www1.eere.energy.gov/buildings/appliance_standards/residential/furnaces_nopm_rulemaking_analysis.html.) The furnaces RAP set forth the product classes DOE planned to analyze for purposes of amending the energy conservation standards for furnaces, and, as set forth below, the approach DOE would use to evaluate such amended standards. DOE also published a notice of public meeting (NOPM) announcing the availability of the RAP and a public meeting to discuss and receive comments on the subjects in that document, and requesting written comment on these subjects. 75 FR 12144 (March 15, 2010) (the March 2010 NOPM). In this notice, DOE stated its interest in receiving views concerning other relevant issues that participants believe would affect energy conservation standards for furnaces or that DOE should address. Id. at 12147-48.

The RAP provided an overview of the activities DOE planned to undertake in developing amended energy conservation standards for furnaces. It included discussion of: (1) a consensus agreement[16] that recommended particular standards for DOE adoption for furnaces and central air conditioners/heat pumps; (2) DOE's consideration of whether to conduct a single rulemaking to address standards either for these two products or for these products and furnace fans, and (3) DOE's intention to develop regional standards for furnaces. In addition, the RAP described the analytical framework that DOE planned to use in any rulemaking that considered amended standards for furnaces, including a detailed description of the methodology, the analytical tools, the analyses DOE would perform, and the relationships among these analyses. DOE also summarized in detail all of these points in the March 2010 NOPM, including the nature and function of the analyses DOE would perform. Id. at 12146-47. These analyses are as follows:

• A market and technology assessment to address the scope of this rulemaking, identify the potential classes for furnaces, characterize the market for this product, and review techniques and approaches for improving its efficiency;

• A screening analysis to review technology options to improve the efficiency of furnaces, and weigh these options against DOE's four prescribed screening criteria;

[16] On January 15, 2010, several interested parties submitted a joint comment to DOE recommending adoption of minimum energy conservation standards for residential central air conditioners, heat pumps, and furnaces, as well as associated compliance dates for such standards, which represents a negotiated agreement among a variety of interested stakeholders including manufacturers and environmental and efficiency advocates. The original agreement (referred to as the "consensus agreement") was completed on October 13, 2009, and had 15 signatories. For more information, see section III.B of this direct final rule.

• An engineering analysis to estimate the manufacturer selling prices (MSPs) associated with more energy-efficient furnaces;

• An energy use analysis to estimate the annual energy use of furnaces;

• A markups analysis to convert estimated MSPs derived from the engineering analysis to consumer prices;

• A life-cycle cost analysis to calculate, for individual consumers, the discounted savings in operating costs throughout the estimated average life of the product, compared to any increase in installed costs likely to result directly from the imposition of a given standard;

• A payback period (PBP) analysis to estimate the amount of time it takes individual consumers to recover the higher purchase price expense of more energy-efficient products through lower operating costs;

• A shipments analysis to estimate shipments of furnaces over the time period examined in the analysis, for use in performing the national impact analysis (NIA);

• A national impact analysis to assess the national and regional energy savings, and the national and regional net present value of total consumer costs and savings, expected to result from specific, potential energy conservation standards for furnaces;

• A manufacturer impact analysis to evaluate the effects on manufacturers of new efficiency standards.

• A utility impact analysis to estimate specific effects of standards for furnaces on the utility industry;

• An employment impacts analysis to assess the indirect impacts of standards on employment in the national economy;

• An environmental impact analysis to quantify and consider the environmental effects of amended standards for furnaces; and

• A regulatory impact analysis to address the potential for non-regulatory approaches to supplant or augment standards to improve the efficiency of furnaces.

The public meeting announced in the March 2010 NOPM took place on March 31, 2010 at DOE headquarters in Washington, D.C. At this meeting, DOE presented the methodologies it intends to use and the analyses it intends to perform to consider amended energy conservation standards for furnaces. Interested parties that participated in the public meeting discussed a variety of topics, but focused on the following issues: (1) the consensus agreement; (2) the scope of coverage for the rulemaking; (3) a combined rulemaking; (4) regional standards and their enforcement; (5) test procedure and rating metrics; (6) product classes; (7) efficiency levels and representative products analyzed in the engineering analysis; (8) installation, repair, and maintenance costs; and (9) product and fuel switching. The comments received since publication of the March 2010 NOPM, including those received at the March 2010 public meeting, have contributed to DOE's resolution of the issues in this rulemaking. This direct final rule quotes and/or summarizes these comments, and responds to all the issues they raised. (A parenthetical reference at the end of a quotation or paraphrase provides the location of the item in the public record.)

b. Central Air Conditioners and Heat Pumps

As with furnaces, NAECA included amendments to EPCA that established EPCA's original energy conservation standards for central air conditioners and heat pumps, consisting of two minimum SEER levels for air conditioners and for heat pumps when operating in the cooling mode and two minimum HSPF levels for heat pumps when operating in the heating mode. (42 U.S.C. 6295(d)(1)-(2)) One of the SEER levels and one of the HSPF levels applied to split systems, and the other SEER and HSPF levels applied to single package systems. Each "split system" consists of an outdoor unit and an indoor unit which are ''split'' from each other and connected via refrigerant tubing. The outdoor unit has a compressor, heat exchanger coil, fan, and fan motor. The indoor unit has a heat exchanger coil and a blower fan unless it resides within a furnace, in which case the furnace contains the blower fan for air circulation. In "single package systems," all the components that comprise a split system, including the air circulation components, are in a single cabinet that resides outdoors. In both types of systems, conditioned air is conveyed to the home via ducts.

EPCA, as amended, also requires DOE to conduct two cycles of rulemakings to determine whether to amend the energy conservation standards for central air conditioners and heat pumps. (42 U.S.C. 6295(d)(3)) Pursuant to 42 U.S.C. 6295(d)(3)(A), on January 22, 2001, DOE published a final rule in the Federal Register that adopted amended standards for split system air conditioners and heat pumps and single package air conditioners and heat pumps. 66 FR 7170 (the January 2001 Rule). However, shortly after publication of the January 2001 Rule, DOE postponed the effective date of the rule from February 21, 2001 to April 23, 2001 in response to President Bush's Regulatory Review Plan, and in order to reconsider the amended standards it contained. 66 FR 8745 (Feb. 2, 2001). While reviewing the amended standards, DOE further postponed the effective date pending the outcome of a petition submitted by the Air Conditioning and Refrigeration Institute. 66 FR 20191 (April 20, 2001). DOE subsequently withdrew the 2001 final rule and published another final rule which adopted revisions of these amended standards, as well as new amended standards for the product classes for which the January 2001 Rule had not prescribed standards. 67 FR 36368 (May 23, 2002) (the May 2002 Rule). The Natural Resources Defense Council (NRDC), along with other public interest groups and several State Attorneys General filed suit in the U.S. Court of Appeals for the Second Circuit, challenging DOE's withdrawal of the January 2001 final rule and promulgation of the May 2002 final rule. On January 13, 2004, the U.S. Court of Appeals for the Second Circuit invalidated the May 2002 Rule's revisions of the standards adopted in the January 2001 Rule, because the May 2002 final rule had lower amended standards than the January 2001 Rule and, thus, violated 42 U.S.C. 6295(o)(1) (i.e., the "anti-backsliding clause"). Natural Resources Defense Council v. Abraham, 355 F.3d 179 (2d Cir. 2004). However, the Court's decision did not affect the standards DOE adopted in the May 2002 Rule for products not covered by the standards in the January 2001 Rule. To be consistent with the court's ruling, DOE published the August 2004 Rule, which established the standards currently applicable to central air conditioners and heat pumps. 69 FR 50997 (August 17, 2004). As stated above, this rule completed the first cycle of rulemaking for revised standards for central air conditioners and heat pumps under 42 U.S.C. 6295(d)(3)(A), and these standards took effect on January 23, 2006. Id.

DOE initiated the current rulemaking on June 2, 2008, by publishing on its website its "Rulemaking Framework for Residential Central Air Conditioners and Heat Pumps." (A PDF of the framework document is available at http://www1.eere.energy.gov/buildings/appliance_standards/residential/cac_heatpumps_new_rulemaking.html.) DOE also published a notice announcing the availability of the framework document and a public meeting on the document, and requesting public comment on the matters raised in the document. 73 FR 32243 (June 6, 2008). The framework document described the procedural and analytical approaches that DOE anticipated using to evaluate energy conservation standards for central air conditioners and heat pumps and identified various issues to be resolved in conducting this rulemaking.

DOE held the public meeting on June 12, 2008, in which it: (1) presented the contents of the framework document; (2) described the analyses it planned to conduct during the rulemaking; (3) sought comments from interested parties on these subjects; and (4) in general, sought to inform interested parties about, and facilitate their involvement in, the rulemaking. Interested parties discussed the following major issues at the public meeting: (1) the scope of coverage for the rulemaking; (2) product classes; (3) test procedure modifications; (4) effects on cost and system efficiency of phasing out certain refrigerants due to climate and energy legislation such as the Waxman-Markey bill (H.R. 2454); (5) regulation of standby mode and off mode energy consumption; and (6) regional standards. At the meeting and during the comment period on the framework document, DOE received many comments that helped it identify and resolve issues pertaining to central air conditioners and heat pumps relevant to this rulemaking.

DOE then gathered additional information and performed preliminary analyses to help develop potential energy conservation standards for these products. This process culminated in DOE's announcement of another public meeting to discuss and receive comments on the following matters: (1) the product classes DOE planned to analyze; (2) the analytical framework, models, and tools that DOE was using to evaluate standards; (3) the results of the preliminary analyses performed by DOE; and (4) potential standard levels that DOE could consider. 75 FR 14368 (March 25, 2010) (the March 2010 Notice).

DOE also invited written comments on these subjects and announced the availability on its website of a preliminary technical support document (preliminary TSD) it had prepared to inform interested parties and enable them to provide comments. Id. (The preliminary TSD is available at: http://www1.eere.energy.gov/buildings/appliance_standards/residential/cac_heatpumps_new_rulemaking.html) Finally, DOE stated its interest in receiving views concerning other relevant issues that participants believed would affect energy conservation standards for central air conditioners and heat pumps, or that DOE should address in this direct final rule. Id. at 14372.

The preliminary TSD provided an overview of the activities DOE undertook to develop standards for central air conditioners and heat pumps and discussed the comments DOE received in response to the framework document. Similar to the RAP for furnaces, it also addressed the consensus agreement that recommended particular standards for DOE adoption for furnaces and central air conditioners/heat pumps, and it addressed DOE's consideration of whether to conduct a single rulemaking to address standards either for these two products or for these products and furnace fans. The preliminary TSD also described the analytical framework that DOE used (and continues to use) in considering standards for central air conditioners and heat pumps, including a description of the methodology, the analytical tools, and the relationships between the various analyses that are part of this rulemaking. The preliminary TSD presented and described in detail each analysis that DOE had performed for these products up to that point, including descriptions of inputs, sources, methodologies, and results, and it included DOE's evaluation of potential regional standards for central air conditioners and heat pumps. These analyses were as follows:

• A market and technology assessment addressed the scope of this rulemaking, identified the potential classes for central air conditioners and heat pumps, characterized the markets for these products, and reviewed techniques and approaches for improving their efficiency;

• A screening analysis reviewed technology options to improve the efficiency of central air conditioners and heat pumps, and weighed these options against DOE's four prescribed screening criteria;

• An engineering analysis estimated the manufacturer selling prices (MSPs) associated with more energy-efficient central air conditioners and heat pumps;

• An energy use analysis estimated the annual energy use of central air conditioners and heat pumps;

• A markups analysis converted estimated MSPs derived from the engineering analysis to consumer prices;

• A life-cycle cost analysis calculated, for individual consumers, the discounted savings in operating costs throughout the estimated average life of central air conditioners and heat pumps, compared to any increase in installed costs likely to result directly from the imposition of a given standard;

• A payback period analysis estimated the amount of time it takes individual consumers to recover the higher purchase price expense of more energy-efficient products through lower operating costs;

• A shipments analysis estimated shipments of central air conditioners and heat pumps over the time period examined in the analysis, and was used in performing the national impact analysis;

• A national impact analysis assessed the national and regional energy savings, and the national and regional net present value of total consumer costs and savings, expected to result from specific, potential energy conservation standards for central air conditioners and heat pumps; and

• A preliminary manufacturer impact analysis took the initial steps in evaluating the effects on manufacturers of amended efficiency standards.

In the March 2010 Notice, DOE addressed the consensus agreement, regional standards, and the possibility of a combined rulemaking. DOE also summarized in detail in the notice the nature and function of the following analyses: (1) engineering analysis;

(2) energy use analysis; (3) markups to determine installed prices; (4) LCC and PBP analyses; and (5) national impact analysis. 75 FR 14368, 14370-71 (March 25, 2010).

The public meeting announced in the March 2010 Notice took place on May 5, 2010 at DOE headquarters in Washington, D.C. At this meeting, DOE presented the methodologies and results of the analyses set forth in the preliminary TSD. Interested parties that participated in the public meeting discussed a variety of topics, but centered on the following issues: (1) the consensus agreement; (2) a combined rulemaking with furnaces and furnace fans; (3) efficiency metrics; (4) technology options; (5) product classes; (6) installation, maintenance, and repair costs; (7) markups and distributions chains; (8) central air conditioner and heat pumps shipments; and (9) electricity prices. The comments received since publication of the March 2010 Notice, including those received at the May 2010 public meeting, have contributed to DOE's resolution of the issues in this rulemaking as they pertain to central air conditioners and heat pumps. This direct final rule responds to the issues raised by the commenters. (A parenthetical reference at the end of a quotation or paraphrase provides the location of the item in the public record.)

III. General Discussion

A. Combined Rulemaking

As discussed in section II.B.2, DOE had been conducting or planning separate standards rulemakings for three interrelated products: (1) central air conditioners and heat pumps; (2) gas furnaces; and (3) furnace fans. Rather than analyze each set of products separately, DOE considered combining the analyses to examine how the interaction between the three products impacts the cost to consumers and the energy savings resulting from potential amended standards. In both its RAP regarding energy conservation standards for residential furnaces and preliminary analysis for residential central air conditioners and heat pumps, DOE specifically invited comment from interested parties related to the potential for combining the rulemakings regarding energy conservation standards for residential central air conditioners and heat pumps, residential furnaces, and furnace fans.

NRDC commented that it supports accelerating the furnace fan rulemaking to coincide with the rulemakings for furnaces and central air conditioners, because a combined rulemaking would potentially provide analytical simplification and is consistent with the President's request that DOE meet all statutory deadlines and accelerate those with large potential energy savings. (FUR: NRDC, No.1.3.020 at pp. 9-10)[17] The California investor-owned utilities (CA IOUs, i.e., Pacific Gas & Electric, Southern California Gas Company, San Diego Gas and Electric, and Southern California Edison) also supported a combined rulemaking, arguing that this approach would allow DOE to more accurately analyze the energy-efficiency impacts of various standards options. The CA IOUs also stated that a combined rulemaking would reduce redundant workload for DOE and minimize the number of public meetings. (FUR: CA IOUs, No.1.3.017 at p. 2) Proctor Engineering Group (Proctor) stated support for combining

[17] In this direct final rule, DOE discusses comments received in response to both the furnaces rulemaking analysis plan and the central air conditioners and heat pumps preliminary analysis. Comments received in response to the furnace rulemaking analysis plan are identified by "FUR" preceding the comment citation. Comments received in response to the central air conditioners and heat pump preliminary analysis are identified by "CAC" preceding the comment citation.

the furnace, furnace fan, and central air conditioner and heat pump rulemakings because the three products work together. Proctor asserted that the standards need to be integrated together and that the analysis should be integrated as well. (FUR: Proctor, Public Meeting Transcript, No. 1.2.006 at p. 29) In written comments, Proctor elaborated that DOE could improve current standards by promulgating standards that recognize the interdependence of furnaces, air conditioners, heat pumps, and air handler fans within the average U.S. household and that are consistent such that they can be properly integrated within a system to produce results that are representative of a system typically found in a home in the United States of America. (FUR, Proctor, FDMS No. 0002 at p. 2)

The American Council for an Energy Efficient Economy (ACEEE), Heating Air-conditioning & Refrigeration Distributors International (HARDI), Ingersoll Rand, Southern Company (Southern), Edison Electric Institute (EEI), and Lennox supported a combined rulemaking of furnaces and central air conditioners and heat pumps, but did not support a combined rulemaking that also covers furnace fans. (FUR: ACEEE, No.1.3.009 at p. 4; HARDI, No.1.3.016 at pp. 2, 5-6; Ingersoll Rand, No.1.3.006 at p. 1; Lennox, No.1.3.018 at p. 2) (CAC: ACEEE, No. 72 at p. 2; HARDI, No. 56 at p. 2; Lennox No. 65 at p. 2; Ingersoll Rand, No. 66 at p. 8; Southern, No. 73 at p.2; EEI, No. 75 at p. 4) HARDI commented that there would not be time for a thorough analysis of furnace fans if that rulemaking is accelerated to include it with furnaces and central air conditioners and heat pumps. (FUR: HARDI, No.1.3.016 at pp. 2, 5-6) Ingersoll Rand concurred, further stating that furnace fan efficiency is a complex topic that needs to be handled separately. (FUR: Ingersoll Rand, No.1.3.006 at p. 1) (CAC: Ingersoll Rand, No. 66 at p.

8) Lennox stated that the furnace fan rulemaking will be more complicated than typical DOE proceedings, and valuable information can be obtained by conducting the furnace and central air conditioner and heat pump rulemakings in advance of the fan rulemaking. Additionally, Lennox stated that the furnace fan rulemaking should not be rushed by accelerating the schedule by a year and a half. (FUR: Lennox, No.1.3.018 at p. 2) (CAC: Lennox, No. 65 at p. 2)

The Appliance Standards Awareness Project (ASAP) submitted a joint comment on behalf of ACEEE, the Air-conditioning, Heating and Refrigeration Institute (AHRI), Alliance to Save Energy (ASE), ASAP, California Energy Commission (CEC), National Consumer Law Center (NCLC) (on behalf of low-income clients), NRDC, Northeast Energy Efficiency Partnerships (NEEP), and Northwest Power and Conservation Council (NPCC). Collectively, these organizations are referred to as "Joint Stakeholders," when referencing this comment. The Joint Stakeholders stated that rules for furnaces and air conditioners can be completed much earlier than a final rule for furnace fans, especially if the furnace and air conditioner rules are based on the consensus agreement. (FUR: Joint Stakeholders, No.1.3.012 at p. 3) Similarly, AHRI supported a separate rulemaking for furnace fans, but it stated that it would agree to a combined central air conditioners and heat pumps and furnaces rulemaking, if the consensus agreement is adopted by DOE in a direct final rule or through an expedited normal rulemaking. In the event that DOE decides not to adopt the consensus agreement, AHRI recommended separate rulemakings for all three products, and explicitly stated that the furnace fan rulemaking should not be combined with either of the other two products under any circumstances because AHRI believes that shortening the furnace fan rulemaking is unreasonable given that DOE has no prior experience with furnace fans. AHRI stated that more time is needed to fully analyze the electrical energy consumed by furnace fans in order to establish appropriate energy conservation standards for those products. (FUR: AHRI, No.1.3.008 at p. 3) (CAC: AHRI, No. 67 at p. 3) Rheem recommended that DOE should conduct a separate rulemaking for furnace fans and should only combine the rulemakings for furnaces and central air conditioners and heat pumps if DOE adopts the consensus agreement. Rheem stated that much study and analysis is needed to determine the appropriate energy conservation standards for furnace fans, and that shortening the timeframe is unreasonable and not imperative. (FUR: Rheem, No.1.3.022 at pp. 2-3) The American Public Power Association (APPA) commented that it supports an "across the board" rulemaking that creates an "even playing field" for residential space heating technologies (e.g., heat pumps and furnaces) so as to avoid a less competitive market that would cause market distortions and non-rational purchasing behavior. (FUR: APPA, No.1.3.011 at p. 4)

The Air Conditioning Contractors of America (ACCA) stated there is no added benefit in combining the rulemakings for furnaces, residential central air conditioners and heat pumps, and furnaces fans. (FUR: ACCA, No.1.3.007 at p. 3) The American Public Gas Association (APGA) commented that it does not support combining the furnace, central air conditioner, and furnace fan rulemakings. (FUR: APGA, No.1.3.004 at p. 2)

DOE agrees with the comments supporting a combined rulemaking for central air conditioners, heat pumps, and furnaces because these products are linked as part of the complete heating, ventilation, and air-conditioning (HVAC) system for a home. A residential HVAC system often includes a central air conditioner, a furnace, and a furnace fan, or in some instances a heat pump, a furnace, and a furnace fan. Further, all of the major manufacturers of these products produce central air conditioners, heat pumps, and furnaces and use the same distribution network for these products. Combining the analyses for these products simplified the analyses and allowed for the analyses to accurately account for the relations between the different systems.

However, DOE also believes there are merits to the comments suggesting that DOE should not attempt to combine furnace fans with the furnace and central air conditioner and heat pump rulemaking. While previous rulemakings have been conducted to regulate central air conditioners and heat pumps and furnaces, furnace fans are not currently regulated. DOE recognizes that the analyses required to develop a test procedure and to determine appropriate energy conservation standards for furnaces fans are complex and will be extensive. Therefore, DOE has determined that the furnace fan analysis cannot be accelerated such that it could be completed in the shortened timeframe that would be necessary for a combined rule that would also include furnace fans, while still generating valid and reliable results. Additionally, DOE believes that the furnace fan rulemaking would benefit from insights gained during the combined rulemaking of central air conditioners and heat pumps and furnaces. Therefore, DOE has decided to combine only the central air conditioner and heat pump and furnace rulemakings into a single combined rulemaking. The furnace fan rulemaking will continue as a separate rulemaking, and DOE will publish a final rule to establish energy conservation standards for furnace fans by December 31, 2013, as required by 42 U.S.C. 6295(f)(4)(D).

B. Consensus Agreement

1. Background

On January 15, 2010, AHRI, ACEEE, ASE, ASAP, NRDC, and NEEP submitted a joint comment to DOE's residential furnaces and central air conditioners and heat pumps rulemakings recommending adoption of a package of minimum energy conservation standards for residential central air conditioners, heat pumps, and furnaces, as well as associated compliance dates for such standards, which represents a negotiated agreement among a variety of interested stakeholders including manufacturers and environmental and efficiency advocates. (FUR: Joint Comment, No. 1.3.001; CAC: Joint Comment, No. 47) More specifically, the original agreement was completed on October 13, 2009, and had 15 signatories, including AHRI, ACEEE, ASE, NRDC, ASAP, NEEP, NPCC, CEC, Bard Manufacturing Company Inc., Carrier Residential and Light Commercial Systems, Goodman Global Inc., Lennox Residential, Mitsubishi Electric & Electronics USA, National Comfort Products, and Trane Residential. Numerous interested parties, including signatories of the consensus agreement as well as other parties, expressed support for DOE adoption of the consensus agreement in both oral and written comments on the furnaces and central air conditioners rulemakings, which are described in further detail in section III.B.3. In both the furnace RAP and the central air conditioner and heat pump preliminary analysis, DOE requested comment on all aspects of the consensus agreement, including the regional divisions, recommended standard levels, and the suggested compliance dates.

After careful consideration of the joint comment containing a consensus recommendation for amended energy conservation standards for residential central air conditioners, heat pumps, and furnaces, the Secretary has determined that this "Consensus Agreement" has been submitted by interested persons who are fairly representative of relevant points of view on this matter. Congress provided some guidance within the statute itself by specifying that representatives of manufacturers of covered products, States, and efficiency advocates are relevant parties to any consensus recommendation. (42 U.S.C. 6295(p)(4)(A)) As delineated above, the Consensus Agreement was signed and submitted by a broad cross-section of the manufacturers who produce the subject products, their trade associations, and environmental and energy-efficiency advocacy organizations. Although States were not signatories to the Consensus Agreement, they did not express any opposition to it. Moreover, DOE does not read the statute as requiring absolute agreement among all interested parties before the Department may proceed with issuance of a direct final rule. By explicit language of the statute, the Secretary has discretion to determine when a joint recommendation for an energy or water conservation standard has met the requirement for representativeness (i.e., "as determined by the Secretary"). Accordingly, DOE will consider each consensus recommendation on a case-by-case basis to determine whether the submission has been made by interested persons fairly representative of relevant points of view.

Pursuant to 42 U.S.C. 6295(p)(4), the Secretary must also determine whether a jointly-submitted recommendation for an energy or water conservation standard is in accordance with 42 U.S.C. 6295(o) or 42 U.S.C. 6313(a)(6)(B), as applicable. This determination is exactly the type of analysis which DOE conducts whenever it considers potential energy conservation standards pursuant to EPCA. DOE applies the same principles to any consensus recommendations it may receive to satisfy its statutory obligation to ensure that any energy conservation standard that it adopts achieves the maximum improvement in energy efficiency that is technologically feasible and economically justified and will result in significant conservation of energy, Upon review, the Secretary determined that the Consensus Agreement submitted in the instant rulemaking comports with the standard-setting criteria set forth under 42 U.S.C. 6295(o). Accordingly, the consensus agreement levels were included as TSL 4 in today's rule, the details of which are discussed at relevant places throughout this document.

In sum, as the relevant criteria under 42 U.S.C. 6295(p)(4) have been satisfied, the Secretary has determined that it is appropriate to adopt amended energy conservation standards for residential central air conditioners, heat pumps, and furnaces through this direct final rule

As required by the same statutory provision, DOE is also simultaneously publishing a NOPR which proposes the identical standard levels contained in this direct final rule with a 110-day public comment period. (While DOE typically provides a comment period of 60 days on proposed standards, in this case DOE provides a comment period of the same length as the comment period on the direct final rule.) DOE will consider whether any comment received during this comment period is sufficiently "adverse" as to provide a reasonable basis for withdrawal of the direct final rule and continuation of this rulemaking under the NOPR.. Typical of other rulemakings, it is the substance, rather than the quantity, of comments that will ultimately determine whether a direct final rule will be withdrawn. To this end, the substance of any adverse comment(s) received will be weighed against the anticipated benefits of the Consensus Agreement and the likelihood that further consideration of the comment(s) would change the results of the rulemaking. DOE notes that to the extent an adverse comment had been previously raised and addressed in the rulemaking proceeding, such a submission will not typically provide a basis for withdrawal of a direct final rule.

2. Recommendations

a. Regions

The consensus agreement divides the nation into three regions for residential central air conditioners and heat pumps, and two regions for residential furnaces based on the population-weighted number of heating degree days (HDD) of each State and recommends a different minimum standard level for products installed in each region. For these products generally, States with 5,000 HDD or more are considered as part of the northern region, while States with less than 5,000 HDD are considered part of the southern region, and these regions (and the States that compose them) are discussed further in section III.D. For residential central air conditioners and heat pumps, the consensus agreement establishes a third region – the "southwest" region – comprised of California, Arizona, New Mexico, and Nevada. For furnaces, the southwest region States are included in the southern region. For residential central air conditioners and heat pumps, the States in the northern region would be subject to the "National standard" under 42 U.S.C. 6295(o)(6)(B)(i), while regional standards would apply for States in the two southern regions (i.e., the hot-dry region and hot-humid region). For furnaces, the States in the southern region would be subject to the "National standard" under 42 U.S.C. 6295(o)(6)(B)(i), while the States in the northern region would be required to meet a more-stringent regional standard. DOE received numerous comments from interested parties regarding the regional definitions for the analysis, some of which were related to the regions recommended in the consensus agreement. These comments are discussed in detail in section III.D, "Regional Standards."

b. Standard Levels

The minimum energy conservation standards for furnaces and central air conditioners and heat pumps recommended by the consensus agreement are contained in Table III.1 and Table III.2. (CAC: Joint Comment, No. 47 at p. 2) The consensus agreement recommends amended AFUE standards for all furnace product classes that are being considered in this rulemaking for amended minimum AFUE energy conservation standards. However, the agreement does not contain recommendations for amended SEER and HSPF standards for the space-constrained or small-duct, high-velocity (SDHV) product classes of central air conditioners and heat pumps, which are also included in this rulemaking. Additionally, the consensus agreement does not contain recommendations for energy conservation standards for standby mode and off mode energy consumption, which DOE is required to consider in this rulemaking pursuant to 42 U.S.C. 6295(gg)(3).

For central air conditioners, the consensus agreement recommends that DOE adopt dual metrics (i.e., SEER and EER) for the hot-dry region. Generally, DOE notes that EPCA's definition of "efficiency descriptor" at 42 U.S.C 6291(22) specifies that the efficiency descriptor for both central air conditioners and heat pumps shall be SEER. Accordingly, DOE used SEER as the sole metric for analyzing most of the TSLs considered for today's direct final rule. However, DOE believes that the language at 42 U.S.C 6295(p)(4) provides DOE some measure of discretion when considering recommended standards in a consensus agreement, if the Secretary determines that the recommended standards are in accordance with 42 U.S.C. 6295(o).

Table III.1 Consensus Agreement Recommended Minimum Energy Conservation Standards for Residential Furnaces

System Type	Recommended AFUE Requirement for States with ≥ 5,000 HDD* %	Recommended AFUE Requirement for States with < 5,000 HDD** %
Non-weatherized Gas Furnaces†	90	80
Non-weatherized Oil Furnaces	83	83
Gas-Packs (weatherized furnace)	81	81

* These States include: Alaska, Colorado, Connecticut, Idaho, Illinois, Indiana, Iowa, Kansas, Maine, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Dakota, Ohio, Oregon, Pennsylvania, Rhode Island, South Dakota, Utah, Vermont, Washington, West Virginia, Wisconsin, and Wyoming.
** These States include: Alabama, Arizona, Arkansas, California, Delaware, District of Columbia, Florida, Georgia, Hawaii, Kentucky, Louisiana, Maryland, Mississippi, New Mexico, Nevada, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia.
† Non-weatherized gas furnaces also include mobile home furnaces.

Table III.2 Consensus Agreement Recommended Minimum Energy Conservation Standards for Residential Central Air Conditioners and Heat Pumps

System	Recommended	Recommended	Recommended

Type	SEER/HSPF Requirements for Northern "Rest of Country" Region*	SEER/HSPF Requirements for Southeast "Hot-Humid" Region**	SEER/HSPF Requirements for Southwest "Hot-Dry" Region[†]
Split AC	13 SEER	14 SEER	14 SEER/12.2 EER <45,000 Btu/h 14 SEER/11.7EER ≥45,000 Btu/h
Split HP	14 SEER/8.2HSPF	14 SEER/8.2 HSPF	14 SEER/8.2 HSPF
Packaged AC	14 SEER	14 SEER	14 SEER/11.0 EER
Packaged HP	14 SEER/8.0 HSPF	14 SEER/8.0 HSPF	14 SEER/8.0 HSPF
Space Constrained AC and HP and SDHV	No standard recommended	No standard recommended	No standard recommended

* These States include: Alaska, Colorado, Connecticut, Idaho, Illinois, Indiana, Iowa, Kansas, Maine, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Dakota, Ohio, Oregon, Pennsylvania, Rhode Island, South Dakota, Utah, Vermont, Washington, West Virginia, Wisconsin, and Wyoming.
** These States include: Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Hawaii, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia.
[†] These States include: Arizona, California, New Mexico, and Nevada.

c. Compliance Dates

The compliance dates specified in the consensus agreement are May 1, 2013, for non-weatherized furnaces and January 1, 2015, for weatherized furnaces (i.e., "gas-packs") and central air conditioners and heat pumps. These dates are at least eighteen months earlier than the compliance dates for these products as determined under 42 U.S.C. 6295(d)(3)(B) and (f)(4)(C). DOE received several comments from interested parties regarding its consideration of the compliance dates specified by the consensus agreement, as well as comments about the compliance dates under EPCA. A full discussion of comments related to the compliance dates for energy conservation standards for furnaces and central air conditioners and heat pumps is contained in section III.C.

3. Comments on Consensus Agreement

In its RAP for residential furnaces and the preliminary analysis for residential central air conditioners and heat pumps, DOE specifically invited comment from interested parties on the consensus agreement. In particular, DOE was interested in comments relating to the recommended AFUE, SEER, and HSPF requirements, the recommended regional divisions, and the recommended compliance dates for amended standards. As noted above, comments on the regional divisions are discussed in section III.D. Additionally, DOE discusses compliance dates and the related comments in section III.C. DOE received numerous other comments regarding whether interested parties support or do not support the consensus agreement, whether DOE should adopt the consensus agreement as a direct final rule, and additional concerns interested parties have about the agreement. These comments are discussed in the paragraphs below.

Many commenters expressed support for the adoption of the consensus agreement. ACEEE stated it is the best available route to the maximum savings that are technologically feasible and economically justified. (FUR: ACEEE, No.1.3.009 at p. 1) (CAC: ACEEE, No. 72 at p. 1) NRDC requested that DOE move expeditiously to adopt the levels and dates presented by the agreement. (FUR: NRDC, No.1.3.020 at pp. 1-2) NEEP expressed support for the standard levels and procedural improvements in the consensus agreement and urged DOE to implement the recommendations through a direct final rule. (FUR: NEEP, No.1.3.021 at p. 1) ASAP stated its strong support for adoption of the consensus agreement, and encouraged DOE to adopt the consensus agreement as a direct final rule. (FUR: ASAP, Public Meeting Transcript, No. 1.2.006 at pp. 38-39)

AHRI stated that the agreement has several benefits including: (1) an accelerated compliance date of May 2013; (2) acceleration of the next rulemaking iteration; (3) a significant amount of energy savings; (4) economic savings to consumers; and (5) the fact that it would allow DOE to focus its resources on completing other rulemakings involving new or amended energy conservation standards. In the event that DOE cannot promulgate a direct final rule, AHRI recommended that DOE adopt the agreement in an expedited rulemaking process. (FUR: AHRI, No.1.3.008 at pp. 1-3) (CAC: AHRI, No. 67 at pp. 1-2) Carrier stated that DOE should adopt the consensus agreement, because it includes a comprehensive, harmonized approach for new regional efficiency standards that could be implemented in an accelerated fashion. (FUR: Carrier, No.1.3.013 at p. 2) (CAC: Carrier, No. 60 at p. 1) Ingersoll Rand and EEI echoed these comments. (FUR: Ingersoll Rand, No.1.3.006 at p. 1) (CAC: Ingersoll Rand, No. 66 at p. 1; EEI, No. 75 at p. 2) Southern initially stated at the furnaces public meeting that DOE should issue a NOPR and have a comment period rather than go directly to a final rule because many stakeholder groups were left out of the consensus agreement process. (FUR: Southern, Public Meeting Transcript, No. 1.2.006 at pp. 258-59) However, in its later comments on the central air conditioners and heat pumps rulemaking, Southern clarified its position, recommending that DOE accept the consensus agreement and, proceed with a direct final rule on central air conditioners, heat pumps, and furnace standards, if the necessary minor statutory revisions (e.g., changes to building codes) are approved by Congress. (CAC: Southern, No. 73 at p. 1)

Lennox and NPCC supported the adoption of the consensus agreement in full, including the AFUE standards, recommended regional divisions, and recommended compliance dates. Lennox supported DOE's use of a direct final rule to adopt the agreement or, as an alternative, use of the standard rulemaking process in an expedited fashion. (FUR: Lennox, No.1.3.018 at p. 1) (CAC: Lennox, No. 65 at pp.1-2) (CAC: NPCC, No. 74 at p.1) Ingersoll Rand commented that DOE should adopt the consensus agreement because it would allow DOE to focus its resources on the furnace fan rule and on development of regional standards. (CAC: Ingersoll Rand, No. 66 at p. 1) Rheem asserted that Congress authorized DOE to issue direct final rules upon receipt of joint stakeholder proposals and that the agreement satisfies the criteria of the law and the Process Improvement Rule.[18] However, Rheem stated that if DOE cannot issue a direct final rule, Rheem would recommend that DOE adopt the agreement in an expedited rulemaking process. (FUR: Rheem, No.1.3.022 at pp. 1-2) (CAC: Rheem, No. 71 at p.2) Daikin expressed support for the consensus agreement, provided that the SEER level for new construction is raised to 15 SEER on January 1, 2013 and to 18 SEER on January 1, 2016. (CAC: Daikin, No. 63 at p.2)

[18] The Process Improvement Rule was published in the Federal Register by DOE on July 15, 1996, and codified in Appendix A to 10 CFR part 430, subpart C. 61 FR 36974. The Process Improvement Rule elaborated on the procedures, interpretations, and policies that guide DOE in establishing new or amended energy conservation standards for consumer products.

The Joint Stakeholders expressed support for the agreement and encouraged DOE to expedite the adoption of the agreement through either a direct final rule or through the standard rulemaking process. The Joint Stakeholders cited many of the previously mentioned benefits and added that the consensus agreement would enable States to incorporate more-stringent appliance efficiency standards into their building codes, which are limited by Federal appliance efficiency standards. The Joint Stakeholders stated that DOE should address the issues of standby mode and off mode energy consumption for residential furnaces and standards for furnace fans in separate rulemakings without impeding the adoption of the consensus agreement in a final rule in the current rulemaking. (FUR: Joint Stakeholders, No.1.3.012 at pp. 1-4)

APPA stated that it is in favor of the consensus agreement because it provides a high degree of regulatory certainty for manufacturers and utilities, and increases the minimum efficiency of gas and oil furnaces, products for which energy conservation standards have not been updated since 1992. APPA argued that DOE has the authority to adopt the consensus agreement in a direct final rule. (FUR: APPA, No.1.3.011 at pp. 2-3) EEI expressed support for the consensus agreement for many of the reasons outlined above, adding that the consensus agreement would have the added benefit of increasing standards for furnaces at nearly the same time as the efficiency standards for residential boilers are increasing. (FUR: EEI, No.1.3.015 at p. 2) CA IOUs supported the consensus agreement as a balanced package that would achieve significant energy, economic, and environmental benefits, while providing regulatory certainty. They urged DOE to adopt as efficiently as possible the regulatory aspects of the agreement, either through a direct final rule or the normal rulemaking process. However, the CA IOUs recognized that not all stakeholders supported the consensus agreement, and encouraged DOE to choose a rulemaking path that will produce a robust, defensible, and enforceable final standard. (FUR: CA IOUs, No.1.3.017 at p. 1)

On behalf of Texas Client Services Center, Massachusetts Union of Public Housing Tenants, Texas Ratepayers Organization to Save Energy (collectively referred to hereafter as Low Income Groups), the National Consumer Law Center encouraged DOE to accept and implement the recommendations contained in the Joint Comment as soon as possible. The Low Income Groups are particularly interested in having DOE adopt the standards for furnaces, heat pumps, and central air conditioners included in the consensus agreement, along with the associated effective dates and regional boundaries. (FUR: Low Income Groups, No.1.3.019 at pp. 5-6)

In contrast to the above viewpoints, some commenters expressed opposition to, or reservations about, adoption of the consensus agreement. The American Gas Association (AGA) stated that DOE should not adopt the consensus agreement and should continue refining the November 2007 Rule. AGA strongly recommended that DOE should not issue a direct final rule requiring a 90-percent AFUE minimum efficiency for furnaces in the northern States and should, instead, proceed with an analysis of the technological feasibility and economic justification of the proposal, consistent with governing statutory requirements. It added that the signatories of the agreement do not represent consumer interests in the affected States, and that DOE needs to more fully account for potential consumer impacts. (FUR: AGA, No.1.3.010 at p. 2) In the public meeting, AGA expressed concerns about replacing a non-condensing furnace with a condensing furnace due to potential problems with venting systems. (FUR: AGA, Public Meeting Transcript, No. 1.2.006 at pp. 40-41) APGA expressed similar comments, further stating that DOE should consider non-regulatory mechanisms to encourage market transformation to condensing non-weatherized furnaces, including through building codes. (FUR: APGA, No.1.3.004 at pp. 3-4) The National Propane Gas Association (NPGA) also opposed requiring 90-percent AFUE furnaces in northern States, because of concerns related to venting issues in replacement installations (particularly when a furnace that has a common vent with a water heater is being replaced). (FUR: NPGA, No.1.3.005 at p. 4)

HARDI stated that it supports the consensus agreement only to the extent that DOE is confident it can justify increases to residential HVAC minimum efficiency standards and regionalization of standards. HARDI is not convinced such justification is possible given its experiences since the last amendments to the central air conditioners and heat pumps standards in 2006. (FUR: HARDI, No.1.3.016 at p. 4) (CAC: HARDI, No. 56 at p. 4) HARDI believes DOE will have difficulty justifying a higher heating standard in a northern region that includes both North Dakota and Kentucky, which have vastly different heating demands. HARDI also stated that a southeastern regional standard that applies to both Florida and Maryland, or a southwestern regional standard that includes cities with significantly different climates appears to significantly threaten consumer choice and product availability. (FUR: HARDI, No.1.3.016 at p. 5) HARDI is also concerned that: (1) the standards in the consensus agreement will encourage utilities to exit the energy-efficiency business as it pertains to HVAC systems, because they might no longer see value in providing an incentive for 95-percent AFUE premium furnaces if a standard is set at 90-percent AFUE; and (2) the loss of such incentives would make purchases of higher-than-minimum-efficiency furnaces highly unlikely. (FUR: HARDI, No.1.3.016 at p. 8)

ACCA expressed concern over the requirement for condensing furnaces in the northern region, noting that the cost of replacing a non-condensing furnace with a condensing furnace (which might require venting retrofit measures) could be prohibitive in some cases. (FUR: ACCA, No.1.3.007 at pp. 2-3)

DOE also received comments that, while not specifically addressing the consensus agreement, concern the standard-level recommendations for central air conditioners and heat pumps. Specifically, Southern remarked that standards should have equal cooling efficiency requirements for central air conditioners and heat pumps, and Ingersoll Rand, Rheem, and EEI provided similar statements. (CAC: Southern, No. 73 at p. 3) (CAC: Ingersoll Rand, No. 66 at p. 1) (CAC: EEI, No. 75 at p. 5) (CAC: Rheem, No. 76 at p. 2)

In considering the proposed standard levels in the consensus agreement, DOE reviewed 42 U.S.C. 6295(p)(4)(C), which states that if DOE issues a direct final rule (as suggested by the signatories to the consensus agreement) and receives any adverse public comments within 120 days of publication of the rule, then DOE would be forced to withdraw the final rule. Interested parties have already submitted comments expressing opposition to the consensus agreement, which indicates there is a possibility that DOE may receive adverse comments to the adoption of the consensus agreement as part of this direct final rule.

DOE recognizes the substantial effort and analysis that resulted in the consensus agreement and analyzed it as a separate TSL, in conjunction with other TSLs for this direct final rule. As described above, the interested parties opposing the consensus agreement were primarily concerned with the requirement that non-weatherized gas furnaces and mobile home furnaces in the northern region achieve a minimum of 90-percent AFUE. In its analysis for today's direct final rule, DOE addressed the issues raised by the parties with respect to replacement installations of 90-percent AFUE non-weatherized gas furnaces or mobile home furnaces. DOE believes that, although in some instances it may be costly, consumers can replace non-condensing furnace with condensing furnaces in virtually all installations.

As suggested by AGA, DOE performed an analysis of the technological feasibility and economic justification of the consensus agreement recommendations, consistent with statutory requirements in EPCA. DOE fully considered all costs of replacing non-condensing furnaces with condensing furnaces in the northern region. DOE's results indicate that some consumers would be negatively impacted by a northern region standard at 90-percent AFUE for non-weatherized gas furnaces or mobile home furnaces, but that on balance, the benefits of such a standard would outweigh the costs.

Section V.C of this notice discusses the results of DOE's analyses and the weighting of benefits and burdens when considering the consensus agreement standard levels and compliance dates (i.e., TSL 4).

C. Compliance Dates

EPCA establishes a lead time between the publication of amended energy conservation standards and the date by which manufacturers must comply with the amended standards for both furnaces and central air conditioners and heat pumps. For furnaces, EPCA dictates an eight-year period between the rulemaking publication date and compliance date for the first round of amended residential furnace standards, and a five-year period for the second round of amended residential furnace standards. (42 U.S.C. 6295(f)(4)(B)-(C)) DOE has concluded that the remand agreement for furnaces does not vacate the November 2007 Rule for furnaces and boilers. Therefore, the November 2007 Rule completed the first round of rulemaking for amended energy conservation standards for furnaces, thereby satisfying the requirements of 42 U.S.C. 6295(f)(4)(B). As a result, the current rulemaking constitutes the second round of rulemaking for amended energy conservation standards for furnaces, as required under 42 U.S.C. 6295(f)(4)(C), a provision which prescribes a five-year period between the standard's publication date and compliance date. For central air conditioners and heat pumps, the statutory provision at 42 U.S.C. 6295(d)(3)(B) establishes a similar five-year time period between the standard's publication date and compliance date.

Therefore, in its analysis of amended energy conservation standards for furnaces and central air conditioners and heat pumps, DOE used a five-year lead time between the publication of the standard and the compliance date for all TSLs, except for the TSL which analyzed the consensus agreement. Because the accelerated compliance dates were a negotiated aspect of the consensus agreement which amounts to an important benefit, DOE used the accelerated compliance dates when analyzing the consensus agreement TSL. (See section V.A for a description of the TSLs considered for this direct final rule.)

In response to the RAP for furnaces and the preliminary analysis for central air conditioners and heat pumps, DOE received comments from interested parties regarding the required lead time between the publication of amended energy conservation standards and the date by which manufacturers must comply with the amended standards. These comments are discussed in the section immediately below.

a. Consensus Agreement Compliance Dates

Several interested parties commented on the issue of the compliance dates for amended energy conservation standards for furnaces and central air conditioners and heat pumps in the context of the dates specified in the consensus agreement. AHRI argued that DOE has the authority to adopt the accelerated standards compliance dates in the consensus agreement whether DOE proceeds via a conventional rulemaking process or via direct final rule. AHRI asserted that 42 U.S.C. 6295(p)(4), "Direct final rules," which delineates procedures for when DOE receives a joint recommendation for amended standards by interested parties that are fairly representative of relevant points of view (including manufacturers, States, and efficiency advocates), trumps 42 U.S.C. 6295(m), "Amendment of standards," which contains specific provisions pertaining to compliance dates and lead time. Further, AHRI commented that DOE has itself previously recognized that in circumstances where the manufacturers who must comply with a standard support acceleration of the compliance date of the standard, DOE has the flexibility to adopt the earlier compliance date (see 67 FR 36368, 36394 (May 23, 2002) and 69 FR 50997, 50998(August 17, 2004)). (FUR: AHRI, No.1.3.008 at pp. 3-4) (CAC: AHRI, No. 67 at pp. 3-4) NRDC and Rheem expressed similar views. (FUR: NRDC, No.1.3.020 at p. 2; Rheem, No.1.3.022 at p. 3) (CAC: Rheem, No. 71 at p. 3) However, AHRI further clarified its position that if DOE decides in a final rule to adopt levels that are different from those in the consensus agreement, then AHRI would maintain that the compliance date (for furnaces) specified by the law would be eight years after publication of the final rule. (FUR: AHRI, Public Meeting Transcript, No. 1.2.006 at p. 126)

EarthJustice asserted that DOE must either adopt the compliance dates specified in the consensus agreement, or adopt an expedited compliance deadline of its own design. EarthJustice asserted that the provisions of EPCA relevant here do not require an eight-year lead time for furnaces, but instead require a hard-date deadline, which has passed. Therefore, EarthJustice believes DOE has discretion in setting a compliance date. EarthJustice added that there is no basis to the argument that maintaining an eight-year lead time is necessary to ease manufacturers' compliance burdens since manufacturers have indicated via the consensus agreement that they can meet the levels in the consensus agreement in a much shorter timeframe than eight years. (FUR: EarthJustice, No.1.3.014 at pp. 2-4)

Similarly, ACEEE stated that DOE should seriously consider adopting the compliance dates in the consensus agreement because the compliance dates in the statute are intended to provide manufacturers time to reengineer their products and production facilities, but in this case, manufacturers have agreed to the compliance dates specified in the consensus agreement. (FUR: ACEEE, Public Meeting Transcript, No. 1.2.006 at pp. 112-113) ACEEE acknowledged that while having the same compliance dates for all products is desirable for implementation and enforcement purposes, limited engineering resources led to different compliance dates for non-weatherized gas and weatherized gas furnaces in the consensus agreement (of 2013 and 2015, respectively). (FUR: ACEEE, Public Meeting Transcript, No. 1.2.006 at pp. 109-110)

EEI suggested that if DOE rejects the consensus agreement, DOE should establish a compliance date for all covered furnaces that is no later than November 19, 2015 (i.e., the compliance date for the standards promulgated in the November 2007 Rule). This date is shortly before the compliance date for the new efficiency standards for heat pumps in June 2016, and according to EEI, it would avoid potential market distortions for space heating equipment that might result from increasing efficiency standards for one product type but not for a competing product. (FUR: EEI, No.1.3.015 at p. 4) (CAC: EEI, No. 75 at p. 4) APPA reiterated EEI's comments on these points. (FUR: APPA, No.1.3.011 at pp. 3-4)

After careful consideration of these comments, DOE has concluded that it is bound by EPCA in terms of setting the lead time between the publication of amended energy conservation standards and the date by which manufacturers must comply with those amended standards. DOE has consistently interpreted the statutory time period between publication of a final rule and the compliance date for amended standards to reflect Congress's determination as to adequate lead time for manufacturers to retool their operations to ensure that the product in question meets the new or amended standards, even in those instances where the statutory deadline has passed. However, DOE agrees with AHRI, Rheem, and NRDC that in circumstances where the manufacturers who must comply with the standard support acceleration of the compliance date of the standard (such as in the case of the consensus agreement where compliance dates were an integral part of the agreement), DOE has some flexibility in establishing the compliance dates for amended energy conservation standards. For the other levels, DOE believes the statutory provisions pertaining to lead time should continue to govern, particularly for levels more stringent than the consensus agreement (i.e., levels to which manufacturers never agreed, particularly on an accelerated basis). Therefore, as noted in the preceding section, DOE has determined that for all TSLs analyzed – except for the consensus agreement TSL – DOE is bound by the lead time requirements in EPCA when determining compliance dates. For those other TSLs, the analysis accounts for a five-year lead time between the publication of the final rule for furnaces and central air conditioners and heat pumps and the date by which manufacturers would have to comply with the amended standard. However, for the consensus agreement TSL, DOE's analyses utilized the compliance dates specified in the consensus agreement.

b. Shift from Peak Season

Several interested parties noted that if DOE follows a typical rulemaking schedule and publishes a final rule on June 30, 2011, then the compliance date (June 2016) would fall during the peak of the air conditioner shipment season in 2016. Interested parties expressed concern that a compliance date during peak season could potentially lead to costly disruptions in the distribution chain, as well as consumer confusion. HARDI, Southern, ACEEE, and Ingersoll Rand stated that the compliance date should not be set during the peak cooling season. (CAC: HARDI, No. 70 at p.2; ACEEE, No. 72 at p. 3; SCS, No. 73 at p. 2; Ingersoll Rand, No. 66 at p. 3). HARDI, ACEEE, and Southern went further and recommended that January 1 be used as the compliance date instead for central air conditioners and heat pumps. (CAC: HARDI, No. 70 at p.2; ACEEE, No. 72 at p. 3; SCS, No. 73 at p. 2) EEI also noted that if compliance dates are moved for central air conditioners and heat pumps, then the compliance dates for furnaces should be moved as well to avoid the same issue for the heating season. (CAC: EEI, No. 75 at p.3)

As discussed above in this section, DOE believes that the applicable statutory provisions (i.e., 42 U.S.C. 6295(f)(4)(C) for furnaces and 42 U.S.C. 6295(d)(3)(B) for central air conditioners and heat pumps) necessitate a five-year time period between the final rule publication date and the compliance date. The only exception would be in the case of the adoption of the consensus agreement, because of the importance of accelerated compliance dates to the energy savings provided by this agreement. If DOE adopts any standards besides those in the consensus agreement, DOE believes that it is constrained by EPCA and does not have the authority to shift the compliance dates away from the peak cooling season (either earlier or later). However, this constraint does not prevent manufacturers from voluntarily complying at an earlier non-peak season date to ease the transition to amended energy conservation standards.

c. Standby Mode and Off Mode Compliance Dates

EPCA, as amended, does direct DOE to incorporate standby mode and off mode energy consumption into a single amended or new standard, if feasible. (42 U.S.C. 6295(gg)(3)(A)) Under such a circumstance where standby mode and off mode energy consumption is integrated into the existing regulatory metric, the standby mode and off mode standards would have the same compliance dates as the amended or new active mode standards. Therefore, DOE believes that, when feasible, the compliance dates for standby mode and off mode should be the same as the compliance dates for amended active mode energy conservation standards. Although DOE has determined that it is technically infeasible to integrate the standby mode and off mode energy consumption into a single standard for furnaces and central air conditioners/heat pumps, DOE believes it is still sensible to keep the timeline for compliance with standby mode and off mode standards the same so that manufacturers of furnaces, central air conditioners, and heat pumps can bring all of their compliance-related modifications forward at the same time. DOE further believes that this approach would provide adequate lead time for manufacturers to make the changes necessary to comply with the standby mode and off mode standards. As a result, DOE is adopting standby mode and off mode standards with compliance dates that match the compliance dates for amended AFUE, SEER, and HSPF minimum energy conservation standards.

D. Regional Standards

As described in section II.A, EISA 2007 amended EPCA to allow for the establishment of a single more-restrictive regional standard in addition to the base national standard for furnaces, and up to two more-restrictive regional standards in addition to the base national standard for residential central air conditioners and heat pumps. (42 U.S.C. 6295(o)(6)(B)) The regions must include only contiguous States (with the exception of Alaska and Hawaii, which can be included in regions with which they are not contiguous), and each State may be placed in only one region (i.e., a State cannot be divided among or otherwise included in two regions). (42 U.S.C. 6295(o)(6)(C))

Further, EPCA mandates that a regional standard must produce significant energy savings in comparison to a single national standard, and provides that DOE must determine that the additional standards are economically justified and consider the impact of the additional regional standards on consumers, manufacturers, and other market participants, including product distributors, dealers, contractors, and installers. (42 U.S.C. 6295(o)(6)(D)) For this rulemaking, DOE has considered the above-delineated impacts of regional standards in addition to national standards for both furnaces and central air conditioners and heat pumps.

Deleted: because the analyses indicate that regional standards will provide additional positive impacts. (See chapter 10 of the direct final rule TSD.)

For single-package air conditioners and single-package heat pumps, DOE has analyzed the standards on a national basis where the standard would be effectively the same in each region. For consistency with the consensus agreement and ease of

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presentation, DOE specifies the requirements of the standard by region, but for all practical purposes the standard is a national one. DOE evaluated whether regional standards with different requirements in certain regions satisfied the statutory criteria for regional standards. Given the low level of shipments of these products, DOE determined that enforcement of regionally distinct standards would be difficult for these product categories. DOE believes that it is likely that given a less stringent requirement in some regions there would be leakage effects (i.e. installers purchasing product in less stringent regions and shipping them to regions with more stringent requirements). Such leakage effects would decrease the energy savings of regionally distinct standards requirements relative to a national standard with the same stringency in each region. DOE has therefore determined that regional standards would not produce significant energy savings in comparison to a single national standard for these products. DOE made a similar determination for oil-fired furnaces.

Where appropriate, DOE has addressed the potential impacts from regional standards in the relevant direct final rule analyses, including the mark-ups to determine product price, the LCC and payback period analysis, the national impact analysis (NIA), and the manufacturer impact analysis (MIA). DOE's approach for addressing regional standards is included in the methodology section corresponding to each individual analysis, in section IV of this notice. For certain phases of the analysis, additional regional analysis is not required. For example, technologies for improving product efficiency generally do not vary by region, and thus, DOE did not perform any additional regional analysis for the technology assessment and screening analysis. Similarly, DOE did not examine the impacts of having two regions in the engineering analysis, since the

Comment [A7]: Change recommended by OIRA.

technologies and manufacturer processes are the same under both a national and regional standard.

1. Furnace Regions for Analysis

To evaluate regional standards for residential furnaces, in the RAP, DOE stated its intention to use the regions shown in Table III.3 and Figure III.1. The allocation of individual States to the regions is similar to the evaluation methodology DOE used in exploring regional standards in the November 2007 Rule, although DOE ultimately decided that it could not adopt such an approach because it lacked statutory authority, a situation which changed with enactment of EISA 2007. The allocation considered in the November 2007 Rule was largely based on whether a State's annual heating HDD average is above or below 5,000. 72 FR 65136, 65146-47 (Nov. 19, 2007). This level offers a rough threshold point at which space heating demands are significant enough to require longer operation of heating systems, which provides a basis for utilization of higher-efficiency systems. In the RAP, DOE proposed two changes from the November 2007 Rule methodology to establish regions for furnaces. The first was moving Nevada from the Northern region to the Southern region, and the second was moving West Virginia from the Southern region to the Northern region. These changes better reflect the climate characteristics of these two States – West Virginia has on average more than 5,000 HDD, and Nevada's major population areas have fewer than 5,000 HDD. DOE notes that the changes resulted in a regional allocation of States that is the same as the regions defined in the consensus agreement.

Table III.3 Regions for Analysis of Furnace Standards

Northern Region States (Rest of Country)		Southern Region States
Alaska	Pennsylvania	Alabama
Colorado	Rhode Island	Arizona
Connecticut	South Dakota	Arkansas
Idaho	Utah	California
Illinois	Vermont	Delaware
Indiana	Washington	District of Columbia
Iowa	West Virginia	Florida
Kansas	Wisconsin	Georgia
Maine	Wyoming	Hawaii
Massachusetts		Kentucky
Michigan		Louisiana
Minnesota		Maryland
Missouri		Mississippi
Montana		Nevada
Nebraska		New Mexico
New Hampshire		North Carolina
New Jersey		Oklahoma
New York		South Carolina
North Dakota		Tennessee
Ohio		Texas
Oregon		Virginia

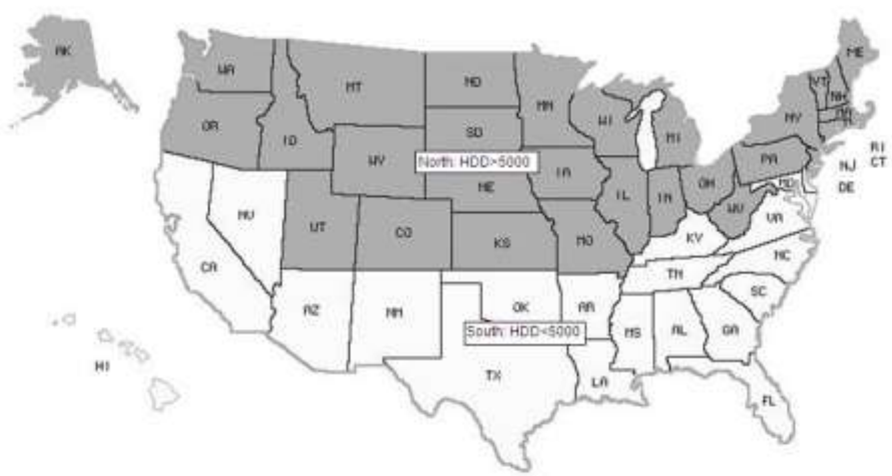

Figure III.1 Map of the Regions for the Analysis of Furnace Standards

Commenting on the furnaces RAP, Ingersoll Rand stated that the regions proposed for the regional analysis are appropriate. (FUR: Ingersoll Rand, No.1.3.006 at p. 1) Lennox expressed a similar view, noting that the regional definitions outlined in the furnaces RAP are consistent with the consensus agreement. (FUR: Lennox, No.1.3.018 at p. 2) NCLC commented that the Low Income Groups support the regions defined as north and south in the agreement. (FUR: NCLC, No.1.3.019 at p. 6) HARDI stated that the 5,000 HDD demarcation makes the most sense. (FUR: HARDI, No.1.3.016 at p. 5) ACEEE expressed a similar view, but added that if the consensus agreement is not adopted, DOE needs to examine the economics and other impacts of high-efficiency furnaces at other possible regional boundaries, such as 4,500 and 4,000 HDD. (FUR: ACEEE, No.1.3.009 at p. 4) ASAP expressed support for the regions proposed for the furnaces regional analysis and stated that having consistent regional borders for furnaces and central air conditioners is important to help reduce issues associated with implementing and enforcing regional standards. (FUR: ASAP, Public Meeting Transcript, No. 1.2.006 at pp. 64-65) APPA stated that if DOE rejects the climate zones specified in the consensus agreement, DOE should modify its definition of the northern region in such a way that, in effect, it would include “southwestern” States, such as Arizona, Nevada, and New Mexico, in the northern region, because the majority of these States have a climate that is similar to some other States that DOE has classified in the northern region. (FUR: APPA, No.1.3.011 at p. 3) EEI stated that DOE should consider establishing California, Nevada, Arizona, and New Mexico as northern States for purposes of regional standards, in order to be more consistent with DOE’s classification of northern States, and to avoid leaving energy savings on the table when establishing new heating efficiency standards. (FUR: EEI, No.1.3.015 at pp. 3-4)

After evaluating these comments, DOE has concluded that using a 5,000 HDD threshold as the basis for assigning States to northern or southern regions, as proposed in the furnaces RAP, is appropriate. DOE does not believe that the States mentioned by APPA and EEI should be classified as northern States for the analysis of furnaces. On average, these States have significantly lower heating loads than the other States that DOE has classified as northern States. Therefore, for the direct final rule analysis of furnaces, DOE used the regions as defined in Table III.3 and Figure III.1. Regarding ACEEE's suggestion that DOE consider additional analysis using other possible regional boundaries if the consensus agreement is not adopted, because DOE is adopting standards consistent with the consensus agreement in today's rule, DOE does not see a compelling reason to conduct such analyses. DOE notes that the 5,000 HDD threshold is supported by most of the interested parties, including ACEEE. DOE further notes that the 5,000 HDD threshold would provide benefits in terms of minimizing the difference between the regional boundaries for central air conditioners/heat pumps and furnaces. Harmonizing boundaries, to the extent possible, may also facilitate subsequent compliance and enforcement efforts.

2. Central Air Conditioner and Heat Pump Regions for Analysis

To evaluate regional standards for residential central air conditioners and heat pumps in the preliminary analysis, DOE used the regions listed in Table III.4 and Figure

III.2. For cooling equipment performance, the annual number of operating hours and relative humidity during those operating hours are the most important regional variations. DOE established two regions (i.e., a "hot-dry" region and a "hot-humid" region) in the south based upon these factors, in addition to a "rest of country" region (i.e., northern region), composed of the remaining States. The southern limit of the northern region was approximately based on whether a State's annual HDD average was above or below 4,500 HDD, and the division between the hot-humid and hot-dry regions was determined from analysis of typical meteorological year (TMY3) weather data.[19] TMY3 weather data are sets of typical hourly values of solar radiation and meteorological elements developed for a one-year span for selected locations based on long-term historical data. The selection of regions for the preliminary analysis was discussed in detail in Appendix 7C of the preliminary TSD.

Table III.4 Preliminary Analysis Proposed Regions for Central Air Conditioner and Heat Pump Standards

Northern Region States (Rest of Country)		Southern Region States (Hot-Humid)	Southwestern Region States (Hot-Dry)
Alaska	Nebraska	Alabama	Arizona
Colorado	New Hampshire	Arkansas	California
Connecticut	New Jersey	Florida	Nevada
Delaware	New York	Georgia	New Mexico
District of Columbia	North Dakota	Hawaii	
Idaho	Ohio	Louisiana	
Illinois	Oregon	Mississippi	
Indiana	Pennsylvania	North Carolina	
Iowa	Rhode Island	Oklahoma	
Kansas	South Dakota	South Carolina	
Kentucky	Utah	Tennessee	
Maine	Vermont	Texas	
Maryland	Virginia		

[19] S. Wilcox and W. Marion, *Users Manual for TMY3 Data Sets*, NREL/TP-581-43156 (May 2008).

Massachusetts	Washington		
Michigan	West Virginia		
Minnesota	Wisconsin		
Missouri	Wyoming		
Montana			

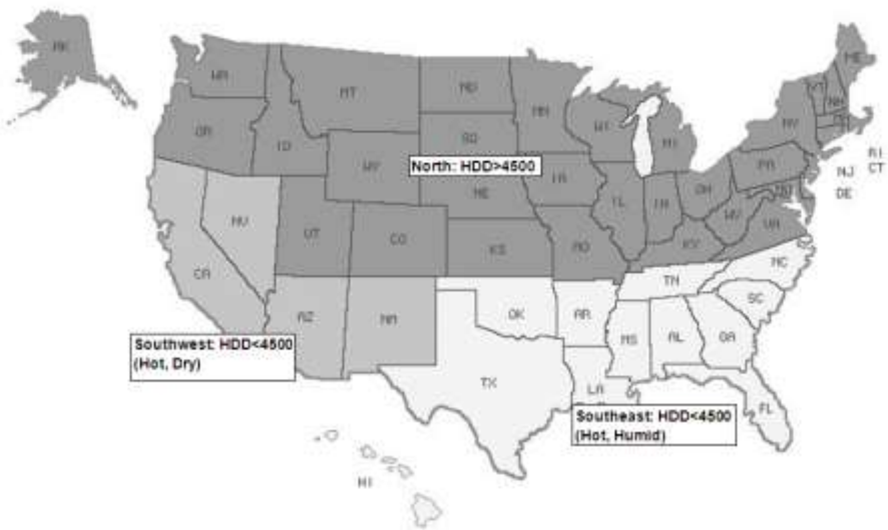

Figure III.2 Map of Preliminary Analysis Proposed Regions for Central Air Conditioner and Heat Pump Standards

In response to DOE’s request for comment on the regions used in the preliminary analysis for central air conditioners and heat pumps, several stakeholders submitted comments. HARDI, Southern, and Ingersoll Rand stated that the regions defined in the consensus agreement should be used instead of those in Table III.4. This suggested change would necessitate moving Delaware, the District of Columbia, Maryland, Kentucky, and Virginia into the southern hot-humid region. (CAC: HARDI, No. 56 at p. 4; Ingersoll Rand, No. 66 at p.4; Southern, Public Meeting Transcript at p. 33; HARDI, No. 56 at p. 4) Southern also remarked that the regional boundaries for central air conditioners and heat pumps and furnaces should be the same to avoid unnecessary complexity for manufacturers and public confusion. (CAC: Southern, No. 73 at p. 2) ACEEE expressed views similar to those of HARDI, Southern, and Ingersoll Rand and further warned that the confusion and complexity associated with differing regional boundaries could lead to inadvertent non-compliance. (CAC: ACEEE, No. 72 at p. 3) Conversely, EEI commented that Nevada should be moved to the "rest of country" region for heating efficiency requirements and the hot-dry region for cooling efficiency requirements because 90 percent of the State is located in climate zone 5, as specified in Figure 2 of 10 CFR 430, subpart B, appendix M . (CAC: EEI, No. 75 at p.3)

In response to these comments, DOE agrees that a unified regional allocation of States for both central air conditioners and heat pumps and furnaces would provide key benefits. As mentioned in section III.A, similar manufacturers produce these products and use the same distribution network. Using the same regional allocation of States, as compared to the "rest of country" national standard, would be easier for manufacturers and distributors to implement and would also help to minimize consumer confusion. Additionally, regional standards may shift enforcement from the manufacturer to the point of sale or place of installation, and a single boundary between regions would reduce the motivation for non-compliance as well as simplify the overall enforcement of regional standards. Of course, there would be some differentiation, given that there is only one regional standard for furnaces, but two regional standards for central air conditioners and heat pumps. Nevertheless, DOE believes that there would still be benefits with harmonizing the States included in the northern region across these products.

To this end, DOE agrees with the comments recommending use of the regions in the consensus agreement for central air conditioners and heat pumps and furnaces. Doing so would also align the boundary of the northern region for the central air conditioners and furnaces. The regions selected for the direct final rule analyses for central air conditioners and heat pumps are shown in Table III.5 and Figure III.3.

Table III.5 Regions for Analysis of Central Air Conditioner and Heat Pump Standards

Northern Region States (Rest of Country)		Southeastern Region States (Hot-Humid)*	Southwestern Region States (Hot-Dry)*
Alaska	New York	Alabama	Arizona
Colorado	North Dakota	Arkansas	California
Connecticut	Ohio	Delaware	Nevada
Idaho	Oregon	District of Columbia	New Mexico
Illinois	Pennsylvania	Florida	
Indiana	Rhode Island	Georgia	
Iowa	South Dakota	Hawaii	
Kansas	Utah	Kentucky	
Maine	Vermont	Louisiana	
Massachusetts	Washington	Maryland	
Michigan	West Virginia	Mississippi	
Minnesota	Wisconsin	North Carolina	
Missouri	Wyoming	Oklahoma	
Montana		South Carolina	
Nebraska		Tennessee	
New Hampshire		Texas	
New Jersey		Virginia	

*The combined southeastern and southwestern regions for central air conditioners and heat pumps correspond to the southern region for furnaces.

Figure III.3 Map of the Regions for the Analysis of Central Air Conditioners and Heat Pumps

3. Impacts on Market Participants and Enforcement Issues

As described in section II.A of this notice, DOE is required to evaluate the impact of introducing regional standards on consumers, manufacturers, and other market participants, including product distributors, dealers, contractors, and installers. (42 U.S.C. 6295(o)(6)(D)) Chapter 17 of the preliminary TSD for central air conditioners and heat pumps details DOE's preliminary analysis on the potential impacts of regional standards on market participants other than manufacturers and consumers for residential central air conditioners and heat pumps and residential furnaces. (However, impacts on manufacturers and consumers were fully addressed in a manner consistent with any other energy conservation standards rulemaking.) The analysis focuses on the unique burdens associated with introducing differentiated energy conservation standards based on geography. The analysis does not incorporate the impact of more-stringent energy conservation standards on market participants, only the impact of multiple geographic standards, because the impacts of more-stringent standards would occur regardless of whether differentiated regional standards are promulgated.

a. Impacts on Additional Market Participants

Chapter 17 of the preliminary TSD began by identifying the primary market participants, identified as distributors, contractors, and general contractors. It described their basic business models and assesses how additional regional standards may impact those models. The chapter then investigated potential non-enforcement impacts on distributors, contractors, and general contractors. Finally, the chapter provided two quantitative analyses looking at the key changes that distributors may face as a result of regional standards: (1) a distributor inventory impact analysis, and (2) a distributor markup impact analysis.

HARDI voiced concern about DOE's preliminary distributor inventory impact analysis, citing its belief that distributors located within border regions would have to carry two lines of stock. As a result, HARDI predicts at least a 5-percent stock increase for these distributors. (CAC: HARDI, No. 56 at p.7) In response, DOE's inventory analysis does assume that distributors located along border regions will need to carry two lines of stock, as indicated by HARDI, and, thus, requires some additional safety stock. In the absence of additional data supporting more or less severe inventory impacts, for the direct final rule, DOE has not revised its estimate of a 2-percent inventory impact for the reference case. However, the impacts of inventory changes ranging from 0 percent to

10 percent are considered in Chapter 17 of the direct final rule TSD as a sensitivity analysis.

Regarding the inventory change analysis, ACEEE stated that distributors located along a border region may find it more cost-effective to stock fewer product models and meet customer demand by shipping the next higher-efficiency model at the same price as the lower-efficiency model under regional standards. (FUR: ACEEE, No.1.2.006 at p.103) ACEEE suggested that this hypothetical substitution effect would reduce the additional inventory necessary for distributors to meet customer demand under regional standards. Based on interviews with distributors and DOE's understanding of the HVAC industry, DOE considers such a scenario unlikely. Such a substitution would remove upsell opportunities for distributors and potentially commoditize higher-margin products. Furthermore, not having the units desired by some contractors may jeopardize relationships with at least some customers. DOE does not expect such a strategy to be the lowest-cost option for distributors along the border region.

HARDI contested the four shipment scenarios detailed in the distribution inventory impact analysis discussed in chapter 17 of the preliminary TSD. Citing the experience following the change in central air conditioner energy conservation standards from 10 SEER to 13 SEER in 2006, HARDI asserted that an impact of increasing standards is a decrease in shipments due to substitution effects. (FUR: HARDI, No. 1.3.016 at p.7) In chapter 17 of the TSD, DOE analyzed the impact of differentiated regional standards rather than the impacts of higher standards. The analysis is intended to model changes in distributor inventory resulting from bimodal product demand, and not the impacts resulting from higher standards. However, DOE notes that the impacts of higher standards on replacement rates and product orders for the industry are accounted for and modeled in DOE’s shipments analysis conducted for this direct final rule. A reduction in product replacement is reflected in the NIA and in the industry net present value analysis presented in the MIA.

Additional comments were received regarding the analysis of distributor markup impact analysis. These comments are addressed in markups portion of this document in section IV.D.

b. Enforcement Issues

Although the preliminary TSD for central air conditioners and heat pumps did not analyze enforcement issues, it did discuss potential enforcement impacts on market participants in chapter 17, section 17.4, of the preliminary TSD. In addition, in section II.A of the RAP for furnaces, DOE described a number of enforcement options and requested data on how, if at all, the enforcement options would increase compliance or other costs.

Multiple manufacturers and trade associations commented on enforcement issues discussed in either the preliminary TSD for central air conditioners and heat pumps or the RAP for furnaces. ACCA, AHRI, and HARDI all emphasized the need for strong enforcement to ensure fair competition in the marketplace and to mitigate risk of diluting intended energy savings. (FUR: ACCA, No. 1.3.007 at p.2) (CAC: AHRI, No. 67 at p.4; HARDI, No. 70 at p.2) HARDI emphasized the complexity of enforcing regional standards and explained that their members (i.e., the industry's distributors) are not equipped to bear the burden of ensuring that product installations are occurring within the boundaries of regional standards. (FUR: HARDI, No. 1.3.016 at pp. 4-7) Manufacturers, including Lennox, Rheem, and Ingersoll Rand; trade groups, including ACCA, AGA, ARI, EEI, and HARDI; advocacy groups, including ACEEE, NCLC, and NRDC; and utilities, including Pacific Gas and Electric, Southern California Gas Company, San Diego Gas and Electric, and Southern California Edison, all commented on the effectiveness, viability, and complexity of various enforcement mechanisms. (FUR: Lennox, No. 1.3.018 at pp.2-4; Rheem, Public Meeting Transcript No. 1.2.006 at p.80; AGA, No. 1.3.010 at pp.2-3; EEI, No. 1.3.015 at p.4; ACEEE, No.1.3.009 at pp.4-5; NCLC, 1.3.019 at p.9; NRDC, No. 1.3.020 at pp.7-8) (CAC: Ingersoll Rand, No. 66 at pp.7-8; ACCA, No. 7 at p. 3; HARDI, No. 56 at p.6; PG&E, No. 17 at pp. 3-4)

DOE recognizes the challenges of regional standards enforcement and continues to investigate the most effective means of meeting those challenges. DOE will incorporate all feedback into the enforcement rulemaking it will conduct within 90 days of the issuance of this direct final rule establishing regional standards, as required by 42 U.S.C. 6295(o)(6)(G)(ii).

E. Standby Mode and Off Mode

As noted in section II.A of this direct final rule, any final rule for amended or new energy conservation standards that is published on or after July 1, 2010 must address standby mode and off mode energy use. (42 U.S.C. 6295(gg)) As a result, DOE has analyzed and is regulating the standby mode and off mode electrical energy consumption for furnaces and off mode energy consumption for central air conditioners and heat pumps. These provisions are addressed in further detail immediately below.

1. Furnaces

AFUE, the statutory metric for furnaces, does not incorporate standby mode or off mode use of electricity, although it already fully addresses use in these modes of fossil fuels by gas and oil-fired furnaces. In the October 2010 test procedure final rule for furnaces, DOE determined that incorporating standby mode and off mode electricity consumption into a single standard for residential furnaces is not feasible. 75 FR 64621, 64626-27 (Oct. 20, 2010). DOE concluded that a metric that integrates standby mode and off mode electricity consumption into AFUE is not technically feasible, because the standby mode and off mode energy usage, when measured, is essentially lost in practical terms due to rounding conventions for certifying furnace compliance with Federal energy conservation standards. Id. Therefore, in this notice, DOE is adopting amended furnace standards that are AFUE levels, which exclude standby mode and off mode electricity use, and DOE is also adopting separate standards that are maximum wattage (W) levels to address the standby mode and off mode electrical energy use of furnaces. DOE also presents corresponding TSLs for energy consumption in standby mode and off mode.

DOE has decided to use a maximum wattage requirement to regulate standby mode and off mode for furnaces. DOE believes using an annualized metric could add unnecessary complexities, such as trying to estimate an assumed number of hours that a furnace typically spends in standby mode. Instead, DOE believes that a maximum wattage standard is the most straightforward metric for regulating standby mode and off mode energy consumption of furnaces and will result in the least amount of industry and consumer confusion.

DOE is using the metrics just described – AFUE and W – in the amended energy conservation standards it adopts in this rulemaking for furnaces. This approach satisfies the mandate of 42 U.S.C. 6295(gg) that amended standards address standby mode and off mode energy use. The various analyses performed by DOE to evaluate minimum standards for standby mode and off mode electrical energy consumption for furnaces are discussed further in section IV.E of this direct final rule.

a. Standby Mode and Off Mode for Weatherized Gas and Weatherized Oil-Fired Furnaces

DOE did not find any weatherized furnaces (both gas and oil-fired) available on the market that are not sold as part of a single package air conditioner or a "dual fuel" single package heat pump and furnace system. In this direct final rule, DOE is adopting new energy conservation standards for the maximum allowable average off mode power consumption ($P_{W,OFF}$) for single package air conditioners and single package heat pumps to account for the power consumed in off mode, and DOE has already determined that the existing test procedures for central air conditioners and heat pumps account for standby mode power consumption within the SEER rating. DOE notes that the proposed test procedure provisions for measuring off mode power consumption of central air conditioners and heat pumps and the existing test procedure provisions for calculating SEER do not provide instructions for disconnecting certain components (e.g., igniter, gas valve) that are only used for furnace operation in single package units. As a result, DOE believes that because weatherized furnaces on the market are manufactured and sold as part of single package air conditioners and heat pumps, and because all standby mode and off mode energy consumption for single package air conditioners and heat pumps is accounted for by $P_{W,OFF}$ and SEER, there is no need to adopt separate standby mode and off mode standards for weatherized gas or weatherized oil-fired furnaces.

b. Standby Mode and Off Mode for Electric Furnaces

As discussed in detail in section IV.A.2.a of this direct final rule, DOE believes that any improvements to electric furnaces to improve the AFUE of these products would have a de minimis energy-savings potential because the efficiency of electric furnaces already approaches 100-percent AFUE. However, DOE notes that the AFUE rating for electric furnaces does not include the electrical power used in standby mode and off mode. As a result, DOE performed an analysis of potential standby mode and off mode energy conservation standards for electric furnaces, and is adopting standards for these products in this direct final rule. The approach for analyzing standby mode and off mode energy conservation standards for electric furnaces is described throughout section IV of this direct final rule.

c. Standby Mode and Off Mode for Mobile Home Oil-Fired Furnaces

DOE is not considering amended AFUE standards for mobile home oil-fired furnaces due to a de minimis potential for energy savings, as discussed in detail in section IV.A.2.a of this notice. However, in order to satisfy the statutory provision in EPCA for establishing standby mode and off mode standards, and to keep a level playing field for all products, DOE examined potential standby mode and off mode standards for mobile home oil-fired furnaces.

To analyze potential standby mode and off mode standards for mobile home oil-fired furnaces, DOE examined specification sheets and manufacturer literature to identify components that are present and would consume standby power (e.g., transformer, burner). DOE determined that these components in mobile home oil-fired furnaces are largely the same as the standby mode and off mode energy-consuming components found in non-weatherized oil-fired furnaces. Therefore, DOE estimated that a mobile home oil-fired furnace would have the same standby mode and off mode energy consumption as a non-weatherized oil-fired furnace, and it did not conduct separate analysis for this product. Accordingly, DOE is adopting standards for non-weatherized oil-fired furnaces and mobile home oil-fired furnaces at the same level in today's direct final rule. The standby mode and off mode analysis for non-weatherized oil-fired furnaces (which is also applicable to mobile home oil-fired furnaces) is discussed throughout section IV of this direct final rule.

2. Central Air Conditioners and Heat Pumps

For central air conditioners and heat pumps, the standby mode is in effect when the system is on but the compressor is not running (i.e., when the system is not actively heating or cooling but the compressor is primed to be activated by the thermostat). Thus, the standby mode for central air conditioners functions during the cooling season and for heat pumps during both the cooling and heating seasons. Correspondingly, the off mode generally occurs for air conditioners during all non-cooling seasons and for heat pumps during the "shoulder seasons" (i.e., fall and spring) when consumers neither heat nor cool their homes. The SEER and HSPF metrics already account for standby mode but not off mode energy use, because off mode energy use occurs outside of the seasons to which these descriptors apply. However, incorporation of off mode into these descriptors would mean that they would no longer be seasonal descriptors. Thus, because EPCA requires use of these descriptors for central air conditioners and heat pumps (see 42 U.S.C. 6291(22) and 6295(d)), it would not be feasible for DOE to incorporate off mode energy use into a single set of standards for both central air conditioners and heat pumps. Additionally, DOE has concluded that a metric that integrates off mode electricity consumption into SEER is not technically feasible because the off mode energy usage is significantly lower than active mode operation and, when measured, it is essentially lost in practical terms due to the fact that manufacturers' ratings of SEER are typically presented to consumers with one or zero decimal places. Therefore, in this notice, DOE is adopting for central air conditioners and heat pumps standards that are SEER and HSPF levels (which exclude off mode energy use), and DOE is also adopting separate standards that are maximum wattage (W) levels to address the off mode energy use of central air conditioners and heat pumps. DOE also presents corresponding TSLs for energy consumption in off mode. DOE has determined that a wattage requirement is appropriate, because it avoids unnecessary complexities and assumptions that may be created by using an annualized metric. The use of a wattage requirement is consistent with the approach used to regulate standby mode and off mode energy consumption in furnaces.

DOE is using the metrics just described – SEER, HSPF, and W – in the amended energy conservation standards it adopts in this rulemaking for central air conditioners and heat pumps. This approach satisfies the mandate of 42 U.S.C. 6295(gg) that amended standards address standby mode and off mode energy use. The various analyses performed by DOE to evaluate minimum standards for off mode electrical energy consumption for central air conditioners and heat pumps are discussed further throughout section IV of this direct final rule.

a. Off Mode for Space-Constrained Air Conditioners and Heat Pumps

As discussed in section III.G.2.b, DOE decided not to amend the existing SEER or HSPF standards for the space-constrained product classes of central air conditioners and heat pumps, because the existing standard is both the baseline and max-tech efficiency level. However, DOE analyzed these products to determine appropriate off mode energy conservation standards. Based on teardowns and manufacturer literature, DOE determined that the space-constrained product classes have the same components contributing to off mode power consumption as split-system air conditioners and heat pumps. Consequently, DOE assumed that the off mode power consumption for the space-constrained products classes is the same as for the split-system product classes, and DOE believes that the off mode analysis for the split-system product classes is representative of the space-constrained products. Therefore, DOE adopted its engineering analysis of off mode energy consumption for split-system air conditioners and heat pumps for use in its engineering analysis of the off mode electrical energy consumption of space-constrained air conditioners and heat pumps. As with all other product classes, the off mode analysis for space-constrained products is described in further detail throughout section IV of this direct final rule.

F. Test Procedures

As noted above, DOE's current test procedures for central air conditioners and heat pumps, and for furnaces, appear at 10 CFR part 430, subpart B, appendices M and N, respectively. Moreover, EPCA, as amended by EISA 2007, requires DOE to amend its test procedures for all covered products, including those for furnaces and central air conditioners and heat pumps, to include measurement of standby mode and off mode energy consumption, except where current test procedures already fully address such energy consumption. (42 U.S.C. 6295(gg)(2)) Because test procedure rulemakings were ongoing to address this statutory mandate regarding standby mode and off mode energy consumption during the course of the current standards rulemaking, a number of test procedure issues were raised in this rulemaking, particularly in terms of how test procedure amendments could impact standard levels. The following discussion addresses these comments and explains developments related to amended test procedures for residential furnaces, central air conditioners, and heat pumps.

1. Furnaces

DOE's existing test procedure for gas and oil-fired furnaces accounted for fossil fuel consumption in the active, standby, and off modes, and for electrical consumption in the active mode (although active mode electrical consumption is not included in the AFUE rating for gas and oil-fired products). For electric furnaces, DOE's existing test procedure accounted for active mode electrical energy consumption. However, the test procedures for gas, oil-fired, and electric furnaces did not address standby mode and off mode electrical energy consumption. Therefore, DOE issued a NOPR in which it proposed modifications to its existing furnace test procedures to include the measurement of standby mode and off mode electricity use. 74 FR 36959 (July 27, 2009) (hereafter referred to as the "July 2009 test procedure NOPR"). DOE held a public meeting at DOE headquarters in Washington, D.C. on August 18, 2009, to receive oral comments on the July 2009 test procedure NOPR. DOE also sought and received written comments from interested parties.

Subsequent to the July 2009 test procedure NOPR, DOE issued a supplemental notice of proposed rulemaking (SNOPR) for the purpose of adding an integrated metric that incorporates standby mode and off mode energy consumption into the statutorily-identified efficiency descriptor, AFUE. The SNOPR was published in the Federal Register on April 5, 2010. 75 FR 17075. In response to the April 2010 test procedure

SNOPR, DOE received a number of comments that opposed both the need for an integrated metric and the possibility of regulating by such a metric. In sum, these comments suggested that DOE misinterpreted the statute in terms of requiring the integration of standby mode and off mode energy consumption into the AFUE metric. Commenters further suggested that regulating by an integrated metric would be counter to the intent of EISA 2007; instead, these commenters urged DOE to regulate standby mode and off mode for these products by using a separate standard, as contemplated by EISA 2007, in situations where an integrated metric would not be technically feasible. DOE also received similar comments regarding incorporating standby mode and off mode electrical consumption into AFUE in response to the RAP for residential furnaces, which are summarized below. In addition, DOE received comments relating to the AFUE test procedure in general (i.e., not specifically about the incorporation of standby mode and off mode electrical energy consumption into AFUE), which are also discussed in the sections that follow.

After considering the comments in response the April 2010 test procedure SNOPR and RAP (discussed below), DOE published a final rule in the Federal Register on October 20, 2010 that amended the test procedures for furnaces and boilers to address standby mode and off mode energy use of these products. 75 FR 64621. In light of the comments on the April 2010 test procedure SNOPR and RAP, DOE reconsidered the feasibility of an integrated AFUE metric in the final rule and abandoned its proposal in the April 2010 test procedure SNOPR that would have integrated the standby mode and off mode electrical energy consumption into the existing AFUE test metric. Accordingly, the final rule amended the test procedure for residential furnaces and boilers to include provisions for separately measuring standby mode and off mode. Id. at 64626-27.

a. AFUE Test Method Comment Discussion

In response to the RAP for residential furnaces, DOE received several comments related to DOE's test procedure for determining the AFUE of residential furnaces. ACEEE commented that AFUE is an imperfect metric, because for weatherized furnaces,[20] a unit operating at part load (i.e., at a reduced input capacity less than the full capacity) might deliver the same comfort as it would at full load, but using less energy (i.e., more efficiently). However, since weatherized furnaces must be kept non-condensing during peak load operation, ACEEE stated that the AFUE metric may not reflect the efficiency benefit from part load operation. (FUR: ACEEE, Public Meeting Transcript, No. 1.2.006 at p. 159) Ingersoll Rand stated that weatherized furnaces have to be non-condensing regardless of whether the furnace is running at a lower input or at the peak input [because these units are not designed to handle corrosive condensate]. (FUR: Ingersoll Rand, Public Meeting Transcript, No. 1.2.006 at pp. 159-160) In response, DOE believes that two-stage and modulating furnaces meet heating load requirements more precisely by operating at a reduced input rate for an extended period of burner on-time, which might deliver the same comfort using less energy as ACEEE asserts. However, DOE also notes that due to issues with condensate freezing in weatherized gas furnaces, products that are currently on the market are typically designed so that they will not condense during part-load or full-load operation, as Ingersoll Rand

[20] Weatherized furnaces, unlike non-weatherized furnaces, are designed to be installed outdoors. As such, weatherized furnaces are often subjected to harsh weather, including below freezing temperatures, rain, snow, etc.

states. Even if a weatherized furnace were designed with materials and components to handle the corrosive condensate, if that condensate freezes while being drained, it will have a significant adverse impact the performance and reliability of the unit. DOE notes that DOE's existing AFUE test procedure contains provisions for two-stage and modulating operation in furnaces, and DOE believes these provisions are adequate for rating the performance of weatherized furnaces. It may be possible for DOE to consider revisiting the provisions for testing the AFUE of two-stage and modulating weatherized furnaces in a future test procedures rulemaking.

Proctor stated that in California, non-weatherized furnaces are installed in attics, which get hot in the summer and cold in the winter. As a result, AFUE may not properly represent what happens in the field, because jacket losses (i.e., heat losses through the outer covering of the furnace) may not be accounted for in the AFUE test procedure for non-weatherized furnaces. (FUR: Proctor, Public Meeting Transcript, No. 1.2.006 at pp. 163-64) In contrast, Ingersoll Rand commented that the AFUE test for non-weatherized furnaces does measure jacket losses, because these furnaces are tested as isolated combustion systems (meaning they are assumed to be installed indoors, but outside of the conditioned space, such as in a garage or unheated basement) with an assumed 45 degree ambient temperature. Ingersoll Rand noted that jacket losses in non-weatherized furnaces are accounted for and multiplied by 1.7 in the AFUE calculation. Ingersoll Rand further stated that weatherized furnaces have a 3.3 multiplier for jacket losses, which accounts for the effects of wind, rain, and other factors affecting the performance of an outdoor furnace. (FUR: Ingersoll Rand, Public Meeting Transcript, No. 1.2.006 at p. 164) In response, DOE agrees with Ingersoll Rand, and notes that the DOE test procedure requires jacket losses to be adjusted by a 1.7 multiplier and a 3.3 multiplier for all non-weatherized furnaces and weatherized furnaces, respectively, in order to account for jacket losses that may occur in the field.

Proctor also remarked that the current standards (which are set in terms of AFUE) are unrepresentative of actual system performance in the home and produce contrary results, by assigning efficiency ratings which are not representative of ratings achieved in the field. Proctor stated that in certain rare situations, the current rating system is such that products' tested efficiency ratings may be reversed in comparison to their actual field performance (i.e., a product with a higher AFUE rating may actually perform less efficiently than a product with a lower AFUE rating in certain situations). (FUR: Proctor, FDMS No. 0002 at p. 2) The energy efficiency ratings for furnaces are developed using DOE's test procedure and sampling plans at the point of manufacture. For residential furnaces, DOE believes that requiring certification at the point of manufacture is the best way to capture the energy use information and variability of the installations that can be experienced in the field. Given the expense of performing tests on the products and the breadth of the installation network for these products, testing and certification based on field installations could be significantly more difficult. DOE believes that its test methods represent product performance in the field; however, DOE agrees with Proctor in that many factors experienced in the field can alter the performance of the furnace (e.g., installation location, external static pressure). Consequently, DOE's analysis takes into account many of the variations experienced in the field on the energy use of the product in the life-cycle cost analysis.

Proctor argued that heating performance and heating fan performance are rated at external static pressures that are a function of furnace heating capacity and are significantly lower than those found in typical residential duct systems, resulting in the furnace blower moving less air or having higher watt draw, or both, when installed. Proctor claimed that these effects reduce the field efficiency of the furnace and that the type of fan motor believed by consumers and HVAC contractors to be the highest efficiency model performs significantly worse at typical field static pressures than at the rating condition. (FUR: Proctor, FDMS No. 0002 at p. 3) The current DOE test procedure assumes a given value for the external static pressure. While DOE acknowledges that the external static pressure of an HVAC system is, in part, a function of the ductwork, DOE believes variations in external static pressures experienced in the field that impact the efficiency of the furnace fan are outside the scope of coverage of this rulemaking. This issue will be considered in DOE's separate rulemaking for furnace fans. Additionally, DOE acknowledges that the blower motor responds to the differences in external static pressure between the ductwork in the field and the pressure specified by the DOE test procedure by increasing or decreasing power draw as needed to maintain consistent airflow. However, the DOE test procedure to calculate AFUE does not account for the type or performance of the blower, and therefore, the rated AFUE is not impacted by the blower power draw.   As noted above, there is a separate rulemaking under way to address the efficiency of furnace fans. DOE is also developing a test procedure for furnace fans in a separate rulemaking, in which DOE will examine the appropriate external static pressure at which to rate the air handling performance of the furnace.

Proctor also commented that the furnace heating performance and air handling performance should be rated separately because some furnace components are related to heating, while others are related to moving household air. Further, Proctor stated that the furnace rating standard should include the energy use of heating-related components, such as the igniter, while components that are not directly related to heating should be included in the air handling rating. (FUR: Proctor, FDMS No. 0002 at p. 4) In response, DOE first notes that this rulemaking to examine amending the minimum AFUE standards addresses the heating performance of furnaces, and the air handling performance will be addressed separately in a furnace fans rulemaking, as Proctor recommends. In response to Proctor's assertion that the furnace heating performance standard should include the use of heating-related components such as the igniter, DOE notes that it is required under 42 U.S.C. 6291(22) to use AFUE as the rating metric for the fuel performance of furnaces. DOE incorporates by reference the definition in section 3 of ANSI/ASHRAE 103-1993 of "annual fuel utilization efficiency" as "the ratio of annual output energy to annual input energy, which includes any non-heating-season pilot input loss and, for gas or oil-fired furnaces or boilers, does not include electric energy." 10 CFR 430 subpart B, appendix N, section 2.0. Under this definition, which captures how efficiently the fuel is converted to useful heat, electrical components such as electronic ignition and the blower motor are outside of the AFUE rating metric coverage. Components in the blower assembly will be covered in DOE's current energy conservation standards rulemaking for residential furnace fans.

b. Standby Mode and Off Mode

As noted above, DOE received numerous comments from interested parties regarding the approach to regulating standby mode and off mode energy consumption proposed in the furnaces RAP. In particular, the comments received pertained to the metric that would be adopted for such regulation.

ACEEE, the CA IOUs, EEI, HARDI, Lennox, AHRI, NRDC, APPA, Ingersoll Rand, and the Joint Stakeholders opposed the proposal to integrate standby mode and off mode electrical power into a new metric and instead supported a separate metric for regulating standby mode and off mode electrical energy consumption in furnaces. (FUR: ACEEE, Public Meeting Transcript, No. 1.2.006 at pp. 130-131; ACEEE, No. 1.3.009 at pp. 1-2; CA IOUs, No. 1.3.017 at p. 3; EEI, No. 1.3.015 at pp. 4-5; HARDI, No. 1.3.016 at p. 8; Lennox, No. 1.3.018 at p. 3; NRDC, No. 1.3.020 at p. 7; APPA, No. 1.3.011 at p. 4; AHRI, Public Meeting Transcript, No. 1.2.006 at pp. 132-133; Ingersoll Rand, No. 1.3.006 at p. 2; Joint Stakeholders, No. 1.3.012 at pp. 3-4) EEI qualified its support for a separate descriptor for standby mode and off mode electrical energy consumption, stating that it supports a separate descriptor for standby mode and off mode efficiency as long as furnaces would be required to provide information about standby mode and off mode fossil fuel consumption as well. EEI asserted that if DOE looks at electric energy attributable to standby mode, it should also look at fossil fuel energy consumption attributable to standby mode just as rigorously. (FUR: EEI, No. 1.3.015 at pp. 4-5) In response, DOE notes that in the final rule for residential furnaces and boilers test procedures, published in the Federal Register on October 20, 2010, DOE concluded that the AFUE metric comprehensively accounts for fossil fuel energy consumption over a full-year cycle, thereby satisfying the fossil fuel portion of the EISA 2007 requirement to regulate standby mode and off mode energy consumption. 75 FR 64621. Lennox supported the use of the E_{SO} value that DOE proposed in the July 27, 2009 test procedures NOPR (74 FR 36959) as the metric for setting standby mode and off mode standards. (FUR: Lennox, No. 1.3.018 at p. 3) In today's direct final rule, DOE is using the standby mode and off mode power consumption metrics ($P_{W,SB}$ and $P_{W,OFF}$, respectively), as defined in the October 2010 test procedure final rule[21] (74 FR 64621, 64632 (Oct. 20, 2010)), as the test metric for regulating standby mode and off mode power consumption. As noted in section III.E of today's notice, DOE believes this metric will provide a more straightforward approach for comparing the standby mode and off mode energy consumption of furnaces, because it does not include assumptions related to the amount of time spent in standby mode or off mode, as an annual metric, such as E_{SO}, would require.

ACEEE, EEI, HARDI, and Lennox stated that DOE should not use an integrated AFUE metric (one which includes standby mode and off mode electrical energy consumption, along with active mode energy consumption) to regulate standby mode and

[21] In this direct final rule, DOE is changing the nomenclature for the standby mode and off mode power consumption metrics for furnaces from those in the furnace and boiler test procedure final rule published on October 20, 2010. 75 FR 64621. DOE is renaming the P_{SB} and P_{OFF} metrics as $P_{W,SB}$ and $P_{W,OFF}$, respectively. However, the substance of these metrics remains unchanged.

off mode electrical energy consumption because doing so would require rerating existing furnaces, which could cause existing ratings to decrease and could lead to confusion in the marketplace. (FUR: ACEEE, No. 1.3.009 at pp. 1-2; EEI, Public Meeting Transcript, No. 1.2.006 at pp. 134-135; EEI, No. 1.3.015 at pp. 4-5; HARDI, Public Meeting Transcript, No. 1.2.006 at p. 138; HARDI, No. 1.3.016 at p. 8; Lennox, No. 1.3.018 at p. 3) Further, AHRI noted that every program that provides incentives for people to buy more-efficient furnaces would have to change its descriptor to avoid widespread confusion in the marketplace, and therefore, AHRI argued that combining metrics is not feasible. (FUR: AHRI, Public Meeting Transcript, No. 1.2.006 at pp. 136-137) Ingersoll Rand added that adoption of an integrated metric would lead to confusion in the marketplace by making higher-capacity furnaces appear more efficient, because standby power is not a function of heating capacity. (FUR: Ingersoll Rand, No. 1.3.006 at p. 2) DOE believes these points are valid. Ultimately, in the test procedure rulemaking, DOE concluded in the final rule that it would not be technically feasible to integrate standby mode and off mode electrical energy consumption into AFUE, because "the standby mode and off mode energy usage, when measured, is essentially lost in practical terms due to the fact that manufacturers' ratings of AFUE are presented to the nearest whole number." 75 FR 64621, 64627 (Oct. 20, 2010). For further details on DOE's reasoning for not integrating standby mode and off mode electrical energy consumption into AFUE, please consult the October 2010 test procedure final rule. Id. at 64626-27.

ACEEE, NRDC, APPA, and the Joint Stakeholders observed that, due to the rounding provisions specified for the AFUE descriptor, standby mode and off mode electrical energy consumption would effectively be lost in an integrated metric. More specifically, these parties reasoned that the magnitude of active mode fuel consumption would obscure the standby mode and off mode electrical energy consumption, thereby providing manufacturers with little or no incentive to reduce standby energy consumption. (FUR: ACEEE, Public Meeting Transcript, No. 1.2.006 at pp. 130-131; ACEEE, No. 1.3.009 at pp. 1-2; NRDC, No. 1.3.020 at p. 7; APPA, No. 1.3.011 at p. 4; Joint Stakeholders, No. 1.3.012 at pp. 3-4) The CA IOUs further asserted that it is not feasible from a testing and enforcement perspective to regulate standby mode and off mode electrical energy consumption when it may be less than the rounding error of the regulated metric, and suggested that DOE would need to regulate an integrated AFUE metric to a hundredth of a percent in order to accurately capture differences in standby mode and off mode energy use. (FUR: CA IOUs, No. 1.3.017 at p. 3) Additionally, according to Ingersoll Rand, the homeowner would not be able to determine how much power is used in standby mode, and an integrated metric would be unlikely to focus furnace redesigns on providing actual reduction in electrical power usage, because the standby power usage could be masked with small improvements in heating efficiency. (FUR: Ingersoll Rand, No. 1.3.006 at p. 2) DOE considered these observations to be valid points, and they played a role in the Department's decision to abandon an integrated AFUE metric in favor of a separate descriptor for standby mode and off mode electrical energy consumption. Again, for further details on DOE test procedures for measuring standby mode and off mode energy consumption, please consult the October 2010 test procedure final rule. 75 FR 64621 (Oct. 20, 2010).

2. Central Air Conditioners and Heat Pumps

DOE has determined that its existing test procedures for central air conditioners and heat pumps address energy use in standby mode, but not in off mode. As explained above in section II.B, off mode occurs for air conditioners during the non-cooling seasons and for heat pumps during the "shoulder seasons" (i.e., fall and spring). Therefore, in a test procedure NOPR published in the Federal Register on June 2, 2010, DOE proposed to modify to its existing test procedures for central air conditioners and heat pumps by adding provisions to determine off mode energy use. 75 FR 31224 (hereafter referred to as "the June 2010 test procedure NOPR"). In the June 2010 test procedure NOPR, DOE also proposed to alter its existing test procedures by adopting: (1) new testing and calculation methods relevant to regional standards for these products, specifically SEER Hot-Dry; (2) a limited number of other new testing methods; (3) a new calculation for the determination of sensible heat ratio,[22] which could be used to assess the dehumidification performance of an air conditioner or heat pump; and (4) modifications and clarifications of certain calculations, testing methods, test conditions and other provisions currently in the test procedure. Id. Similar to off mode for furnaces, DOE concluded that it would not be technically feasible to integrate off mode electrical energy consumption into SEER or HSPF, because SEER and HSPF are seasonal descriptors, not annualized descriptors, and the off mode energy usage, when measured, is essentially lost in practical terms due to the fact that it is a very small portion of overall electrical energy consumption. DOE held a public meeting on June 11, 2010 at DOE headquarters in Washington, D.C., to receive

[22] "Sensible heat ratio" is the relative contribution of an air conditioner or heat pump which reduces the dry bulb temperature of the ambient air to the cooling output which reduces the moisture content of the ambient air.

oral comments on its proposal, and it also sought and received numerous written comments.

Given the interrelated and tandem nature of these two rulemaking proceedings, during the public meeting for the preliminary TSD and in subsequent written comments, interested parties also commented on the revision of the central air conditioner and heat pump test procedure. Several comments were related to standby mode and off mode energy consumption. ACEEE commented that DOE must determine whether any products use crankcase heaters and whether such use is standby mode or off mode. (CAC: ACEEE, No. 72 at p. 3) In response, DOE believes that off mode power exists for central air conditioners and heat pumps in the form of controls, certain types of fan motors, and refrigerant crankcase heaters, so DOE worked to develop appropriate standards for off mode power for each class of equipment based on how the components that contribute to a unit's off mode power consumption are treated in the test procedure. Ingersoll Rand and EEI commented that a standard for off mode energy consumption is not needed, because the existing ratings (SEER and HSPF) already account for off mode power. (CAC: Ingersoll Rand, No. 66 at p. 8; CAC: EEI, No. 75 at p. 3) DOE agrees that SEER and HSPF already account for off mode and standby mode energy consumption of an air conditioning system during the cooling season and, for heat pumps, during the heating season. However, the energy consumed by an air conditioner during the heating and shoulder seasons, while the unit sits idle but powered, is not currently accounted for within the DOE test procedure. Similarly, the energy consumed by a heat pump during the shoulder season, while the unit sits idle but powered, is not currently accounted for within the DOE test procedure.

A number of interested parties commented during the public meeting that DOE should use the combination of SEER and energy efficiency ratio (EER) rather than SEER Hot-Dry as a metric for hot-dry climates because EER is more indicative of performance than SEER Hot-Dry and also more straightforward to calculate and understand. (CAC: ACEEE, Public Meeting Transcript at pp. 93, 95, 103; CAC: AHRI, Public Meeting Transcript at p. 94; CAC: PGE, Public Meeting Transcript at p. 97; CAC: Southern, Public Meeting Transcript at p. 100; CAC: Rheem, No. 76 at p. 6) EEI expressed concern that incorporating a SEER Hot-Dry metric would significantly change the results of the preliminary TSD because a new efficiency metric would result in different energy and cost savings to the consumer. (CAC: EEI, No. 75 at p. 5) DOE agrees that using a SEER Hot-Dry metric is unnecessary because the combination of SEER and EER is more representative of system performance. As discussed in section III.B.2, DOE has determined that it can consider dual metrics (i.e., SEER and EER) when considering recommendations arising out of a consensus agreement. For its analysis of potential standards apart from those recommended in the consensus agreement, DOE chose not to use the SEER Hot-Dry metric, which it had been considering, to characterize equipment performance in the hot-dry region, because DOE did not have sufficient information on how product costs and overall system performance might change if a SEER Hot-Dry metric were used. Therefore, DOE continued to use the current SEER rating metric for analysis of those potential amended standards.

a. Proposed Test Procedure Amendments

As mentioned above, DOE proposed amendments to its test procedure for central air conditioners and heat pumps to measure off mode power consumption during the heating and shoulder seasons for central air conditioners and the shoulder season for heat pumps. 75 FR 31224, 31238-39 (June 2, 2010). For central air conditioners and heat pumps, these changes included a measurement of the off mode power consumption during the shoulder season, P_1, in watts. For central air conditioners only, the test procedure also provides a method to measure the off mode power consumption during the heating season, P_2, also in watts. Id. at 31269. P_2 does not apply to heat pumps, because heat pumps are used during both the heating and cooling seasons, and, therefore, off mode power consumption only occurs during the shoulder seasons.

However, the June 2010 test procedure NOPR did not contain an off mode metric which combined P_1 and P_2. In general, issues concerning test procedure provisions for standby mode and off mode power consumption are being addressed in a separate SNOPR for the Residential CAC test procedure. However, in that SNOPR, DOE is proposing the following off mode metric, $P_{W,OFF}$, to regulate off mode power consumption for central air conditioners and heat pumps. $P_{W,OFF}$ is calculated for air conditioners using an equation involving P_1 and P_2 based on the national average relative lengths of each season (739 hours for P_1 and 5,216 hours for P_2). For heat pumps, $P_{W,OFF}$ equals P_1 because the heat pump is in active mode during the heating season. The equations used to calculate $P_{W,OFF}$ are as follows:

For air conditioners: $P_{W,OFF} = 0.124*P_1 + 0.876*P_2$

For heat pumps: $P_{W,OFF} = P_1$

As noted above, these equations were not included in the June 2010 test procedure NOPR, but are being addressed in an SNOPR.

G. Technological Feasibility

1. General

In each standards rulemaking, DOE conducts a screening analysis, which it bases on information it has gathered on all current technology options and prototype designs that could improve the efficiency of the products or equipment that are the subject of the rulemaking. As the first step in such analysis, DOE develops a list of design options for consideration in consultation with manufacturers, design engineers, and other interested parties. DOE then determines which of these means for improving efficiency are technologically feasible. DOE considers a design option to be technologically feasible if it is in use by the relevant industry or if research has progressed to the development of a working prototype. "Technologies incorporated in commercial products or in working prototypes will be considered technologically feasible." 10 CFR 430, subpart C, appendix A, section 4(a)(4)(i). Further, although DOE does consider technologies that are proprietary, it will not consider efficiency levels that can only be reached through the use of proprietary technologies (i.e., a unique pathway), which could allow a single manufacturer to monopolize the market.

Once DOE has determined that particular design options are technologically feasible, it further evaluates each of these design options 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. 10 CFR part 430, subpart C, appendix A, section 4(a)(4)(ii)-(iv). Section IV.B of this notice discusses the results of the screening analyses for furnaces and central air conditioners and heat pumps. Specifically, it presents the designs DOE considered, those it screened out, and those that are the basis for the TSLs in this rulemaking. For further details on the screening analysis for this rulemaking, see chapter 4 of the direct final rule TSD.

2. Maximum Technologically Feasible Levels

When DOE proposes to adopt (or not adopt) an amended or new energy conservation standard for a type or class of covered product, it must "determine the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible" for such product. (42 U.S.C. 6295(p)(1)) Accordingly, DOE determined the maximum technologically feasible ("max-tech") improvements in energy efficiency for furnaces and central air conditioners and heat pumps in the engineering analysis using the design parameters that passed the screening analysis and that lead to the creation of the most efficient products available. (See chapter 5 of the direct final rule TSD.)

The max-tech efficiency levels are set forth in TSL 7 for residential furnaces and again in TSL 7 for central air conditioners and heat pumps and represent the most efficient products available on the market in the given product class. Products at the max-tech efficiency levels for both furnaces and central air conditioners and heat pumps are either currently offered for sale or have previously been offered for sale. However, no products at higher efficiencies are available or have been in the past, and DOE is not aware of any working prototype designs that would allow manufacturers to achieve higher efficiencies. For central air conditioners and heat pumps, the max-tech levels are listed at various cooling capacities within the each product class, because they vary depending on the cooling capacity of the product. Table III.6 and Table III.7 list the max-tech levels that DOE determined for the products that are the subjects of this rulemaking.

Table III.6 Max-Tech AFUE Levels Considered in the Furnaces Analyses

Product Class	**Max-Tech AFUE Level %**
Non-weatherized Gas	98
Mobile Home Gas	96
Non-weatherized Oil-Fired	97
Weatherized Gas	81

Table III.7 Max-Tech SEER and HSPF Levels Considered in the Central Air Conditioner and Heat Pump Analyses

Product Class		Cooling Capacity	Max-Tech Efficiency Level
Split Systems	Air Conditioners Blower-Coil*	2 Ton	24.5 SEER
		3 Ton	22 SEER
		5 Ton	18 SEER
	Air Conditioners Coil-Only*	2 Ton	18 SEER
		3 Ton	17 SEER
		5 Ton	16 SEER
	Heat Pumps	2 Ton	22 SEER
		3 Ton	21 SEER
		5 Ton	18 SEER
Single-Package Systems	Air Conditioners	3 Ton	16.6 SEER
	Heat Pumps	3 Ton	16.4 SEER
Niche Products	SDHV	3 Ton	14.3 SEER
	Space-Constrained Air Conditioners	2.5 Ton	12 SEER
	Space-Constrained Heat Pumps	2.5 Ton	12 SEER

* Although analyzed separately, DOE is setting the same standard level for split-system blower-coil air conditioners and split-system coil-only air conditioners. DOE analyzed these products separately for greater accuracy in its analyses, but is adopting the same standard level. The difference between the two types of split-system air conditioners is that a blower-coil unit is matched with an indoor fan, while a coil-only unit is not. The rating method for a coil-only unit uses a default fan power consumption (limiting the SEER that can be achieved), while a blower-coil unit uses the measured fan power consumption of its matched indoor fan. For additional discussion of DOE's treatment of blower-coil and coil-only products, see section IV.A.3.b of this direct final rule.

For the weatherized gas furnace product class and the space-constrained central air conditioner and heat pumps product classes, the max-tech levels identified are the same level as the existing minimum standards for each respective product. The max-tech levels for these products are further discussed in the subsections immediately below.

a. <u>Weatherized Gas Furnace Max-Tech Efficiency Level</u>

For the RAP, DOE examined the efficiencies of weatherized gas furnaces available on the market and determined that 81-percent AFUE is the highest efficiency available for weatherized gas furnaces. In the RAP, DOE proposed to analyze several efficiency levels for weatherized gas furnaces, including an 81-percent max-tech level, and received feedback from several interested parties, described below.

ACEEE suggested that DOE should use a condensing furnace at 90-percent AFUE for the max-tech level for weatherized gas furnaces, because limited numbers of commercial packaged units are available with condensing gas sections, and this technology may be feasible for use with condensate drains to the house interior. (FUR: ACEEE, No. 1.3.009 at p. 6) In contrast, Lennox stated that it supports the 81-percent AFUE max-tech efficiency levels shown for weatherized gas furnace furnaces only for the purposes of undertaking required analysis; Lennox does not support DOE's setting max-tech as the minimum required efficiency level in a standard, and stated that DOE should avoid doing so. (FUR: Lennox, No. 1.3.018 at p. 3)

During the screening analysis (see section IV.B of this direct final rule), DOE considered technologies to improve the AFUE of weatherized gas furnaces, but determined that no weatherized gas furnace technologies satisfied all four screening criteria. As a result, 81-percent AFUE is the maximum technologically feasible efficiency level for these products. At efficiencies above 81-percent AFUE, the potential for the formation of condensate increases, causing concerns about condensate freezing in weatherized furnaces, which are installed outdoors. When condensate freezes, the performance of the unit is impacted, and failure rates increase, while reliability decreases. As suggested by ACEEE, DOE examined a condensing design for weatherized gas furnaces. In researching weatherized gas furnace designs currently on the market as well as prototype designs, DOE did not discover any designs that have been or are currently being used in commercially-available designs or working prototypes for residential condensing weatherized gas furnaces. Therefore, DOE is not aware of any designs that have reliably overcome issues associated with condensate freezing in weatherized gas furnaces, and this direct final rule does not include efficiency levels where condensate formation is possible for this product class. However, DOE recognizes that if the issues associated with condensate freezing in weatherized gas furnaces can be reliably overcome, there may be potential for developing products at condensing efficiency levels in the future.

The minimum energy conservation standard for weatherized gas furnaces that was promulgated by the November 2007 Rule is 81-percent AFUE. 72 FR 65136, 65169 (Nov. 19, 2007); 10 CFR 430.32(e)(1)(ii). Because DOE has concluded that the November 2007 Rule was not vacated by the remand agreement, 81-perecent AFUE was used as the baseline for this rulemaking. As a result, DOE has determined that 81-percent AFUE is both the baseline and max-tech level for weatherized gas furnaces. DOE concluded that there is no need to perform additional analyses for these products, since the de facto minimum standard will be 81-percent AFUE.

b. Space-Constrained Central Air Conditioner and Heat Pump Max-Tech Efficiency Levels

In conducting its analyses, DOE determined that the max-tech levels for both the space-constrained air conditioner and heat pump product classes are 12 SEER, which is equivalent to the baseline level. DOE has concluded that unique factors may prevent through-the-wall products from realizing the full potential of energy saving design options available to other product classes. Typically, increased condenser coil surface area is the most cost-effective energy saving measure available for air conditioners and heat pumps. However, manufacturers of space-constrained products are limited in their ability to implement this option by the apparent constraints upon coil size inherently present in this product class, and some manufacturers have expressed concern that the available condenser coil surface area may have already been maximized in order to reach the 10.9 SEER standard, which was set forth in the previous rulemaking for through-the-wall products. 69 FR 50997, 51001(August 17, 2004). Similarly, manufacturers have claimed that the number of coil rows has also been maximized to the point at which the addition of further rows would not provide a noticeable improvement in performance. Other coil improvements, such as micro-channel tubing[23], were proven technologically infeasible during research and development testing because manufacturers have been unable to solve defrosting issues, calling into question the technological feasibility of this technology option for all types of heat pumps. If coil improvements are insufficient to increase product efficiency, through-the-wall manufacturers must explore more-costly

[23] Microchannel heat exchangers have a rectangular cross-section containing several small channels through which refrigerant passes. Fins pass between the tubes and are brazed to the tubes. These heat exchangers are capable of transferring more heat per unit of face area than a round-tube plate-fin coil of comparable capacity.

design options, such as high-efficiency compressors and fan motors and controls. According to certain manufacturers, higher-efficiency compressors were incorporated into products on the market to meet the 10.9 SEER standard, and variable speed fan motors and advanced controls were incorporated into product designs when the through-the-wall product class expired and those products were required to meet the 12 SEER standard as part of the space-constrained product classes. The expiration of this product class and inclusion of the through-the-wall units in the space-constrained product class is discussed in greater detail in section IV.A.3.b. The implementation of these technologies to meet the 12 SEER requirement of the space-constrained product class suggests that manufacturers have few, if any, technology options left to improve efficiency level beyond 12 SEER.

DOE conducted teardowns and further market research to confirm this hypothesis and found the space-constrained max-tech efficiency level to be 12 SEER for both the space-constrained air conditioner and heat pump product classes. This level matches the baseline, and therefore, DOE would be unable to raise the energy conservation standards. Therefore, DOE concluded that there is no need to perform additional analyses for these products, since the de facto minimum standard will be 12 SEER. However, during its investigation, DOE found that space-constrained products have the potential to achieve higher off mode efficiency levels, and, therefore, considered these products in the off mode analysis, which is discussed in section III.E.2.a.

H. Energy Savings

1. Determination of Savings

DOE used its NIA spreadsheet to estimate energy savings from amended standards for residential furnaces and central air conditioners and heat pumps. (The NIA spreadsheet model is described in section IV.G of this notice and chapter 10 of the direct final rule TSD.) For most of the considered TSLs, DOE forecasted cumulative energy savings beginning in the year in which compliance with amended standards would be required, and ending 30 years afterward. For TSL 4, which matches the recommendations in the consensus agreement, DOE forecasted the energy savings from 2015 through 2045 for central air conditioners and heat pumps, and from 2013 through 2045 for furnaces.[24] DOE quantified the energy savings attributable to each TSL as the difference in energy consumption between the standards case and the base case. The base case represents the forecast of energy consumption in the absence of new or amended mandatory efficiency standards, and considers market demand for more-efficient products.

The NIA spreadsheet model calculates the energy savings in "site energy," which is the energy directly consumed by products at the locations where they are used. DOE reports national energy savings on an annual basis in terms of the source (primary) energy savings, which is the savings in the energy that is used to generate and transmit energy to the site. To convert site energy to source energy, DOE derived annual conversion factors from the model used to prepare the Energy Information

[24] TSL 4 incorporates the recommendations of the consensus agreement, which include compliance dates in 2015 for central air conditioners and heat pumps and in 2013 for furnaces.

Administration's (EIA) Annual Energy Outlook 2010 (AEO2010), which presents long-term projections of energy supply, demand, and prices.[25]

2. Significance of Savings

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

I. Economic Justification

1. Specific Criteria

As discussed in section II.B, EPCA provides seven factors to be evaluated in determining whether a potential energy conservation standard is economically justified. (42 U.S.C. 6295(o)(2)(B)(i)) The following sections generally discuss how DOE is addressing each of those seven factors in this rulemaking. For further details and the results of DOE's analyses pertaining to economic justification, see sections IV and V of today's notice.

[25] For more information on AEO2010, see: http://www.eia.doe.gov/oiaf/aeo/.

a. Economic Impact on Manufacturers and Consumers

In determining the impacts of a new or amended standard on manufacturers, DOE first determines the quantitative impacts using an annual cash-flow approach. This includes both a short-term assessment (based on the cost and capital requirements associated with new or amended standards during the period between the announcement of a regulation and when the regulation comes into effect) and a long-term assessment (based on the costs and margin impacts over the 30-year analysis period). The impacts analyzed include INPV (which values the industry on the basis of expected future cash flows), cash flows by year, changes in revenue and income, and other measures of impact, as appropriate. Second, DOE analyzes and reports the impacts on different types of manufacturers, paying particular attention to impacts on small manufacturers. Third, DOE considers the impact of standards on domestic manufacturer employment and manufacturing capacity, as well as the potential for standards to result in plant closures and loss of capital investment. Finally, DOE takes into account cumulative impacts of different DOE regulations and other regulatory requirements on manufacturers.

For individual consumers, measures of economic impact include the changes in LCC and the PBP associated with new or amended standards. The LCC, which is also separately specified as one of the seven factors to be considered in determining the economic justification for a new or amended standard (42 U.S.C. 6295(o)(2)(B)(i)(II)), is discussed in the following section. For consumers in the aggregate, DOE also calculates the net present value from a national perspective of the economic impacts on consumers over the forecast period used in a particular rulemaking.

b. Life-Cycle Costs

The LCC is the sum of the purchase price of a product (including the cost of its installation) and the operating expense (including energy and maintenance and repair expenditures) discounted over the lifetime of the product. The LCC savings for the considered efficiency levels are calculated relative to a base case that reflects likely trends in the absence of amended standards. The LCC analysis requires a variety of inputs, such as product prices, product energy consumption, energy prices, maintenance and repair costs, product lifetime, and consumer discount rates. DOE assumes in its analysis that consumers purchase the product in the year in which compliance with the amended standard is required.

To account for uncertainty and variability in specific inputs, such as product lifetime and discount rate, DOE uses a distribution of values with probabilities attached to each value. A distinct advantage of this approach is that DOE can identify the percentage of consumers estimated to achieve LCC savings or experiencing an LCC increase, in addition to the average LCC savings associated with a particular standard level. In addition to identifying ranges of impacts, DOE evaluates the LCC impacts of potential standards on identifiable subgroups of consumers that may be disproportionately affected by an amended national standard.

c. Energy Savings

While significant conservation of energy is a separate statutory requirement for imposing an energy conservation standard, the Act requires DOE, in determining the economic justification of a standard, to consider the total projected energy savings that are expected to result directly from the standard. (42 U.S.C. 6295(o)(2)(B)(i)(III)) DOE uses the NIA spreadsheet results in its consideration of total projected savings.

d. Lessening of Utility or Performance of Products

In establishing classes of products, and in evaluating design options and the impact of potential standard levels, DOE seeks to develop standards that would not lessen the utility or performance of the products under consideration. None of the TSLs presented in today's direct final rule would reduce the utility or performance of the products considered in the rulemaking. (42 U.S.C. 6295(o)(2)(B)(i)(IV)) During the screening analysis, DOE eliminated from consideration any technology that would adversely impact consumer utility. For the results of DOE's analyses related to the potential impact of amended standards on product utility and performance, see section IV. B of this notice and chapter4 of thedirect final rule TSD.

e. Impact of Any Lessening of Competition

EPCA directs DOE to consider any lessening of competition that is likely to result from standards. Specifically, it directs the U.S. Attorney General (Attorney General) to determine in writing the impact, if any, of any lessening of competition likely to result from a proposed standard and to transmit such determination to the Secretary, not later than 60 days after the publication of a proposed rule, together with an analysis of the nature and extent of such impact. (42 U.S.C. 6295(o)(2)(B)(i)(V) and (ii)) DOE is simultaneously publishing a NOPR containing energy conservation standards identical to those set forth in today's direct final rule and has transmitted a copy of today's direct final rule and the accompanying TSD to the Attorney General, requesting that the U.S. Department of Justice (DOJ) provide its determination on this issue. DOE will consider DOJ's comments on the rule in determining whether to proceed with the direct final rule. DOE will also publish and respond to the DOJ's comments in the Federal Register in a separate notice.

f. Need of the Nation to Conserve Energy

Another factor which DOE must consider in determining whether a new or amended standard is economically justified is the need for national energy and water conservation. (42 U.S.C. 6295(o)(2)(B)(i)(VI)) The energy savings from new or amended standards are likely to provide improvements to the security and reliability of the Nation's energy system. Reductions in the demand for electricity may also result in reduced costs for maintaining the reliability of the Nation's electricity system. DOE conducts a utility impact analysis to estimate how new or amended standards may affect the Nation's needed power generation capacity.

Energy savings from today's standards are also likely to result in environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases associated with energy production (i.e., from power plants), and through reduced use of fossil fuels at the homes where gas and oil furnaces are used. DOE reports the environmental effects from today's standards, as well as from each TSL it considered for furnaces and central air conditioners and heat pumps, in the environmental assessment contained in chapter 15 in the direct final rule TSD. DOE also reports estimates of the economic value of emissions reductions resulting from the considered TSLs.

g. Other Factors

The Act allows the Secretary, 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 developing the standards set forth in this notice, DOE has also considered the comments submitted by interested parties, including the recommendations in the consensus agreement, which DOE believes provides a reasoned statement by interested persons that are fairly representative of relevant points of view (including representatives of manufacturers of covered products, States, and efficiency advocates) and contains recommendations with respect to energy conservation standards that are in accordance with 42 U.S.C. 6295(o). DOE has encouraged the submission of consensus agreements as a way to get diverse stakeholders together, to develop an independent and probative analysis useful in DOE standard setting, and to expedite the rulemaking process. In the present case, one outcome of the consensus agreement was a recommendation to accelerate the compliance dates for these products, which would have the effect of producing additional energy savings at an earlier date. DOE also believes that standard levels recommended in the consensus agreement may increase the likelihood for regulatory compliance, while decreasing the risk of litigation.

2. Rebuttable Presumption

As set forth in 42 U.S.C. 6295(o)(2)(B)(iii), EPCA provides for a rebuttable presumption that an energy conservation standard is economically justified if the additional cost to the consumer of a product that meets the standard level is less than three times the value of the first-year energy (and, as applicable, water) savings resulting from the standard, as calculated under the applicable DOE test procedure. DOE's LCC and PBP analyses generate values that calculate the payback period for consumers of potential new and amended energy conservation standards. These analyses include, but are not limited to, the three-year payback period contemplated under the rebuttable presumption test. However, DOE routinely conducts a full economic analysis that considers the full range of impacts to the consumer, manufacturer, Nation, and environment, as required under 42 U.S.C. 6295(o)(2)(B)(i). The results of this analysis serve as the basis for DOE to evaluate the economic justification for a potential standard level definitively (thereby supporting or rebutting the results of any preliminary determination of economic justification). The rebuttable presumption payback calculation is discussed in section IV.F.12 of this direct final rule and chapter 8 of the direct final rule TSD.

IV. Methodology and Discussion

DOE used two spreadsheet tools, which are available online,[26] to estimate the impact of all the considered standard levels, including today's standards. The first spreadsheet calculates LCCs and payback periods of potential amended energy conservation standards. The second provides shipments forecasts and then calculates national energy savings and net present value impacts of potential energy conservation standards. The Department also assessed manufacturer impacts, largely through use of the Government Regulatory Impact Model (GRIM), which is an industry cash-flow model that is described in detail in section IV.I.

Additionally, DOE estimated the impacts on utilities and the environment of potential amended energy efficiency standards for furnaces and central air conditioners and heat pumps. DOE used a version of EIA's National Energy Modeling System (NEMS) for the utility and environmental analyses. The NEMS model simulates the energy sector of the U.S. economy. EIA uses NEMS to prepare its Annual Energy Outlook. For more information on NEMS, refer to The National Energy Modeling System: An Overview, DOE/EIA–0581 (98) (Feb. 1998) (available at: http://tonto.eia.doe.gov/FTPROOT/forecasting/058198.pdf).

The version of NEMS used for appliance standards analysis is called NEMS-BT, which is based on the AEO version but with minor modifications.[27] NEMS-BT offers a

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[26] http://www1.eere.energy.gov/buildings/appliance_standards/residential/furnaces_boilers.html and http://www1.eere.energy.gov/buildings/appliance_standards/residential/central_ac_hp.html

[27] EIA approves the use of the name "NEMS" to describe only an AEO version of the model without any modification to code or data. Because the present analysis entails some minor code modifications (to allow

sophisticated picture of the effect of standards, because it accounts for the interactions between the various energy supply and demand sectors and the economy as a whole.

A. Market and Technology Assessment

1. General

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 (e.g., manufacturer specification sheets, industry publications, and data from trade organization websites, such as AHRI at http://www.ahrinet.org/). The subjects addressed in the market and technology assessment for this rulemaking include: (1) quantities and types of products sold and offered for sale; (2) retail market trends; (3) products covered by the rulemaking; (4) product classes; (5) manufacturers; (6) regulatory requirements and non-regulatory programs (such as rebate programs and tax credits); and (7) technologies that could improve the energy efficiency of the products under examination. See chapter 3 of the direct final rule TSD for further discussion of the market and technology assessment.

2. Products Included in this Rulemaking

This subsection addresses the scope of coverage for this energy conservation standards rulemaking for furnaces, central air conditioners, and heat pumps. It will also

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modeling of the impact of energy conservation standards on the appropriate energy end uses) and uses 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.)

address whether EPCA covers certain other products and authorizes DOE to adopt standards for them.

a. Furnaces

EPCA defines a residential "furnace" as a product that: (1) either uses only single-phase electric current, or uses single-phase electric current or direct current (DC) in conjunction with natural gas, propane, or home heating oil; (2) is designed to be the principal heating source for the living space of a residence; (3) is not contained within the same cabinet with a central air conditioner whose rated cooling capacity is above 65,000 Btu per hour; (4) is an electric central furnace, electric boiler, forced- air central furnace, gravity central furnace, or low pressure steam or hot water boiler; and (5) has a heat input rate of less than 300,000 Btu per hour for electric boilers and low pressure steam or hot water boilers and less than 225,000 Btu per hour for forced-air central furnaces, gravity central furnaces, and electric central furnaces. (42 U.S.C. 6291(23)) This definition covers the following types of products: (1) gas furnaces (non-weatherized and weatherized); (2) oil-fired furnaces (non-weatherized and weatherized); (3) mobile home furnaces (gas and oil-fired); (4) electric resistance furnaces; (5) hot water boilers (gas and oil-fired); (6) steam boilers (gas and oil-fired); and (7) combination space/water heating appliances (water-heater/fancoil combination units and boiler/tankless coil combination units).

Residential boilers are outside the scope of this rulemaking. EISA 2007 included amendments to EPCA that established amended standards for these boilers (42 U.S.C.

6295(f)(3)), and DOE subsequently incorporated these standards into its regulations at 10 CFR 430.32(e)(2)(ii). 73 FR 43611 (July 28, 2008). Compliance with the new statutory boilers standards is required for covered products manufactured or imported on or after September 1, 2012. As discussed in section II.B.2.a above, under the voluntary remand, DOE agreed to undertake analyses to determine whether it should establish regional energy conservation standards for residential furnaces. As part of this analysis, DOE agreed to consider the effect of alternate standards on natural gas prices. The current rulemaking for furnaces is the second amended energy conservation standards rulemaking which is being conducted pursuant to authority under 42 U.S.C. 6295(f)(4)(C) and (o)(6). Given the relatively recent enactment of statutorily-prescribed boiler standards in EISA 2007, DOE has decided to consider amended energy conservation standards for boilers under 42 U.S.C. 6295(f)(4)(C) in a future rulemaking.

For furnaces, this rulemaking covers the same products as those covered by the November 2007 Rule, consisting of the following types of furnaces: (1) non-weatherized gas; (2) weatherized gas; (3) mobile home gas; and (4) non-weatherized oil-fired. However, DOE did not perform an AFUE analysis for weatherized gas furnaces because the November 2007 Rule promulgated standards at the max-tech AFUE level. As described in section III.G, DOE has concluded that 81-percent AFUE is still the max-tech efficiency achievable for weatherized gas furnaces. Therefore, because EPCA's anti-backsliding clause would not allow DOE to consider adoption of a minimum standard below 81-percent AFUE, and because there are no viable efficiency levels above 81-percent AFUE, DOE did not perform an AFUE analysis for weatherized gas furnaces.

Although DOE did not consider amended AFUE standards for electric furnaces, mobile home oil-fired furnaces, and weatherized oil-fired furnaces in this rulemaking for the reasons discussed in the following sections, DOE did consider standby mode and off mode standards for these products. Additionally, DOE did not analyze energy conservation standards for combination space/water heating appliances for reasons discussed below.

(i) Mobile Home Oil-Fired and Weatherized Oil-Fired Furnaces

DOE is not proposing amended AFUE standards for mobile home oil-fired furnaces and weatherized oil-fired furnaces because DOE understands that only a very small number of these products are shipped (as these products combine to make up less than one percent of all furnace models in the AHRI directory) and that the few models that are shipped exceed the currently applicable standards (i.e., 75-percent AFUE for mobile home oil-fired furnaces and 78-percent AFUE for weatherized oil-fired furnaces). As a result, DOE believes that promulgating higher standards for these products would result in de minimis energy savings. DOE initially made these determinations in the proposed rule leading to the development of the November 2007 Rule (71 FR 59204, 59214 (Oct. 6, 2006)), and based on a more recent review of products on the market and feedback from manufacturers, DOE believes the market for all of these furnaces has not changed. DOE initially made this proposal in the RAP and did not receive any related comments.

(ii) Electric Furnaces

EPCA initially prescribed standards at 78-percent AFUE for "furnaces," which did not exclude electric furnaces. (42 U.S.C. 6295(f)(1)) The definition of a "furnace" in EPCA (42 U.S.C. 6291(23)) explicitly includes "electric furnaces," and, therefore, the 78-percent AFUE standard set by EPCA applies to electric furnaces. In the November 2007 final rule, DOE stated that it was not adopting amended standards for electric furnaces. 72 FR 65136, 65154 (Nov. 19, 2007). However, when outlining the minimum AFUE requirements for the other furnace product classes, DOE did not restate the requirement for electric furnaces that was originally established by EPCA. To clarify the existing standards for electric furnaces, DOE is reaffirming the 78-percent minimum AFUE level for electric furnaces that was originally established by EPCA in today's direct final rule. As noted previously, DOE is not adopting amended AFUE standards for electric furnaces because it understands that their efficiency already approaches 100-percent AFUE. The AFUE ratings for electric furnace products currently on the market range from 96-percent (for outdoor units due to jacket losses) to 100-percent, and as discussed below, the test procedures for these products effectively limit them from having AFUE ratings any lower than this. Therefore, for the reasons explained below, DOE believes that any improvements to electric furnaces would have a de minimis energy-savings potential and did not consider amending the AFUE standards for these products. (However, as noted in section III.E.1.b of this direct final rule, DOE analyzed new energy conservation standards for standby mode and off mode energy consumption of these products.)

The test procedure for residential furnaces specifies that AFUE for electric furnaces is calculated as 100 percent minus jacket losses, and gives the option of assigning jacket losses equal to 1 percent.[28] The AFUE is calculated in this manner because the electric heating elements convert all of the electrical input energy into heat energy, and the only losses at the point of operation are through the jacket. The jacket losses are then multiplied by a factor of 1.7 for indoor furnaces (which must be tested as isolated combustion systems) and 3.3 for outdoor furnaces, and subtracted from 100 percent to get the AFUE rating. Therefore, the lowest possible AFUE rating for an electric furnace, according to DOE's test procedure and assuming a default value of 1 percent jacket losses, is 98.3 percent AFUE for non-weatherized (indoor) electric furnaces and 96.7 percent AFUE for weatherized (outdoor) electric furnaces. Further, a significant portion of electric furnaces are installed in the conditioned space, and any heat lost through the jacket in such installations would contribute to the heated space, effectively making the electric furnace completely efficient at the point of use.

The jacket losses of furnaces currently on the market are low, as jacket losses are already assumed by the test procedure to be a default of 1 percent, and it is unlikely that further improvements will have much impact on efficiency. Because reducing jacket losses are the only means for improving the efficiency of these products as rated by DOE's test procedure, they have an extremely limited potential for additional energy

[28] For the rulemaking analysis in support of the 2007 Final Rule for residential furnaces and boilers, DOE gathered test data on the jacket losses for furnaces. This data is summarized in a presentation available at: http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/support_material.pdf. The actual jacket loss values based on testing ranged from 0.11 percent to 0.75 percent. Thus, DOE believes one percent jacket losses to be representative of a conservative estimate of the actual jacket losses of furnaces.

savings. Any efficiency levels analyzed would be very unlikely to result in significant energy savings.

In response to DOE's planned approach for considering amended AFUE standards for electric furnaces, which was outlined in the RAP, DOE received several comments.

NRDC stated that DOE should include electric furnaces in the scope of this rulemaking because these products represent a low-cost option that could grow in market penetration as the efficiency (and as a result, cost) of competing products that provide the exact same consumer utility (i.e., heat pumps, which in most cases have electric furnaces as back up and would use the same duct system) may potentially increase with upcoming standards. Further, NRDC stated that unless the energy savings potential of amended standards for electric furnaces is less than 0.032 quads (an amount deemed significant by DOE in the packaged terminal air conditioners (PTACs) rulemaking[29]), DOE should include them in the scope of this rulemaking. (FUR: NRDC, No. 1.3.020 at pp. 8) ACEEE recommended including electric furnaces and requiring a minimum AFUE of greater than 100-percent for all ducted electric furnaces, given the substantial energy losses in transmission from source to site. (FUR: ACEEE, No. 1.3.009 at p. 3-4) AGA stated that excluding electric furnaces from consideration in the rulemaking is counterproductive to reducing energy consumption, so the commenter urged DOE to look at the number of electric furnaces on the market and to use that number in a comparative

[29] DOE published the final rule for PTACs on October 7, 2008. 73 FR 58772.

analysis to determine the potential impact of inclusion of such products in this rulemaking. (FUR: AGA, Public Meeting Transcript, No. 1.2.006 at p. 42)

Conversely, EEI stated that it supports the scope of the current rulemaking and agreed with DOE's conclusions in the RAP regarding electric resistance furnaces and boilers. (FUR: EEI, No. 1.3.015 at p. 3) The American Public Power Association (APPA) commented that if DOE decides to reject the use of the consensus agreement and proceed with a rulemaking, APPA would support the scope as outlined by DOE. More specifically, APPA supported the finding that the rulemaking should not cover electric resistance furnaces because their efficiency is already very high. (FUR: APPA, No. 1.3.011 at p. 3)

In response, DOE notes that it cannot promulgate a standard that would lead to the elimination of any product class. (42 U.S.C. 6295(o)(4)) Because it is currently impossible for manufacturers to achieve an AFUE standard of greater than 100 percent for electric furnaces, and because such a standard would effectively eliminate electric furnaces from the market, DOE does not believe ACEEE's suggestion is a valid opportunity for energy savings under EPCA. Additionally, as noted above, DOE reviewed the market for electric furnaces and determined that because the efficiency of these products approaches 100-percent AFUE, the energy-savings potential is de minimis. As a result, DOE does not believe there is reason to consider amended standards for electric furnaces in this rulemaking.

EarthJustice stated that DOE has the statutory authority to consider heat pump technology as a design option to improve the efficiency of electric furnaces. EarthJustice asserted that because heat pumps use the same kind of energy and provide the same functionality as electric resistance furnaces, there is no basis for treating the products differently, and separate standards for these products are inconsistent with EPCA's mandate to save energy. Further, EarthJustice stated that the definition of a “furnace” is broad enough to cover heat pumps even though they are already defined under 42 U.S.C. 6291(24) and argued that a heat pump meets all of the requirements of the furnace definition. (FUR: EarthJustice, No. 1.3.014 at pp. 3-6) Similarly, NRDC stated that electric furnaces should be added to the heat pump product class and be required to achieve the same performance. NRDC suggested rating both types of products using the same metric – testing the furnaces for HSPF if possible, or exploring an AFUE rating for a heat pump. (FUR: NRDC, No. 1.3.020 at pp. 8-9)

DOE notes that EPCA defines a “furnace” as “an electric central furnace, electric boiler, forced-air central furnace, gravity central furnace, or low pressure steam or hot water boiler.” (42 U.S.C. 6291(23)(C)) Further, DOE’s definitions in the Code of Federal Regulations define an “electric central furnace” as “a furnace designed to supply heat through a system of ducts with air as the heating medium, in which heat is generated by one or more electric resistance heating elements and the heated air is circulated by means of a fan or blower.” 10 CFR 430.2. Separately, EPCA defines a “heat pump” as a product that (1) consists of one or more assemblies; (2) is powered by single phase electric current; (3) is rated below 65,000 Btu per hour; (4) utilizes an indoor conditioning coil, compressors, and refrigerant-to-outdoor-air heat exchanger to provide air heating; and (5) may also provide air cooling, dehumidifying, humidifying circulating, and air cleaning. (42 U.S.C. 6291(24)) DOE believes that the definition of "heat pump" in EPCA does not include electric furnaces, because electric furnaces do not meet all of the criteria of the "heat pump" definition (such as utilizing a compressor and refrigerant). (42 U.S.C. 6291(24)(D)) Further, DOE believes that because "heat pumps" are defined separately by EPCA, they are not included under the definition of a "furnace" under 42 U.S.C. 6291(23)(C), which states that a furnace is an electric central furnace, electric boiler, forced-air central furnace, gravity central furnace, or low pressure steam or hot water boiler. Because an electric central furnace utilizes heat "generated by one or more electric resistance elements," a heat pump would not be covered under the definition of an "electric central furnace." Once heat pump technology is added to an electric furnace, the product would no longer generate heat using an electric resistance element, but instead would use a refrigerant-to-outdoor-air heat exchanger to provide air heating. Such a change in the mechanism for generating heat would exclude the product from being covered as a furnace (as it would no longer be an "electric furnace" under the definition of a "furnace" in 42 U.S.C. 6291(23)(C))), and would instead cause it to be classified it as a heat pump, under EPCA's definitions. Therefore, DOE has concluded that it will not consider heat pump technology as a design option for electric furnaces in the analysis.

(iii) Combination Space/Water Heating Appliances

DOE excluded combination space/water heating appliances from consideration in this rulemaking, as was done in the NOPR leading to the November 2007 Rule for furnaces and boilers. 69 FR 45420, 45429 (July 29, 2004). An adequate test procedure does not exist that would allow DOE to set standards for these products.

ACEEE urged DOE to develop a test method and energy conservation standard for combination hot water/space heating units. (FUR: ACEEE, No. 1.3.009 at p. 3) EEI stated that if combination space/water heating appliances obtain greater market share, then DOE should create a test procedure and efficiency standards in a future rulemaking because they are a competitive product. (FUR: EEI, No. 1.3.015 at p.3)

DOE has not yet initiated a test procedure rulemaking to establish a test procedure for combination space/water heating appliances. DOE believes that doing so as a part of this rulemaking would cause delays that could prevent DOE from issuing amended standards for residential furnaces and central air conditioners and heat pumps in a timely manner, and thus, may reduce energy savings to the Nation from amended standards (if the compliance date must be delayed). Therefore, DOE may consider a test procedure and energy conservation standards for combination space/water heating appliances in future rulemakings, but will not do so as a part of this rulemaking for residential furnaces and central air conditioners and heat pumps.

b. Central Air Conditioners and Heat Pumps

EPCA defines a residential "central air conditioner" as a product, other than a packaged terminal air conditioner, which is: (1) powered by single-phase electric current, (2) air cooled, (3) rated below 65,000 Btu per hour, (4) not contained within the same cabinet as a furnace the rated capacity of which is above 225,000 Btu per hour, and (5) a heat pump or a cooling only unit. (42 U.S.C. 6291(21)) Furthermore, EPCA defines a "heat pump" as a product, other than a packaged terminal heat pump, which: (1) consists of one or more assemblies, (2) is powered by single-phase electric current, (3) is rated below 65,000 Btu per hour, (4) uses an indoor conditioning coil, compressors, and refrigerant-to-outdoor air heat exchanger to provide air heating, and (5) may also provide air cooling, dehumidifying, humidifying circulating, and air cleaning. (42 U.S.C. 6291 (24))

For this rulemaking, DOE is evaluating amended energy conservation standards for the products covered by DOE's current standards for central air conditioners and heat pumps, specified at 10 CFR 430.32(c)(2), which DOE adopted in the August 2004 Rule. These products consist of: (1) split-system air conditioners; (2) split-system heat pumps; (3) single package air conditioners; (4) single package heat pumps; (5) small-duct high-velocity (SDHV) air conditioners and heat pumps; (6) space-constrained air conditioners; and (7) space-constrained heat pumps. The August 2004 Rule also prescribed standards for through-the-wall air conditioners and heat pumps, but those products are now considered space-constrained products because the through-the-wall product class expired on January 23, 2010. 69 FR 51001.

(i) Evaporative Coolers

In response to the preliminary analysis, ACEEE indicated that DOE should consider evaporative pre-cooled air conditioner condensers (i.e., the evaporative precooler is an add-on to a conventional condenser) as a technology that could improve the efficiency of air conditioners. (CAC: ACEEE, No. 72 at p. 4) As a result of this input, DOE reexamined its treatment of evaporative coolers both as stand-alone products and as add-ons to air conditioners. Evaporative coolers, also sometimes referred to as swamp coolers, can be used as stand-alone residential cooling systems. This type of system is generally found in hot, dry regions such as the southwestern United States. Evaporative coolers operate by passing dry outdoor air over a water-saturated medium, which cools the air as the water evaporates. The cooled air is then directed into the home by a circulating fan. As mentioned above, EPCA defines a residential "central air conditioner," in part, as "air-cooled." (42 U.S.C. 6291(21)) Because residential evaporative coolers are "evaporatively-cooled" (instead of "air-cooled"), DOE has determined that they do not meet this definition and are, therefore, outside the scope of this rulemaking.

In some instances, however, evaporative coolers can be added on to air conditioners, and the combined system is referred to as an evaporative pre-cooled air conditioner. In this application, the add-on evaporative cooler functions in the same manner as the stand-alone system, except that its output air is blown over the air conditioner condenser coils, instead of directly into the conditioned space. The increased temperature gradient between the condenser coil and the air improves heat transfer and increases the efficiency of the condenser coil. DOE is unaware of either any evaporative pre-cooled central air conditioning systems offered as a complete package by any air conditioner manufacturer, or of any prototype of such a system. Consequently, without cost or performance data, DOE cannot give this combined system full consideration in the analysis. Therefore, the assumed cost of meeting each TSL is based on other technologies, which may be more or less costly than evaporative pre-cooling.

3. Product Classes

In evaluating and establishing energy conservation standards, DOE generally divides covered products into classes by the type of energy used, or by capacity or other performance-related feature that justifies a different standard for products having such feature. (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.

a. Furnaces

The existing Federal energy conservation standards for residential furnaces are codified at 10 CFR 430.32(e)(1)(i). The November 2007 Rule amended energy conservation standards for residential furnaces and established six residential furnace product classes. 72 FR 65136, 65169 (Nov. 19, 2007). In the furnaces RAP, DOE stated that it intends to maintain these product classes. Ingersoll Rand commented that the planned product classes seem appropriate. (FUR: Ingersoll Rand, No. 1.3.006 at p. 2) Lennox stated that it supports DOE's planned product classes to the extent they mirror those in the consensus agreement. (FUR: Lennox, No. 1.3.018 at p. 3)

For today's direct final rule, DOE reviewed the market for residential furnaces, and determined that it is appropriate to consider the same six product classes established for the November 2007 Rule for this analysis. In addition, DOE also considered electric furnaces for standby mode and off mode standards only. Therefore, the furnace product classes are:

- Non-weatherized gas;
- Weatherized gas;
- Mobile home gas;
- Mobile home oil-fired;
- Non-weatherized oil-fired;
- Weatherized oil-fired; and
- Electric.

As stated in section IV.A.2.a above, DOE only performed an AFUE analysis for non-weatherized gas, mobile home gas, and non-weatherized oil-fired furnaces. Additionally, DOE conducted a standby mode and off mode analysis for non-weatherized gas, mobile home gas, non-weatherized oil-fired (including mobile home oil-fired), and electric furnaces. DOE did not perform a standby mode and off mode analysis for weatherized gas and weatherized oil-fired furnaces, as discussed in section III.E.1.a.

In response to the RAP for furnaces, DOE received several comments related to setting different standards for new construction and replacement installations for furnaces. AGA recommended that DOE should adopt a condensing standard at 90-

percent AFUE for new construction, but allow non-condensing 80-percent furnaces to be installed in replacement applications. (FUR: AGA, Public Meeting Transcript, No. 1.2.006 at p. 41) NEEP stated that it does not support limiting a revised standard to new construction, because approximately 70 percent of furnace sales are into the replacement market, and such a limitation would undermine too much of the amended standard's projected energy savings. (FUR: NEEP, No. 1.3.021 at p. 3) ACEEE stated that the expected life of a house is roughly 100 years, and that exempting existing houses from a standard sets a precedent for the following rounds of rulemakings. Further, ACEEE stated that at some point, DOE would have to set standards that force consumers to retrofit their homes to accommodate more-efficient products, and the cost to do this will not go down with time. Therefore, ACEEE reasoned that the sooner this is done, the longer the benefits will be recognized in an existing house. (FUR: ACEEE, Public Meeting Transcript, No. 1.2.006 at pp. 51-52)

EEI stated strong opposition to setting new efficiency standards for new construction for only gas heating products (and not other types of heating products). EEI asserted that if new efficiency standards for gas furnaces are to only apply to new construction, then new efficiency standards for all other competitive products covered by DOE should also apply only to new construction. EEI stated that otherwise, standards in each product class should apply to both new construction and retrofit situations to maximize energy savings and economies of scale (as has been done in the past). (FUR: EEI, No. 1.3.015 at p. 3)

In response, DOE notes that setting different standards for products intended for replacement installations and products intended for new construction would effectively create separate product classes for each of these types of products. As stated above, EPCA directs DOE to divide covered products into classes based on the type of energy used, capacity, or other performance-related feature that justifies a different standard for products having such feature. (42 U.S.C. 6295(q)) DOE does not believe that the intended installation type (i.e., new construction or replacement) falls under any of the qualifications listed above. As a result, DOE has determined that it does not have the authority to establish differentiated standards for product installed in new construction and products installed in replacement of an existing unit. Therefore, DOE did not consider such standards for this direct final rule.

b. Central Air Conditioners and Heat Pumps

The existing Federal energy conservation standards for residential central air conditioners and heat pumps went into effect on January 23, 2006. 69 FR 50997 (Aug. 17, 2004). At 10 CFR 430.32(c)(2), there is a list of the nine product classes of residential central air conditioners and heat pumps and their corresponding energy conservation standards. However, because the through-the-wall air conditioner and heat pump product classes expired on January 23, 2010, DOE examined only seven product classes for this residential central air conditioner and heat pump rulemaking. 69 FR 50997, 51001 (Aug. 17, 2004). The seven product classes DOE examined are:

- Split-system air conditioners;
- Split-system heat pumps;

- Single-package air conditioners;
- Single-package heat pumps;
- Small-duct, high-velocity systems;
- Space-constrained air conditioners; and
- Space-constrained heat pumps.

The subsections below provide additional detail and discussion of stakeholder comments relating to these seven product classes.

(i) Expiration of Through-the-Wall Product Class

Through-the-wall systems were established as a separate product class, and were required by the August 2004 Rule to meet a 10.9 SEER standard. As previously mentioned, when the through-the-wall product class was created, DOE included a provision that the product class would expire on January 23, 2010, after which time units in the through-the-wall product class could be considered part of the space-constrained product class. 69 FR 50997, 50998 (August 17, 2004). In the August 2004 Rule, DOE also established a separate product class for space-constrained systems, requiring them to meet a 12 SEER standard. For this direct final rule, because the through-the-wall product class has expired, DOE reclassified through-the-wall products. The product class assignment of any product depends on that product's characteristics, but DOE believes that most (if not all) of the historically-characterized "through-the-wall" products would now be assigned to one of the space-constrained product classes. As a result, DOE considered through-the-wall products to be part of the space-constrained product class for

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its analyses. In addition, DOE is updating the footnote to the table in 10 CFR 430.32(c)(2) to clarify the classification of through-the-wall products.

In the preliminary analysis, DOE sought feedback on this classification and potential market shifts which may result from considering the former through-the-wall products to be space-constrained products. Ingersoll Rand commented that replacement units of all types have to contend with the space constraints of the existing installation, and the intended benefit of minimum efficiency standards would be severely diminished if special treatment of the space-constrained products is continued. (CAC: Ingersoll Rand, No. 66 at p. 2)

Federal law does not allow DOE to promulgate efficiency standards that would result in the unavailability in the United States in any covered product type (or class) of performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as those currently on the market. (42 U.S.C. 6295(o)(4)) The space-constrained product class acts as a safe harbor for product types available before 2001 whose efficiency is limited by physical dimensions that are rigidly constrained by the intended application. DOE believes that through-the-wall equipment intended for replacement applications can meet the definition of space-constrained products because they must fit into a pre-existing hole in the wall, and a larger through-the-wall unit would trigger a considerable increase in the installation cost to accommodate the larger unit. On the other hand, while split system and single package air conditioners and heat pumps have certain size limitations mainly associated with installation and consumer preferences, these units typically have a component installed outdoors. Because part of the unit is outdoors, there is more flexibility to allow for increases in the overall unit size. This greater flexibility with regard to product size provides these products with an advantage in achieving an increased efficiency because a larger coil can be used. Because physical size constraints for through-the-wall products continue to exist, DOE determined that continuation of the space-constrained product class is warranted.

(ii) Large-Tonnage Products

For the preliminary analysis of conventional central air conditioner and heat pump product classes, DOE selected 36,000 Btu/hour (i.e., three-tons) as the representative capacity for analysis because units at this capacity are ubiquitous across manufacturers, have high sales volumes, and span a relatively large range of efficiencies. However, large-tonnage products (i.e., products with cooling capacities of approximately five tons) have additional constraints that three-ton products do not have, such as added installation costs and space requirements, which could potentially lead to different incremental costs between efficiency levels for three-ton units as compared to larger-capacity units. In its preliminary analysis, DOE determined that these incremental cost differences between three-ton units and large-tonnage units were not large enough to necessitate a large-tonnage product class, but sought comment on the treatment of larger-tonnage products in the analysis.

Ingersoll Rand stated that in the past there have not been sufficient differences to justify a separate large-tonnage product class. However, when considering the EER metric, Ingersoll Rand asserted that the marketability, serviceability, and installation cost differences are substantial enough to warrant a separate product class. (CAC: Ingersoll Rand, No. 66 at p. 2) Rheem noted that achieving higher efficiency in large-tonnage products is more difficult because of size limitations in the coils and the air handler, and that there are other issues such as additional refrigerant charge and handling issues associated with the larger size. (CAC: Rheem, No. 76 at p. 3)

For this direct final rule, DOE only considered an EER minimum conservation standard for the consensus agreement TSL (see section V.A for more details about the TSLs analyzed). The consensus agreement TSL has separate EER levels for large-tonnage products to account for the unique characteristics of those products that lead to increased costs. DOE believes that the impacts of unit size on EER are enough to justify a separate product class for large tonnage units, but does not believe these impacts on SEER are enough to justify a separate product class. Therefore, DOE believes a large tonnage product class is applicable for the consensus agreement TSL due to the EER standard. Because DOE is not considering minimum EER standards for the other TSLs, DOE did not establish a separate product class for large-tonnage products for other TSLs. However, DOE has determined that the differences among products with different cooling capacities are substantial enough to justify an expansion of the engineering analysis to two, three, and five tons for split systems. See section IV.C.5.b of today's direct final rule for further information on DOE's approach to scaling the analysis at the representative cooling capacity to additional cooling capacities.

(iii) Blower-Coil and Coil-Only Designation for Split System Air Conditioners

In replacement applications for split-system air conditioners, consumers are presented with two options: (1) replace a portion of their system, or (2) replace the entire system. For the first option, if a consumer has a furnace installed, and a portion of the air conditioning system (i.e., condensing unit or evaporator coil) fails, the consumer may choose to only replace the air conditioning portion of the system. This scenario involves the replacement of a condensing unit and an evaporator coil used with the existing blower fan in the furnace. In these applications, manufacturers are constrained by the efficiency of the fan in the installed furnace, and they only have the ability to modify the condensing unit or evaporator coil to achieve the desired efficiency. These systems are referred to as "coil-only" systems and are tested and rated using the combination of a specific condensing unit and evaporator coil with a default indoor fan energy consumption specified in the DOE test procedure. Because the default indoor fan energy consumption value specified in the test procedure is not for a high-efficiency furnace fan, these types of units are limited in the SEER levels that they can achieve.

For the second option, if a consumer's entire system is replaced or installed as one complete system (as in new construction), the consumer has the ability to select a combination of indoor and outdoor units that can achieve any efficiency within the commercially-available range of efficiencies for split-system air conditioners because the indoor fan efficiency no longer limits the achievable SEER. Because the systems are sold as specific combinations of indoor and outdoor units, manufacturers have the ability to modify all portions of the system (i.e., condensing unit, evaporator coil, and indoor fan blower) to achieve the desired efficiency. These systems are referred to as "blower-coil" systems and are tested and rated using the combination of a specific condensing unit, evaporator coil, and indoor fan blower. Because manufacturers have the option to improve the efficiency of the indoor blower fan in blower-coil systems, the cost-efficiency relationship is inherently different than for coil-only systems. Both types of systems are prevalent in the marketplace, and for the preliminary analysis, DOE characterized split-system air conditioners with separate cost-efficiency curves for blower-coil and coil-only systems within a single product class.

In response to DOE's request for comment on establishing a single product class for blower-coil and coil-only systems, Ingersoll Rand noted that the distinction between coil-only and blower-coil systems is artificial because all systems have some means for moving indoor air, even when rated coil-only. (CAC: Ingersoll Rand, No. 66 at p. 5) In this direct final rule, DOE is not establishing separate product classes for coil-only and blower-coil split system air conditioners, and, therefore, DOE continued to analyze them separately within the split system air conditioner product class for the direct final rule analysis.

(iv) "Dual-Fuel" Systems

In the preliminary analysis, DOE found that the majority of split-system heat pumps are sold as a matched set of indoor and outdoor units for both the new construction and replacement markets. However, DOE recognized that in some instances heat pumps are used in conjunction with gas or oil-fired furnaces, providing a “dual-fuel” heating capability. Consequently, DOE sought input on the characterization of the heat pump replacement market and whether installations of matched sets of indoor and outdoor products should be the basis for DOE’s analysis for all heat pumps.

Ingersoll Rand commented that DOE should consider installations of matched sets of indoor and outdoor products for all heat pumps, and that the few heat pumps in “dual-fuel” systems are found primarily in the northern region of the United States. (CAC: Ingersoll Rand, No. 66 at 6) Rheem supported this statement and stated that heat pump installations should be considered as matched sets. (CAC: Rheem, No. 76 at p. 8) In response, DOE believes the large majority of heat pump shipments consists of matched sets (i.e., pairing an outdoor and indoor unit) and has assumed that all heat pumps are installed with matched indoor air handlers for purposes of the direct final rule analyses.

4. Technologies That Do Not Impact Rated Efficiency

As part of the market and technology assessment performed for the direct final rule analysis, DOE developed a comprehensive list of technologies that would be expected to improve the energy efficiency of furnaces and central air conditioners and heat pumps, including those that do not impact the efficiency as rated by AFUE (for furnaces), SEER (for central air conditioners and heat pumps), and HSPF (for heat pumps). For example, certain technologies have the potential to reduce the electrical energy consumption of furnaces, but the AFUE metric does not capture the electrical energy use, and, therefore, such technologies would not be used to improve AFUE. Chapter 3 of the direct final rule TSD contains a detailed description of each technology that DOE identified. Although DOE identified a complete list of technologies that improve efficiency, DOE only considered in its analysis technologies that would impact the efficiency rating of the appliance as tested under the applicable DOE test procedure. Therefore, DOE excluded several technologies from the analysis during the technology assessment because they do not improve the rated efficiency of furnaces or central air conditioners and heat pumps. Technologies that DOE determined have an impact on the rated efficiency were carried through to the screening analysis and are discussed in section IV.B, which also contains the technologies that were considered as part of the standby mode and off mode analyses.

In response to DOE's preliminary analysis for central air conditioners and heat pumps, ACEEE remarked that DOE eliminated technologies that save energy in real-world conditions or would require an additional performance metric, but do not improve the SEER or HSPF rating according to the current DOE test procedure. ACEEE stated that as a result, DOE screened out many important technologies in the central air conditioners and heat pumps preliminary analysis. (CAC: ACEEE, No. 72 at p. 4) Similarly, during the public meeting to discuss the furnaces RAP, ACEEE commented that the initial screening-out of technologies based on their impact on AFUE, as opposed to end-use efficiency, is unnecessarily restrictive to DOE's consideration of options. (FUR: ACEEE, Public Meeting Transcript, No. 1.2.006 at p. 149)

A product's efficiency rating under the applicable Federal test procedure determines whether it meets a particular minimum efficiency standard. An individual technology is relevant in the rulemaking process only to the extent that the technology has the potential to raise the efficiency rating of a product as measured under the test procedure. Therefore, DOE removes from consideration technologies that have no impact on a product's rating. Major changes to the DOE test procedures would be required to update the test procedures to include provisions that account for the impact of certain technologies on product efficiency, which would significantly delay the standards rulemaking such that DOE would not be able to meet its deadline of June 30, 2011, for publishing the final rule for these products. However, potential changes in the test procedures could be considered during the next round of test procedure rulemakings for these products. DOE believes that such delays may reduce energy savings to the Nation from amended standards (if the compliance date must be delayed). Therefore, in this rulemaking, DOE will continue to exclude technologies that do not improve the energy efficiency ratings of residential furnaces and central air conditioners and heat pumps, as tested by the applicable DOE test procedures.

For residential furnaces, DOE has determined that the following technologies would not impact AFUE as it is rated using the DOE test procedure: (1) infrared burners; (2) positive shut-off valves for oil burner nozzles; (3) improved blower efficiency; and (4) micro combined heat and power. DOE did not analyze these technologies further because the technology either does not improve AFUE or there are insufficient data available to demonstrate an AFUE benefit of the technology.

For central air conditioners and heat pumps, DOE has determined that the following technologies would not impact the SEER and HSPF as calculated using the DOE test procedure: (1) condenser fan motor controllers; (2) liquid-suction heat exchangers; and (3) heat pump defrost mechanisms. DOE did not analyze these technologies further because the technology either does not increase the SEER or HSPF ratings, or there are insufficient data available to demonstrate a SEER or HSPF benefit of the technology.

In response to the technology assessment performed for the preliminary analysis, DOE received feedback from several interested parties. ACEEE noted that in the preliminary analysis, DOE excluded advanced defrost controls for heat pumps that can save significant amounts of energy at low relative humidity outdoors. (CAC: ACEEE, No. 72 at p. 4) Regarding solar-assist products, EEI stated that this technology has no influence on units in terms of cooling efficiency as measured by SEER or EER. (CAC: EEI, No. 75 at p. 5) Ingersoll Rand commented that solar-assist technology should be excluded because it does not improve the operating efficiency of the refrigeration cycle. (CAC: Ingersoll Rand, No. 66 at p. 9) Southern remarked that there would need to be significant changes made to the test procedure to measure the solar-assist contribution. Additionally, a solar-assist component could potentially be used to qualify a unit at a minimum SEER level and then removed later, resulting in unit operation at levels below the minimum standard. (CAC: Southern, No. 73 at p. 3) Rheem commented that technological feasibility of high-volume manufacture, installation, and servicing of both solar-assist and three-stage heat pumps has not been established (CAC: Rheem, No. 76 at p. 11) Regarding three-stage heat pumps, Ingersoll Rand stated that the HSPF values for these products are not higher than conventional single-stage systems, because compressor capacity is not the only limiting factor on low-temperature heating capacity. (CAC: Ingersoll Rand, No. 66 at p. 9)

In response to these comments, DOE reassessed its preliminary views on the technologies in question. DOE revisited its conclusion regarding advanced defrost controls in the preliminary analysis, and found that advanced defrost controls can increase the HSPF of heat pumps according to the DOE test procedure. Accordingly, DOE has considered advanced defrost controls in the analyses for the direct final rule.

Regarding solar-assist technology, DOE has determined that this technology has no impact on SEER or HSPF using the DOE test procedure, and, therefore, DOE did not consider it as a technology option for the screening and engineering analyses. Similarly, three-stage heat pumps appear to have no impact on SEER or HSPF using the DOE test procedure, and therefore, DOE decided not to consider it as a technology option for analysis.

<u>B.</u> <u>Screening Analysis</u>

DOE uses the following four screening criteria to determine which design options are suitable for further consideration in a standards rulemaking:

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

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

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

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

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

In response to the screening criteria outlined in the furnace RAP, ACEEE argued that, although it is inappropriate to preclude from initial consideration technologies that are not widely used in the U.S., it may be appropriate to eliminate them in the screening analysis after adequate consideration if DOE finds the labor force to be insufficient to adequately manufacture, sell, and service products on the scale necessary to serve the relevant market by the compliance date of the amended standard. (FUR: ACEEE, Public Meeting Transcript, No. 1.2.006 at pp. 148-151) ACEEE also commented that DOE should screen in technology options that are not used in the United States, but that are used internationally. (FUR: ACEEE, No. 1.3.009 at p.2)

In response, DOE considers a complete list of technology options in the market and technology assessment, including those used on the international market, and then examines each technology that impacts the rated efficiency to determine if the four screening criteria are met. International technology options are treated no differently than those that are domestic and must meet all four screening criteria, including practicability to manufacture, install, and service on the scale necessary to serve the U.S. market by the compliance date. If DOE determines that a technology option does not meet all of the relevant criteria, it will eliminate that technology option from further consideration.

1. Furnaces

DOE identified the following technology options that could improve the AFUE rating of residential furnaces: (1) condensing secondary heat exchanger for non-weatherized furnaces; (2) heat exchanger improvements for non-weatherized furnaces;

(3) condensing and near-condensing technologies for weatherized gas furnaces; (4) two-stage or modulating combustion; (5) pulse combustion; (6) low NO_X premix burners; (7) burner derating; (8) insulation improvements; (9) off-cycle dampers; (10) concentric venting; (11) low-pressure, air-atomized oil burner; (12) high-static oil burner; and (13) delayed-action oil pump solenoid valve.

In response to DOE's request for comments on technologies in the furnaces RAP, Ingersoll Rand commented that all of the technology options that are technologically feasible and economically justified for furnaces are already incorporated by manufacturers into their current products, and that there are no new efficiency-benefitting technologies on the horizon. (FUR: Ingersoll Rand, No. 1.3.006 at p. 2)

DOE notes that a large amount of research regarding technology options for improving the efficiency of furnaces has already been conducted by industry and others. However, DOE's initial list of technology options identified in the market and technology assessment includes all technology options that could improve rated efficiency, without regard to technological feasibility or economic justification (a matter considered in other downstream analyses). Each technology option is reviewed during the screening analysis according to the four screening criteria. If a prototype or other technology option is "screened in," DOE further considers it in the engineering analysis regardless of whether it is already widely used in the market.

a. Screened-Out Technology Options

DOE excluded six of the technologies listed above from consideration in this rulemaking based on one or more of the four screening criteria. The technology options that DOE "screened out" include: (1) condensing and near-condensing technologies for weatherized gas furnaces; (2) pulse combustion; (3) low NO_X premix burners; (4) burner derating; (5) advanced forms of insulation; and (6) low-pressure, air-atomized oil burner. The following discussion explains DOE's rationale for screening out these technologies.

Due to lack of evidence of technological feasibility, DOE screened out: condensing and near-condensing technologies for weatherized furnaces; low NO_x premix burners; advanced forms of insulation (including foam insulation, vacuum insulation panels, gas-filled panels, aerogel insulation, and evacuated panels); and low-pressure, air-atomizing oil burners. To the best of DOE's knowledge, none of these technologies have been successfully demonstrated in the design of a commercially-available furnace model or a working prototype. Therefore, they were eliminated from further consideration.

Pulse combustion was screened out due to concerns about adverse impacts on safety. Although products with this technology are generally safe, discussions with manufacturers indicated that the same or similar efficiencies could be achieved using other technologies that do not operate with positive pressure in the heat exchanger. In pulse combustion systems, the positive pressure in the heat exchanger could cause hazardous combustion products (e.g., carbon monoxide) to leak into the home if fatigue caused the heat exchanger to breach. DOE concluded that the efficiency-related benefits of these products in terms of AFUE do not outweigh the possible adverse impacts on health or safety, especially given that manufacturers already achieve high efficiencies without the use of pulse combustion.

Finally, burner derating (i.e., reducing the burner firing rate) lessens heat output from the furnace. As such, burner derating was eliminated from further consideration due to its significant adverse impacts on product utility to the consumer.

For more detail regarding each technology option and the screening process, see chapters 3 and 4 of the TSD accompanying today's notice.

2. Central Air Conditioners and Heat Pumps

DOE identified the following technologies that could improve the SEER and/or HSPF efficiency ratings of central air conditioners and heat pumps: (1) higher-efficiency compressors; (2) higher-efficiency fan motors; (3) higher-efficiency fan blades; (4) improvements to baseline coils; (5) micro-channel heat exchangers; (6) flat-tube heat exchangers; (7) heat pump defrost controls; (8) inverter technology; and (9) high-efficiency expansion valves.

After eliminating those technologies which did not increase the SEER or HSPF ratings (as described in section IV.A.4), DOE subjected the remaining technologies listed above to the four screening criteria. DOE determined that each of the technologies listed above passed all four of the screening criteria, and thus, DOE considered those technologies further in the downstream analyses.

In response to the central air conditioner and heat pump preliminary analysis, DOE received comments from interested parties suggesting the inclusion of inverter-driven components as a technology option in the analysis. Daikin noted that inverter technology can substantially increase the energy efficiency of central air conditioners and should be considered as a technology option. (CAC: Daikin, No. 63 at p. 2) Further, Daikin also commented that inverter technology is in widespread use outside of the United States, which demonstrates that it is not cost-prohibitive, and the technology is not proprietary. (CAC: Daikin, No. 63 at p. 4) Northwest Power and Conservation Council (NPCC) remarked that inverter technology is already used domestically in ductless mini-splits, and the technology is applicable to both conventional split system and packaged central air conditioners and heat pumps. (CAC: NPCC, No. 74 at 5)

After considering these comments, DOE believes that inverter technology is a non-proprietary method of improving the SEER and HSPF ratings of central air conditioners and heat pumps. Accordingly, DOE included inverter technology as a technology option in its analysis.

In response to DOE's request for comment on the preliminary screening analysis, ACEEE questioned DOE's decision to screen out several important technologies, including modulating compressors and condenser fans. (CAC: ACEEE, No. 72 at p. 4)

However, DOE believes that the higher-efficiency fan motors and higher-efficiency compressors technology options encompass the technologies that ACEEE identified. Therefore, DOE did not identify those technologies as separate technologies in the preliminary analysis, but both modulating compressors and modulating condenser fans were considered in the engineering analysis.

3. Standby Mode and Off Mode

As discussed above, DOE is required by EPCA, as amended by EISA 2007, to amend its test procedures for furnaces and central air conditioners and heat pumps in order to address standby mode and off mode energy consumption of these products. (42 U.S.C. 6295(gg)(2)) As explained in the October 20, 2010 test procedure final rule for furnaces and boilers, DOE determined that it was not technically feasible to set an integrated metric encompassing active mode, standby mode, and off mode, so the Department adopted a separate metric to address standby mode and off mode energy consumption. 75 FR 64621, 64626-27. Accordingly, DOE conducted a separate screening analysis for standby mode and off mode technologies. DOE identified the following technology options that could improve the standby mode and off mode efficiency rating of residential furnaces: (1) switching mode power supplies; (2) toroidal transformers; and (3) a relay that disconnects power to the blower's electronically-commutated motor (ECM) while in standby mode.

DOE identified the following technology options that could improve the off mode efficiency rating of central air conditioners and heat pumps: (1) thermostatically-controlled crankcase heaters; (2) toroidal transformers; (3) self-regulating (i.e., variable resistance) crankcase heaters; (4) compressor covers and (5) a relay that disconnects power to the ECM blower while in off mode.

After applying the four screening criteria to these technology options for furnaces and central air conditioners and heat pumps, DOE screened out the technology option of a control relay for disconnecting power to the ECM blower because of the potential for adverse impacts to product utility for all product classes. DOE believes that such a design would cause failure rates of blower motors to increase significantly, which would severely degrade reliability and consumer utility of the product. Furthermore, DOE is not aware of any commercially-available models or working prototypes of an ECM that completely depowers between uses, making the design option technologically infeasible in the context of this rulemaking. The remaining two design options for furnaces were screened in and carried forward in the analyses. For central air conditioners and heat pumps, the remaining four design options were screened in and were considered in the downstream analyses.

4. Technologies Considered

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

C. Engineering Analysis

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

The Department conducted the engineering analyses for this rulemaking using a combination of the efficiency level and cost-assessment approaches for analysis of the minimum AFUE standards for furnaces and minimum SEER and HSPF standards for central air conditioners and heat pumps. More specifically, DOE identified efficiency levels for analysis, and then used the cost-assessment approach to determine the manufacturing costs at those levels. For analyzing standby mode and off mode electrical energy consumption standards, DOE used the design-option approach to develop the cost-efficiency relationship, as explained in greater detail in section IV.C.7. Additional details of the engineering analysis are in chapter 5 in the direct final rule TSD.

1. Cost Assessment Methodology

At the start of the engineering analysis, DOE identified the energy efficiency levels associated with residential furnaces and central air conditioners and heat pumps on the market, as determined in the market assessment. DOE also identified the technologies and features that are typically incorporated into products at the baseline level and at the various energy efficiency levels analyzed above the baseline. Next, DOE selected products for the physical teardown analysis having characteristics of typical products on the market at the representative input capacity for furnaces and representative cooling capacity for central air conditioners and heat pumps. DOE gathered information from performing a physical teardown analysis (see section IV.C.1.a) to create detailed bills of materials that included all components and processes used to manufacture the products. DOE used the bills of materials (BOMs) from the teardowns as an input to a cost model, which was used to calculate the manufacturing production cost (MPC) for products at various efficiency levels spanning the full range of efficiencies from the baseline to the maximum technology available. For the central air conditioners and heat pumps, DOE reexamined and revised its cost assessment performed for the preliminary analysis based on additional teardowns and in response to comments received on the preliminary analysis. Additionally, DOE decided to expand the analyses for split system air conditioners to include capacities beyond the representative capacities, as described in section IV.C.5.

During the development of the engineering analysis for the direct final rule, DOE held interviews with manufacturers to gain insight into the heating, ventilation, and air conditioning (HVAC) industry, and to request feedback on the engineering analysis and assumptions that DOE used. DOE used the information gathered from these interviews, along with the information obtained through the teardown analysis and public comments, to refine the assumptions and data in the cost model. Next, DOE derived manufacturer markups using publicly-available furnace and central air conditioner and heat pump industry financial data, in conjunction with manufacturers' feedback. The markups were used to convert the MPCs into manufacturer selling prices (MSPs). Further information on comments received and the analytical methodology is presented in the subsections below. For additional detail, see chapter 5 of the direct final rule TSD.

a. Teardown Analysis

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

DOE also used a supplementary method, called a “virtual teardown,” which examines published manufacturer catalogs and supplementary component data to estimate the major physical differences between a product that was physically disassembled and a similar product that was not. For supplementary virtual teardowns, DOE gathered product data such as dimensions, weight, and design features from publicly-available information, such as manufacturer catalogs. DOE also obtained information and data not typically found in catalogs and brochures, such as fan motor details, gas manifold specifications, or assembly details, from the physical teardowns of a similar product or through estimates based on industry knowledge. The teardown analysis included over 40 physical and virtual teardowns of furnaces for the direct final rule analysis, 31 physical and virtual teardowns of central air conditioners and heat pumps during the preliminary analysis, and one additional central air conditioner and heat pump teardown for the direct final rule analysis. The additional teardowns performed for the direct final rule analysis allowed DOE to further refine the assumptions used to develop the MPCs.

The teardown analysis allowed DOE to identify the technologies that manufacturers typically incorporate into their products, along with the efficiency levels associated with each technology or combination of technologies. The end result of each teardown is a structured BOM, which DOE developed for each of the physical and virtual teardowns. The BOMs incorporate all materials, components, and fasteners, classified as either raw materials or purchased parts and assemblies, and characterize the materials and components by weight, manufacturing processes used, dimensions, material, and quantity. The BOMs from the teardown analysis were then used as inputs to the cost model to calculate the MPC for each product that was torn down. The MPCs resulting from the teardowns were then used to develop an industry average MPC for each product class analyzed. See chapter 5 of the direct final rule TSD for more details on the teardown analysis.

b. Cost Model

The cost model is a spreadsheet that converts the materials and components in the BOMs into dollar values based on the price of materials, average labor rates associated with manufacturing and assembling, and the cost of overhead and depreciation, as determined based on manufacturer interviews and DOE expertise. To convert the information in the BOMs to dollar values, DOE collected information on labor rates, tooling costs, raw material prices, and other factors. For purchased parts, the cost model estimates the purchase price based on volume-variable price quotations and detailed discussions with manufacturers and component suppliers. For fabricated parts, the prices of raw metal materials (e.g., tube, sheet metal) are estimated on the basis of 5-year averages (from 2005 to 2010). The cost of transforming the intermediate materials into finished parts is estimated based on current industry pricing. For the central air conditioners and heat pumps analysis, DOE updated all of the labor rates, tooling costs, raw material prices, the costs of resins, and the purchased parts costs used in the preliminary analysis when developing costs for the direct final rule analysis. For furnaces, there was no preliminary analysis, and DOE used the updated rates and costs described in the preceding sentence when conducting the direct final rule analysis. Chapter 5 of the direct final rule TSD describes DOE's cost model and definitions, assumptions, data sources, and estimates.

Ingersoll Rand commented on the material prices collected for use in the cost model, noting that due to the volatility and overall increasing trend of material prices, 5-year average material prices will potentially be an underestimation of current material prices, which could lead to significant errors. (FUR: Ingersoll Rand, No. 1.3.006 at p. 5)

DOE acknowledges Ingersoll Rand's concerns about the material costs used in the engineering analysis because a large portion of the manufacturer production cost can typically be attributed to raw materials, the price of which can fluctuate greatly from year to year. However, DOE uses a 5-year span to attempt to normalize the fluctuating prices experienced in the metal commodities markets and screen out temporary dips or spikes. DOE believes a 5-year span is the longest span that would still provide appropriate weighting to current prices experienced in the market. DOE updates the 5-year span for metal prices based on a review of updated commodity pricing data, which point to continued increases. Consequently, DOE calculated a new 5-year average materials price using the U.S. Department of Labor's Bureau of Labor Statistics (BLS) Producer Price Indices (PPIs)[30] for various raw metal materials from 2005 to 2010 for use in this rulemaking. The updated material prices incorporate the changes within each material

[30] For more information, visit the BLS website at http://www.bls.gov/ppi/.

industry and account for 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 (GDP) implicit price deflator.[31] See chapter 5 of the direct final rule TSD for additional details.

c. Manufacturing Production Cost

Once the cost estimates for all the components in each teardown unit were finalized, DOE totaled the cost of materials, labor, and direct overhead used to manufacture a product in order to calculate the manufacturer production cost. The total cost of the product was broken down into two main costs: (1) the full manufacturer production cost, referred to as MPC; and (2) the non-production cost, which includes selling, general, and administration (SG&A) costs; the cost of research and development; and interest from borrowing for operations or capital expenditures. DOE estimated the MPC at each efficiency level considered for each product class, from the baseline through the max-tech. After incorporating all of the assumptions into the cost model, DOE calculated the percentages attributable to each element of total production cost (i.e., materials, labor, depreciation, and overhead). These percentages are used to validate the assumptions by comparing them to manufacturers' actual financial data published in annual reports, along with feedback obtained from manufacturers during interviews. DOE uses these production cost percentages in the MIA (see section IV.I).

[31] The GDP implicit price deflator is an economic metric that accounts for inflation by converting output measured at current prices into constant-dollar GDP. For more information, visit the Bureau of Economic Analysis website at www.bea.gov.

DOE revised the cost model assumptions used for the central air conditioner and heat pumps preliminary analysis based on additional teardown analysis, updated pricing, and additional manufacturer feedback, which resulted in refined MPCs and production cost percentages. For furnaces, DOE made cost model assumptions based on teardown analysis, publicly-available information, and manufacturer feedback. DOE calculated the average product cost percentages by product type (i.e., furnace, central air conditioner, heat pump) as well as by product class (e.g., non-weatherized gas furnace, split-system air conditioner) due to the large variations in production volumes, fabrication and assembly costs, and other assumptions that affect the calculation of the product's total MPC. Chapter 5 of the direct final rule TSD presents DOE's estimates of the MPCs for this rulemaking, along with the different percentages attributable to each element of the production costs that comprise the total product MPC.

d. Cost-Efficiency Relationship

The result of the engineering analysis is a cost-efficiency relationship. DOE created a separate relationship for each input capacity analyzed for each residential furnace product class examined for this direct final rule. DOE also created 12 cost-efficiency curves representing the cost-efficiency relationship for each central air conditioner and heat pump product class (except for the space-constrained product classes), as well as products having different capacities within the split air conditioner and split heat pump product classes. A cost-efficiency relationship was not developed for the space constrained product classes because the max-tech efficiency level is the same as the baseline efficiency level.

In order to develop the cost-efficiency relationships for furnaces and central air conditioners and heat pumps, DOE examined the cost differential to move from one efficiency level to the next for each manufacturer. DOE used the results of teardowns on a market share weighted-average basis to determine the industry average cost increase to move from one efficiency level to the next. Additional details on how DOE developed the cost-efficiency relationships and related results are available in the chapter 5 of the direct final rule TSD. Chapter 5 of the direct final rule TSD also presents these cost-efficiency curves in the form of energy efficiency versus MPC. Cost-efficiency curves relating HSPF to MPC can be created by using the relationship between SEER and HSPF that DOE derived (see section IV.C.6).

The results indicate that, for both furnaces and central air conditioners/heat pumps, cost-efficiency relationships are nonlinear. In other words, as efficiency increases, manufacturing becomes more difficult and more costly. For furnaces, a large cost increase is evident between non-condensing and condensing efficiency levels due to the requirement for a secondary heat exchanger, and another large increase is evident at the max-tech efficiency level which employs continuously-modulating operation. For central air conditioners and heat pumps, large increases in cost are evident at efficiency levels requiring high-efficiency compressors and fan motors.

In response to the furnace RAP, ACEEE stated at the public meeting that DOE's depiction of the cost-efficiency relationship is a static one that does not reflect the time-variability of the MPCs subsequent to adoption of amended energy conservation standards. The commenter argued that DOE's depiction does not reflect the consistent decline in the cost of manufactured products relative to the consumer price index (CPI). ACEEE requested that DOE complement the static cost-efficiency depiction with a more thorough retrospective analysis. (FUR: ACEEE, Public Meeting Transcript, No. 1.2.006 at p. 153) In response, HARDI cautioned that a time-variable analysis of the cost-efficiency relationship could neglect the effect on the marketplace of peak price points that result from adoption and implementation of amended AFUE standards. (FUR: HARDI, Public Meeting Transcript, No. 1.2.006 at p. 155) In other words, HARDI believes that such an analysis suggested by ACEEE would not account for the peak prices that occur shortly after a new standard is implemented.

In response, DOE notes that trends in the CPI reflect changes in consumer price that arise from a host of factors, including a change in market mix, market structure, profitability and manufacturing cost (including labor, capital, and energy costs), the cost of raw materials, and technological change. Historical averages of some of these factors are already used in DOE's analysis. A more sophisticated projection of consumer price depends on the availability of credible, publicly-vetted tools for making such projections, as well as an expectation that such tools will enhance the robustness, accuracy, or usefulness of the analysis. Such a tool does not currently exist, and DOE is not convinced that development of such a tool would significantly benefit energy conservation standard rulemakings, when it is already possible to conduct a straightforward calculation of the effect of different product cost assumptions on consumer payback. In the absence of a suitable tool, DOE believes that holding current manufacturing costs steady into the future provides the best balance between analytical transparency, credibility, and expected accuracy.

DOE's decision not to perform a historical analysis of the cost-efficiency relationship allays HARDI's concern that a retrospective analysis would ignore one-time peak price points that would create the most significant burden on the marketplace.

e. Manufacturer Markup

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

To calculate the manufacturer markups, DOE used 10-K reports submitted to the U.S. Securities and Exchange Commission (SEC) by the six publicly-owned HVAC companies. (SEC 10-K reports can be found using the search database available at: http://www.sec.gov/edgar/searchedgar/webusers.htm.) The financial figures necessary for calculating the manufacturer markup are net sales, costs of sales, and gross profit. For furnaces, DOE averaged the financial figures spanning the years 2004 to 2008 in order to calculate the markups. For central air conditioners and heat pumps, DOE updated the financial figures used in the preliminary analysis (which spanned 2003 to 2007) by using 10-K reports spanning from 2004 to 2008. To calculate the average gross profit margin for the periods analyzed for each firm, DOE summed the gross profit for all of the aforementioned years and then divided the result by the sum of the net sales for those years. DOE presented the calculated markups to manufacturers during the interviews for the direct final rule (see section IV.C.1.g). DOE considered the feedback from manufacturers in order to supplement the calculated markup and refined the markup to better reflect the residential furnace and central air conditioner and heat pump markets. DOE developed the manufacturer markup by weighting the feedback from manufacturers on a market share basis, since manufacturers with larger market shares more significantly affect the market average. DOE used a constant markup to reflect the MSPs of both the baseline products and higher-efficiency products. DOE used this approach because amended standards may transform high-efficiency products, which currently are considered premium products, into baselines. See chapter 5 of the direct final rule TSD for more details about the manufacturer markup calculation.

In response to the markup calculation methodology outlined in the furnaces RAP, and to the markup multiplier of 1.32 used in the central air conditioner and heat pump preliminary analysis, Ingersoll Rand argued that DOE has consistently underestimated manufacturer markup in past rulemakings. According to Ingersoll Rand, DOE has a tendency to underestimate unapplied labor that is involved in a wide range of support activities that are not associated with production, including research and development, engineering, field service, marketing, training, human resources, finance, legal, and business management. (FUR: Ingersoll Rand, No. 1.3.006 at p. 6; CAC: Ingersoll Rand, No. 66 at p. 5)

In response, DOE's manufacturer markups include all non-production costs (with the exception of shipping, which is calculated separately as described below) and profit. As noted above, as part of the process for developing manufacturer markups, DOE solicits manufacturer feedback during MIA interviews and incorporates that feedback on a market-share weighted average basis to refine the markups that are derived from financial data. Although DOE recognizes that the manufacturer markup will vary from one manufacturer to another, DOE believes this process allows for the development of a manufacturer markup that reflects the typical manufacturer markup in the industry. As a result, for the direct final rule analysis, DOE modified the markups for central air conditioners and heat pumps based upon additional manufacturer input. The markup used in the direct final rule analysis for split system air conditioners and heat pumps was 1.30, while the markup for packaged systems was 1.28. For SDHV systems, the markup remained 1.32. Because no additional data were provided to support a change, DOE developed a markup for furnaces for the direct final rule based on the methodology outlined in the furnaces RAP.

f. Shipping Costs

Manufacturers of HVAC products typically pay for freight to the first step in the distribution chain. Freight is not a manufacturing cost, but because it is a substantial cost incurred by the manufacturer, DOE is accounting for shipping costs of furnaces and central air conditioners and heat pumps separately from the other non-production costs that comprise the manufacturer markup. To calculate MSP for furnaces and central air conditioners and heat pumps, DOE multiplied the MPC determined from the cost model by the manufacturer markup and added shipping costs. More specifically, DOE calculated shipping costs based on use of a typical 53-foot straight frame trailer with a storage volume of 4,240 cubic feet.

In the central air conditioners and heat pumps preliminary analysis, shipping costs were preliminarily determined on a weight basis at $0.20 per pound, based on quotes from freight shipping services. However, ACEEE suggested that shipping costs would be more accurately estimated if calculations were based on product volume, rather than weight. (CAC: ACEEE, No. 72 at p.7)

DOE reexamined of the physical attributes of the products (e.g., the outer shipping dimensions, the shipping weight) and consulted with manufacturers regarding their shipping practices, and as a result of this additional inquiry, DOE determined that manufacturers were likely to "cube-out" a truck (i.e., run out of space inside the truck) before reaching the maximum weight capacity for the truckload. Therefore, the limiting factor for transporting these products would be the size of the products rather than their weight. Accordingly, as noted above, DOE revised its methodology for the direct final rule in terms of shipping costs by determining a product's shipping cost as a function of its volume for both central air conditioners and heat pumps and residential furnaces. To do so, DOE first calculated the cost per cubic foot of space on a trailer, based on a cost of $2,500 per shipping load and the standard dimensions of a 53-foot trailer. DOE examined the average sizes of products in each product class at each efficiency and capacity combination analyzed. DOE then estimated the shipping costs by multiplying the product volume by the cost per cubic foot of space on the trailer. For central air conditioners and heat pumps, where product size greatly depends on efficiency, DOE calculated a separate volumetric cost for each efficiency level. However, furnaces, which typically do not vary in size based on efficiency, had the same shipping cost across the range of efficiencies for a given capacity. In determining volumetric shipping costs, DOE also revised its estimates based on manufacturer feedback regarding product mix on each trailer, packing efficiency, and methods and equipment used to load the trailers. Chapter 5 of the direct final rule TSD contains additional details about DOE's shipping cost assumptions and DOE's shipping cost estimates.

g. Manufacturer Interviews

Throughout the rulemaking process, DOE has sought and continues to seek feedback and insight from interested parties that would improve the information used in its analyses. DOE interviewed manufacturers as a part of the direct final rule manufacturer impact analysis (see section IV.I.4). During the interviews, DOE sought feedback on all aspects of its analyses for residential furnaces and central air conditioners and heat pumps. For the engineering analysis, DOE discussed the analytical assumptions and estimates, cost model, and cost-efficiency curves with HVAC manufacturers. DOE considered all the information manufacturers provided when refining the cost model and assumptions. However, DOE incorporated equipment and manufacturing process figures into the analysis as averages in order to avoid disclosing sensitive information about individual manufacturers' products or manufacturing processes. More details about the manufacturer interviews are contained in chapter 12 of the direct final rule TSD.

2. Representative Products

a. Furnaces

DOE based its engineering analysis on teardown analysis of a representative sample of products from the furnace market. DOE selected units for teardown that have characteristics that are representative of most furnaces available on today's market. In the rulemaking analysis plan, DOE identified several characteristics common to baseline furnaces in each product class, including a representative capacity for analysis, and focused the teardown selection for furnaces on products that exhibited those representative characteristics. (However, DOE also scaled its analysis to products outside the representative capacity, as described in section IV.C.5.)

DOE received several comments about the representative input capacity proposed in the furnaces RAP. AHRI remarked that each manufacturer offers their products in different input capacities, and, as such, DOE should not lock its analysis into discrete input capacities. (FUR: AHRI, Public Meeting Transcript, No. 1.2.006 at pp. 176-177) Likewise, Ingersoll Rand cautioned against comparing dissimilar products (with respect to number of burners and heat exchangers) chosen simply because their input capacities are close. Instead, the commenter suggested surveying the furnace market across efficiencies and capacities to characterize the number of heat exchangers and burners for each capacity and efficiency. Then, based on the results of this survey, DOE should select teardown units and determine the limits of interpolation. Ingersoll Rand further suggested that the sample selection should include products from a broad cross-section of manufacturers, concentrating on those with market shares greater than 10 percent, a representative spread of installation configurations, and a bias towards the most common heating and cooling air flow capacities. (FUR: Ingersoll Rand, Public Meeting Transcript, No. 1.2.006 at pp. 156-157; FUR: Ingersoll Rand, No. 1.3.006 at p. 4) ACEEE stated that many furnaces with the same input capacities are shipped with differing blower motor power and fan diameter, considerations to which DOE should be sensitive in its analysis. (FUR: ACEEE, Public Meeting Transcript, No. 1.2.006 at p. 178)

In response, for its direct final rule analysis, DOE attempted to compare similar furnace products made by a broad cross-section of manufacturers when choosing models for teardowns. DOE included factors such as blower characteristics and the number of burners and heat exchangers when choosing models for teardown. DOE modified the representative characteristics to include an airflow rate of 1,200 cubic feet per minute for a typical furnace (which corresponds to the three-ton representative capacity for central air conditioners and heat pumps). In addition, DOE recognizes that manufacturers may offer products at varying input capacities, and as a result, DOE did not restrict its analysis to discrete representative input capacities, but rather considered all models that were capable of satisfying a similar heating load. While DOE focused its analysis for furnaces around the representative 80,000 Btu/h input capacity, DOE also considered other units at input capacities near the representative capacity for manufacturers that do not manufacture products at the representative capacity.

DOE also received feedback from Ingersoll Rand that two of the input capacities identified in the RAP to represent the furnace market are not common in the market. The company suggested that input capacities of 80,000 Btu/h and 90,000 Btu/h are more appropriate than 75,000 Btu/h for non-weatherized gas furnaces and weatherized gas furnaces, respectively. (FUR: Ingersoll Rand, No. 1.3.006 at p. 2)

DOE reexamined the availability of input capacities on the furnace market and determined that 80,000 Btu/h is a very common and representative input capacity for non-weatherized gas furnaces. Thus, for the direct final rule analysis, DOE considered

80,000 Btu/h as the representative capacity for non-weatherized gas furnaces. As described in section III.G, DOE did not perform an analysis for weatherized gas furnaces.

In the furnaces RAP, DOE proposed retaining the representative characteristics identified in the 2007 rulemaking, including the baseline efficiency of 78-percent AFUE.[32] Ingersoll Rand commented that a baseline non-weatherized gas furnace would have the following characteristics: 80-percent AFUE; 80,000 Btu/h input capacity; induced draft; single-stage burner; permanent split capacitor (PSC) motor-driven, direct-drive, forward curved blower, sized for use with a three-ton air conditioner; multi-poise configuration; builder model; and hot surface igniter. (FUR: Ingersoll Rand, No. 1.3.006 at p. 3)

After reviewing the current furnaces market, DOE agrees that the baseline characteristics identified by Ingersoll Rand are representative of many furnaces on the market. Although it is true that the majority of furnaces are manufactured and shipped as multi-poise units, the specific configuration in which the unit operates is determined by the configuration in the field. Therefore, DOE based its analysis on furnaces that could be installed in the representative configuration, whether multi-poise or not, and used the AFUE rating associated with the representative configuration.

[32] In the furnaces RAP, DOE took the position that the baseline for non-weatherized gas furnaces was 78-percent AFUE, which is the current energy conservation standard for non-weatherized gas furnaces. However, DOE subsequently determined that because the November 2007 Rule was not vacated by the remand agreement, it will use 80-percent AFUE as the baseline for the direct final rule analyses in order to avoid violating the "anti-backsliding provision" in 42 U.S.C. 6295(o)(1).

With respect to the standby mode energy use analysis, Lennox cautioned that DOE should not exclude “premium” controls and features that that do not improve AFUE from its analysis, as these features could increase the standby power consumption of the furnace. (FUR: Lennox, Public Meeting Transcript, No. 1.2.006 at pp. 164-165; FUR: Lennox, No. 1.3.018 at p.4)

For the direct final rule analysis, DOE performed a large number of furnace teardowns, including some teardowns on products with premium features that consume electricity in standby mode and off mode. Although the products with premium features were included for the standby mode and off mode analysis, DOE did not include these premium (non-AFUE efficiency related) features in its engineering analysis for analyzing amended AFUE standards, as they could distort DOE’s estimates of MPC at each efficiency level.

Accordingly, the baseline furnace characteristics that DOE used in the direct final rule analysis are presented in Table IV.1.

Table IV.1 Characteristics of Representative Residential Furnaces

	Non-Weatherized Gas Furnaces	Mobile Home Gas Furnaces	Non-Weatherized Oil-Fired Furnaces
Input Capacity Btu/h	80,000	80,000	105,000
Configuration	Upflow	Downflow	Upflow
Heat Exchanger Type	Clamshell or Tubular	Clamshell or Tubular	Drum
Ignition Type	Hot Surface	Hot Surface	Intermittent Ignition
Draft	Induced	Induced	Forced
Blower Size	1200 cfm	1200 cfm	1200 cfm
Transformer	40 VA Laminated Core	40 VA Laminated Core	40 VA Laminated Core
Power Supply Type	Linear	Linear	Linear

b. Central Air Conditioners and Heat Pumps

DOE reviewed all of the product classes of residential central air conditioners and heat pumps and chose units for analysis that represent a cross-section of the residential central air conditioning and heat pump market within each product type. For the conventional split system and single package central air conditioner and heat pump product classes, as well as for the SDHV product classes, DOE selected 36,000 Btu/h (three tons of cooling capacity) as the representative capacity for analysis because units at this capacity are common across manufacturers, with high sales volumes spanning a relatively large range of efficiencies.

DOE acknowledges that manufacturers tend to optimize residential central air conditioner and heat pump split systems around the three-ton capacity. Therefore, DOE expanded the engineering analysis to include additional cooling capacities for split system central air conditioners and heat pumps based upon the analysis at the representative capacity. (See section IV.C.5.b for further information about the scaling of the engineering analysis to different cooling capacities.)

In the preliminary analysis, DOE was unaware of any suitable alternative refrigerant which could be used as a replacement for R410a, and therefore, considered R410a to be the only available refrigerant option. During manufacturer interviews, the viability of HFO-1234YF as an alternative was discussed. However, manufacturer feedback indicated that this refrigerant is still in the early phases of development and is a more likely replacement for R134a in automotive applications than R410a in central air conditioners and heat pumps. This conclusion leads to questions about the technological feasibility of HFO-1234YF as a replacement. Further, because it is still in development, the requirements for large scale production of this refrigerant and the ability to service units charged with it on a national scale are undetermined.

DOE received comments regarding the need for analysis on alternative refrigerants because of a possible hydrofluorocarbon (HFC) refrigerant cap and subsequent phase-out, which would force the industry to find a replacement refrigerant for R410a. Carrier did not mention specific climate policies but commented generally that there are climate policies which are going to restrict the use of HFC. However, higher SEER equipment requires more refrigerant charge, and, thus, it is critical to understand the impact on cost of refrigerant for this rulemaking. (CAC: Public Meeting Transcript at p. 152) Emerson noted that the cost of the additional refrigerant could be much higher than what is paid today due to a possible leverage effect from a potential "cap-and-trade" regime.[33] (CAC: Public Meeting Transcript at p. 153) DOE does not conduct analyses based on potential legislation because doing so would be highly speculative, and the lack of a suitable alternative refrigerant adds another speculative layer of uncertainty. Therefore, DOE decided not to alter its analyses and did not consider alternative refrigerants in the direct final rule analyses.

DOE did not receive any comments on the other representative characteristics chosen for the baseline unit for preliminary analysis and continued to use the same representative traits for the direct final rule. These characteristics of a typical baseline unit are:

- 36,000 Btu/h cooling capacity;
- Rifled copper tubes;
- Lanced aluminum fins;
- Single-speed, single-capacity compressor;
- Single-speed permanent split capacitor (PSC) fan and blower motor;
- Expansion orifice; and
- R410a refrigerant.

3. Efficiency Levels

For each of the representative products, DOE analyzed multiple efficiency levels and estimated manufacturer production costs at each efficiency level. The following

[33] "Cap-and-trade" is a market-based emissions trading program in which the government sets a limit on the amount of emissions and allocates permits to emit a specified amount. Companies with higher emissions are able to buy permits from companies which emit less.

subsections provide a description of the full range of efficiency levels DOE analyzed for each product class, from the baseline efficiency level to the maximum technologically feasible (max-tech) efficiency level.

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

DOE conducted a survey of the residential furnace and central air conditioner and heat pump markets to determine what types of products are available to consumers and to identify the efficiency levels corresponding to the greatest number of models. Then, DOE established intermediate energy efficiency levels for each of the product classes that are representative of efficiencies that are typically available on the market. DOE reviewed AHRI's product certification directory, manufacturer catalogs, and other publicly-available literature to determine which efficiency levels are the most prevalent for each representative product class.

DOE also determined the maximum improvement in energy efficiency that is technologically feasible (max-tech) for furnaces and central air conditioners and heat pumps, as required under 42 U.S.C. 6295(p)(1). 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. Furnaces

(i) Baseline Efficiency Level

As discussed above, the energy conservation standards for residential furnaces are codified at 10 CFR 430.32(e)(1)(i), which sets forth the existing standard levels for residential furnaces, as well as the amended minimum standards codified at 10 CFR 430.32(e)(1)(ii), which were set by the November 2007 Rule (72 FR 65136 (Nov. 19, 2007)), which will require compliance starting on November 19, 2015. At the time of publication of the furnaces RAP, DOE believed that its voluntary remand of the November 2007 Rule in response to a joint lawsuit voided the furnace standards set forth by that rule. Under this interpretation, DOE proposed setting the baseline for the current analysis at 78-percent AFUE for non-weatherized gas furnaces, weatherized gas furnaces, and oil-fired furnaces, and at 75-percent AFUE for mobile home gas furnaces.[34] However, since the publication of the furnaces RAP, DOE has reevaluated its interpretation of the effect of the voluntary remand and determined that because the November 2007 Rule was not vacated, the standards promulgated in that rule will still require compliance for products manufactured on or after November 19, 2015. Due to EPCA's anti-backsliding clause (42 U.S.C. 6295(o)(1)), DOE cannot set minimum standards below the levels promulgated in the November 2007 Rule. As a result, DOE considered the levels set in the November 2007 Rule to represent the baseline efficiency

[34] Energy Conservation Standards for Residential Furnaces Rulemaking Analysis Plan, March 11, 2010, p. 31. Available at: http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/furnaces_framework_rap.pdf.

in each product class for the direct final rule analysis. Therefore, the baseline levels for the direct final rule analysis were set at 80-percent AFUE for non-weatherized gas furnaces and mobile home furnaces, 81-percent AFUE for weatherized gas furnaces, and 82-percent AFUE for non-weatherized oil furnaces. (Note that, as described in section III.G.2.a, DOE did not perform an analysis for weatherized gas furnaces, because the standards adopted for this product are already set at the max-tech level.)

(ii) Max-Tech Efficiency Level

The "max-tech" efficiency levels are the maximum technologically feasible efficiency levels possible for each product class. As required under 42 U.S.C. 6295(p)(1), DOE determined the max-tech efficiency level for each residential furnace product class. DOE has identified the max-tech efficiency levels as being the highest efficiencies on the market at the representative capacities. In the furnaces RAP, for purposes of its analyses, DOE proposed using max-tech efficiency levels of 97.7-percent AFUE for non-weatherized gas furnaces, 95.5-percent AFUE for mobile home furnaces, and 97-percent AFUE for oil-fired furnaces. In addition, DOE proposed to use 81-percent AFUE as the max-tech for weatherized gas furnaces in the furnaces RAP, which DOE used for the direct final rule analysis. Consequently, no analysis was needed for weatherized gas furnaces because the standard was already set at the max-tech level, as discussed further in section III.G.2.a.

DOE received several comments related to the max-tech levels proposed in the furnaces RAP. Ingersoll Rand stated that the max-tech level for non-weatherized gas furnaces should be 98-percent AFUE. (FUR: Ingersoll Rand, No. 1.3.006 at p. 3) Lennox stated support for DOE's proposed max-tech levels for the non-weatherized gas furnace and mobile home gas furnace product classes for the purpose of undertaking the required analysis, although Lennox noted that it does not believe that DOE should establish minimum efficiency standards at max-tech levels. (FUR: Lennox, No. 1.3.018 at p. 3)

In response, DOE notes that the AFUE requirements for furnaces established in EPCA are specified as whole number percentages. Additionally, in previous rulemakings to amend standards for furnaces, DOE has specified amended minimum standards in terms of the nearest whole percentage point. To remain consistent with the original standards in EPCA, DOE rounded the efficiency levels being analyzed in today's direct final rule (including max-tech AFUE) to the nearest whole percentages. For non-weatherized gas furnaces and mobile home furnaces, this results in max-tech levels of 98-percent and 96-percent AFUE, respectively. DOE also notes that the DOE residential furnaces test procedure currently provides instructions for rounding annual operating cost and estimated regional annual operating cost to the nearest dollar per year. 10 CFR 430.23(n)(1); 10 CFR 430.23(n)(3). However, the test procedure does not provide instructions for rounding AFUE. This lack of specificity for rounding may lead to uncertainty in terms of how to complete calculations using the reported metrics or to discrepancies among results generated by test laboratories for the same product. Overall, DOE is concerned that unless the applicable portion of DOE's furnace test procedures are modified, there may be difficulties associated with ascertaining, certifying, and reporting compliance with the existing standards. Therefore, to remedy this situation, DOE is adding instructions to 10 CFR 430.23(n)(2) requiring that AFUE be rounded to the nearest whole percentage point.

Additionally, EEI stated that DOE should analyze gas-fired air source heat pumps with coefficient of performance (COP) ratings above 1.2 as a maximum technology option for gas furnaces. (FUR: EEI, No. 1.3.015 at p. 5) In response, DOE reexamined the definition of a "gas furnace." DOE notes that EPCA defines a "furnace," in part, as "an electric central furnace, electric boiler, forced-air central furnace, gravity central furnace, or low pressure steam or hot water boiler." (42 U.S.C. 6291(23)(C)) DOE's definitions in the CFR further clarify the definition of a "forced-air central furnace," defining that term as a product in which "[t]he heat generated by the combustion of gas or oil is transferred to the air within a casing by conduction through heat exchange surfaces . . . . " 10 CFR 430.2. DOE notes that products using gas-fired air source heat pump technology do not use the heat generated by the combustion of gas or oil to heat the circulation air, as required under DOE's definitions. Therefore, DOE has concluded that products using this technology are outside the scope of this rulemaking because they do not meet the definition of a "furnace," as defined by DOE.

Regarding oil-fired furnaces, Lennox stated that it does not agree with DOE's max-tech level, which it believes is unrealistic. Lennox asserted that although condensing oil-fired furnaces do exist in the market, they comprise a very small minority and are, therefore, not representative of the market and should not be considered in the rulemaking. Instead, Lennox urged DOE to consider oil-fired furnaces with AFUE values between 85-percent and 87-percent as the true max-tech level for oil-fired furnaces. (FUR: Lennox, No. 1.3.018 at p. 3)

While DOE does not believe that condensing oil-fired furnaces are representative of the market, their existence and commercial availability are evidence of technological feasibility. DOE believes that this technology warrants consideration in the analysis, and, therefore, the condensing level was retained for the oil-fired furnace product class.

(iii) Efficiency Levels for Analysis

For each residential furnace product class, DOE analyzed both the baseline and max-tech efficiency levels, as well as several intermediate efficiency levels. In the furnaces RAP, DOE identified the intermediate efficiency levels that it proposed to include in the analysis, based on the most common efficiencies on the market. These levels are shown in Table IV.2.

Table IV.2 Efficiency Levels Considered in the RAP for the Residential Furnaces Analysis

Product Class	Efficiency Level (AFUE)
Non-weatherized Gas	78%
	80%
	90%
	92%
	93%
	95%
	97.7%
Mobile Home	75%
	80%
	90%
	92%
	93%
	95.5%
Oil-Fired Non-weatherized	78%
	80%
	83%
	84%
	85%
	97%

For non-weatherized gas furnaces, Ingersoll Rand suggested performing teardowns at 90-percent, 95-percent, and 98-percent AFUE with interpolation to span the range of intermediate values. (FUR: Ingersoll Rand, No. 1.3.006 at p. 4) ACEEE suggested adding a level at 81-percent AFUE, substituting 94-percent for 93-percent AFUE if there are more models available, and keeping an efficiency level at 95-percent, which is the current tax credit level. (FUR: ACEEE, No. 1.3.009 at p. 6)

In response to these comments, DOE reexamined the market and reduced the efficiency levels for analysis to the most common efficiencies on the furnace market. DOE determined that there are very few products currently on the market at 81-percent AFUE. Because shipments are so low, DOE determined that 81-percent AFUE did not warrant consideration in the analysis. DOE also examined the prevalence of 93-percent and 94-percent AFUE products on the market, and determined that 93-percent AFUE models are more common. However, upon further consideration, DOE believes 92-percent AFUE models are the most commonly shipped units in this range. Therefore, DOE analyzed only 92-percent AFUE instead of 93-percent or 94-percent AFUE. DOE kept the level at 95-percent AFUE for the direct final rule analysis, as was recommended by interested parties. Rather than performing teardowns at only 90-percent, 95-percent, and 98-percent AFUE, as Ingersoll Rand suggested, DOE performed teardowns at every efficiency level analyzed to provide greater accuracy in the analysis.

The baseline, max-tech, and intermediate efficiency levels for each furnace product class analyzed are presented in Table IV.3. As noted above and discussed in section III.G.2.a, weatherized gas furnaces were not analyzed, and as a result, the table shows efficiency levels for only non-weatherized gas, mobile home, and non-weatherized oil furnaces.

Table IV.3 Efficiency Levels Analyzed for Residential Furnaces

Product Class	Efficiency Level (AFUE)
Non-weatherized Gas	80%
	90%
	92%
	95%
	98%
Mobile Home	80%
	90%
	92%
	96%
Oil-Fired Non-weatherized	82%
	83%
	84%

	85%
	97%

b. Central Air Conditioners and Heat Pumps

DOE selected baseline efficiency levels as reference points for all of the product classes of central air conditioners and heat pumps and compared these baselines to projected changes resulting from potential amended energy conservation standards. Products at the baseline efficiency in each product class represent products with the common characteristics of equipment in that class that just meet current Federal energy conservation standards, while still providing basic consumer utility.

For each of the representative products, DOE analyzed multiple efficiency levels and estimated manufacturer production costs at each efficiency level. Table IV.4 and Table IV.5 provide the full efficiency level range that DOE analyzed from the baseline efficiency level to the max-tech efficiency level for each product class. The highest efficiency level in each of the seven product classes was identified through a review of products listed in AHRI-certified directories, manufacturer catalogs, and other publicly-available documents.

Table IV.4 Split-System SEER Values by Efficiency Level*

	Split AC			Split HP		
	2 Ton	3 Ton	5 Ton	2 Ton	3 Ton	5 Ton
Efficiency Level 1 - Baseline	13	13	13	13	13	13
Efficiency Level 2	13.5	13.5	13.5	13.5	13.5	13.5
Efficiency Level 3	14	14	14	14	14	14
Efficiency Level 4	14.5	14.5	14.5	14.5	14.5	14.5
Efficiency Level 5	15	15	15	15	15	15

Efficiency Level 6	15.5	15.5	15.5	15.5	15.5	15.5
Efficiency Level 7	16	16	16	16	16	16
Efficiency Level 8	16.5	16.5	16.5	16.5	16.5	16.5
Efficiency Level 9	17	17	17	17	17	17
Efficiency Level 10	18	18	18	18	18	18
Efficiency Level 11	19	19		19	19	
Efficiency Level 12	20	20		20	20	
Efficiency Level 13	21	21		21	21	
Efficiency Level 14	22	22		22		
Efficiency Level 15	23					
Efficiency Level 16	24.5					
Max-Tech Efficiency Level**	24.5	22	18	22	21	18

* The efficiency levels were analyzed independent of one another for each product class and are not linked as they are when considered in the downstream analyses as trial standard levels. The table depicts various levels for different product classes as part of the same efficiency level for convenience only, and not because the levels were analyzed together across product classes for the engineering analysis. Therefore, certain product classes have more or less efficiency levels depending on the number of levels analyzed for the given product class.
**This level is a summary of all of the max-tech efficiency levels for each product class and capacity, which corresponds to the highest efficiency level analyzed.

Table IV.5 Single-Package and Niche Product SEER Values by Efficiency Level*

	Single Pkg AC	Single Pkg HP	SDHV
Efficiency Level 1 - Baseline	13	13	13
Efficiency Level 2	13.5	13.5	13.5
Efficiency Level 3	14	14	14
Efficiency Level 4	14.5	14.5	14.3
Efficiency Level 5	15	15	
Efficiency Level 6	15.5	15.5	
Efficiency Level 7	16	16	
Efficiency Level 8	16.5	16.4	
Efficiency Level 9	16.6		
Max-Tech Efficiency Level**	16.6	16.4	14.3

* The efficiency levels were analyzed independent of one another for each product class and are not linked as they are when considered in the downstream analyses as trial standard levels. The table depicts various levels for different product classes as part of the same efficiency level for convenience only, and not because the levels were analyzed together across product classes for the engineering analysis. Therefore, certain product classes have more or less efficiency levels depending on the number of levels analyzed for the given product class.
**This level is a summary of all of the max-tech efficiency levels for each product class and capacity, which corresponds to the highest efficiency level analyzed.

In the preliminary analysis of split system air conditioners and heat pumps, DOE 1only examined products at the representative three-ton capacity. For the direct final rule, DOE performed additional analyses for two-ton and five-ton products. Therefore, the efficiency levels analyzed for split system products were expanded to include the relevant efficiency levels at the additional cooling capacities. For single package central air conditioners and heat pumps, as well as SDHV systems, the efficiency levels did not change from the preliminary analysis.

For space-constrained products, AHRI certification directory listings and manufacturer catalogs only contain units rated at a single efficiency level. DOE defined the baseline for space-constrained products as the efficiency specified by the current Federal energy conservation standards (i.e., 12 SEER). This SEER value is the same as the max-tech SEER value identified in DOE's analysis. Therefore, DOE did not conduct further analysis on the space-constrained products because the energy conservation standards for these two product classes are already set at the max-tech level and cannot be amended to provide additional savings. For additional details, see section III.G of this direct final rule.

4. Results

Using the manufacturer markup and shipping costs, DOE calculated estimated manufacturer selling prices of the representative furnaces and central air conditioners and heat pumps from the manufacturer production costs developed using the cost model. Chapter 5 of the TSD accompanying today's notice provides a full list of manufacturer production costs and manufacturer selling prices at each efficiency level for each product class and capacity analyzed, for both furnaces and central air conditioners and heat pumps. Chapter 5 of the TSD also contains the estimated cost to implement each design option that DOE analyzed for reducing the standby mode and off mode energy consumption of furnaces and off mode energy consumption of central air conditioners and heat pumps.

5. Scaling to Additional Capacities

DOE developed MPCs for the analysis of additional input capacities for furnaces and cooling capacities for residential central air conditioners and heat pumps by performing virtual teardowns of products at input capacities and cooling capacities other than the representative capacities. DOE developed a cost model for each virtual teardown product based on physical teardowns of representative units with a range of nominal capacities and from multiple manufacturers. Whenever possible, DOE maintained the same product line that was used for the physical teardown of the representative products to allow for a direct comparison of models at representative capacities and models at higher and lower capacities. For furnaces, the cost model accounts for changes in the size of components that would scale with input capacity (e.g., heat exchanger size), while components that typically do not change based on input capacity (e.g., gas valves, thermostats, controls) were assumed to remain largely the same across the different input capacities. Similarly, for central air conditioners and heat pumps, the cost model accounts for changes in the size of components that would scale with input capacity (e.g., coil size, compressor), while components that typically do not change based on input capacity (e.g., expansion valves, electronic controls) were assumed to remain largely the same across the different input capacities. DOE estimated the changes in material and labor costs that occur at capacities higher and lower than the representative capacities based on observations made during teardowns and professional experience. Performing physical teardowns of models outside of the representative capacities allowed DOE to accurately model certain characteristics that are not identifiable in manufacturer literature.

a. Furnaces

DOE recognizes that there is a large variation in the input capacity ratings of residential furnaces beyond the representative input capacity, which causes large discrepancies in manufacturer production costs. To account for this variation, DOE analyzed additional common input capacities (as determined during the market assessment) for the largest class of residential furnaces (i.e., non-weatherized gas furnaces). DOE performed physical teardowns of several non-weatherized gas furnaces above and below the representative input capacity to gather the necessary data to accurately scale the results from the representative input capacity to other input capacities. Performing teardowns of models outside of the representative capacity allowed DOE to accurately model certain characteristics that are not identifiable in manufacturer literature. In the furnaces RAP, DOE set forth its plans to analyze models at input capacities of 50,000 Btu/h and 125,000 Btu/h in addition to the models at the representative input capacity.

In comments, Ingersoll Rand stated that the additional input capacities which DOE planned to analyze are not very common, and instead, the company suggested that

DOE should analyze units at 40,000 Btu/h and 120,000 Btu/h, as the AHRI furnace directory lists a much greater number of models at these capacities. (FUR: Ingersoll Rand, No. 1.3.006 at p. 5) ACEEE, too, favored 40,000 Btu/h for analysis, because it argued that the smaller input capacity is more appropriate for the heating loads of modest-sized houses. (FUR: ACEEE, No. 1.3.009 at pp. 6-7) At the upper bounds of capacity, Ingersoll Rand also commented that there are not many condensing furnaces above 120,000 Btu/h input capacity. (FUR: Ingersoll Rand, Public Meeting Transcript, No. 1.2.006 at p. 178) AHRI again advised DOE not to lock into discrete capacities in its analysis of the low and high ends of the capacity range. (FUR: AHRI, Public Meeting Transcript, No. 1.2.006 at pp. 176-177)

In response to these comments, DOE reevaluated the distribution of capacities on the furnace market and determined that the majority of non-weatherized gas furnace models on the market are offered in 20,000 Btu/h increments between 40,000 Btu/h and 120,000 Btu/h, with the bulk of models at 60,000, 80,000, 100,000 and 120,000 Btu/h. Therefore, DOE scaled its analysis for non-weatherized gas furnaces (using virtual teardowns in conjunction with physical teardowns) to 60,000 Btu/h, 100,000 Btu/h, and 120,000 Btu/h, in addition to the analysis that was performed for the representative input capacity of 80,000 Btu/h. DOE selected these three additional input capacities to align them with the number of additional cooling capacities being analyzed for the central air conditioners analysis. DOE believes that 60,000 Btu/h is more representative of the lower end of the capacity range than 40,000 Btu/h, which is the minimum specified input capacity that meets DOE's definition.

The results of DOE's analysis for the additional input capacities are presented in chapter 5 of the direct final rule TSD. Chapter 5 also contains additional details about the calculation of MPCs for input capacities outside of the representative capacity.

b. Central Air Conditioners and Heat Pumps

To account for the variation in the rated cooling capacities of split system residential central air conditioners and heat pumps, and differences in both usage patterns and first cost to consumers of split system air conditioners and heat pumps larger or smaller than the representative capacity, DOE developed MPCs for central air conditioners and heat pumps at two-ton and five-ton cooling capacities, in addition to MPCs for the representative three-ton units.

To develop the MPCs for the analysis of two-ton and five-ton units, DOE used its cost model based on teardowns of representative units from multiple manufacturers. DOE modified the cost model for the representative capacity (i.e., three-tons) to account for changes in the size of central air conditioner and heat pump components that would scale with cooling capacity (e.g., evaporator and condenser coils, outer cabinet, packaging). DOE accurately modeled certain other characteristics (e.g., compressor, fan motor, fan blades) using information contained in manufacturer literature.

The results of DOE's analysis for the additional cooling capacities are presented in chapter 5 of the direct final rule TSD along with details about the calculation of central air conditioner and heat pump MPCs.

6. Heat Pump SEER/HSPF Relationships

For heat pumps, energy conservation standards must establish minimum values for HSPF in addition to SEER. In previous rulemakings (see section 4.8.1 of the 2001 final rule TSD available at http://www1.eere.energy.gov/buildings/appliance_standards/residential/ac_central_1000_r.html), analyses performed in terms of SEER were used as the basis for determining HSPF standards, and DOE has continued that approach for the current analysis. Consequently, DOE investigated the relationship between SEER and HSPF in the preliminary analysis, and reexamined that relationship for the direct final rule analysis. As a first step in examining the relationship, DOE plotted the median HSPF values for units that met or exceeded the existing standard of 7.7 HSPF for each product class and cooling capacity analyzed at half-SEER increments up to 16 SEER, and one-SEER increments from 16 SEER up to the max-tech level. For the preliminary analysis, DOE tentatively proposed using a SEER-HSPF relationship consisting of two separate linear sections, which roughly followed the median HSPF at each SEER. One trend line was developed for SEER values ranging from 13 to 16, and a separate second trend line was developed for SEER values above 16 SEER level. DOE proposed to use these two different trends because a substantial increase in the median HSPF was evident for units with cooling efficiencies greater than 16 SEER, which would be more accurately reflected through the use of two lines. DOE proposed to use the same relationship for single package units as well. Niche product relationships were not developed because these products were not fully analyzed in the preliminary analysis.

Based on updates to unit listings in the AHRI directory[35] as of June 2010, DOE has reexamined and updated the SEER-HSPF relationship for the direct final rule analysis. When DOE plotted the median HSPF values for the various SEER increments using 2010 version of the AHRI directory as opposed to a 2008 version which was used in the preliminary analysis, the more recent data exhibited a more gradual increase in the HSPF trend at SEER values over 16 SEER. As a result, DOE trended the data set of median values using a single linear relationship. DOE believes that this approach, which follows the median more closely than the relationship developed for the preliminary analysis, is more representative of the SEER-HSPF relationship illustrated by heat pumps currently available in the market. Additionally, while examining the relationship for different product classes and capacity sizes, DOE determined that the differences in HSPF values across product classes were substantial enough to warrant separate SEER-HSPF relationships for each product class and each cooling capacity analyzed. See chapter 5 of the TSD accompanying today's notice for the specific HSPF values considered at given SEER levels based on the SEER-HSPF relationship developed for this direct final rule.

[35] Available at: http://www.ahridirectory.org/ceedirectory/pages/hp/defaultSearch.aspx.

7. Standby Mode and Off Mode Analysis

As mentioned in section III.C, DOE is required by EPCA, as amended, to address standby mode and off mode energy consumption when developing amended energy conservation standards for furnaces and central air conditioners and heat pumps. (42 U.S.C. 6295(gg)) DOE adopted a design-option approach for its standby mode and off mode engineering analysis for both furnaces and central air conditioners/heat pumps, which allowed DOE to calculate the incremental costs of adding specific design options to a baseline model. DOE decided on this approach because sufficient data do not exist to execute an efficiency-level analysis, and DOE is not aware of any manufacturers that currently rate or publish data on the standby mode energy consumption of their products. Unlike standby mode and off mode fossil-fuel consumption for furnaces which is accounted for by AFUE for gas and oil-fired furnaces, standby mode and off mode electricity consumption for furnaces (including for electric furnaces) is not currently regulated. Similarly, although SEER and HSPF account for the standby mode electricity consumption of central air conditioners and furnaces, off mode electricity consumption is currently unregulated. Because of this, DOE believes manufacturers generally do not invest in research and development (R&D) to design products with reduced standby mode and off mode electrical energy consumption. Therefore, DOE determined that there is no basis for comparison of efficiency levels among products in terms of standby mode and off mode energy consumption. The design-option approach, by contrast, allowed DOE to examine potential designs for reducing the standby mode and off mode power consumption of residential furnaces and the off mode energy consumption of central air conditioners and heat pumps. Standby mode energy consumption for central air conditioners and heat pumps is already accounted for in the SEER and HSPF metrics. As discussed in section III.E of this direct final rule, DOE analyzed new, separate standards for standby mode and off mode energy consumption using separate metrics, because it is not technologically feasible to integrate standby mode and off mode into the existing metrics for these products; standby mode and off mode power consumption is orders of magnitude less than active mode power consumption, so in most cases, any effects would likely be lost because AFUE is reported to the nearest whole number for these products.

a. Identification and Characterization of Standby Mode and Off Mode Components

Using the design-option approach, DOE identified components that contribute to standby mode and off mode energy consumption in the teardown-generated BOMs used for analyzing amended AFUE and SEER standards. For furnaces, DOE performed measurements of standby mode and off mode electrical energy consumption of each product before it was torn down in accordance with the test procedures specified in DOE's July 2009 furnaces test procedure NOPR (whose approach was subsequently adopted in a final rule published in the Federal Register on October 20, 2010 (75 FR 64621)). 74 FR 36959 (July 27, 2009). In addition, DOE performed testing on individual components that DOE believes consume most of the standby energy (e.g., transformer, ECM blower motor). DOE aggregated these measurements to characterize and estimate the electrical energy use of each component operating in standby mode or off mode, as well as the standby mode and off mode consumption of the entire product. During manufacturer interviews, manufacturers provided feedback on these data, which

DOE used to update its estimates. DOE also estimated the costs of individual components and designs capable of being used to reduce standby mode and off mode power consumption based on volume-variable price quotations and detailed discussions with manufacturers and component suppliers, and DOE received feedback from manufacturers which was used to refine the estimates.

For electric furnaces, DOE analyzed the expected standby mode and off mode power consumption of an electric furnace in comparison to the standby mode and off mode power consumption of a non-weatherized gas furnace. For non-weatherized gas furnaces, DOE found that for the baseline standby mode and off mode design, the components that primarily contribute to standby mode and off mode power consumption are the control transformer, an ECM fan motor (which was assumed present for the baseline standby mode and off mode design), and the control board power supply, which were estimated to use a total of nine watts on average. Additionally, furnaces with more complex controls and features (which are included in the baseline for the standby mode and off mode analysis since they are the highest-power consuming designs), DOE found that additional standby mode and off mode power requirements could be up to 2 watts, for a total of 11 watts of standby mode and off mode power consumption.

To estimate the likely standby mode and off mode power consumption of electric furnaces, DOE compared wiring diagrams, control schematics, and images of control boards of gas and electric furnaces. DOE found that electric furnaces commonly use a 40VA transformer that is very similar to those found in non-weatherized gas furnaces.

Hence, DOE expects the power consumption associated with these transformers is the same. A DOE review of electric furnaces suggests that other components are also the same as (or very similar to) those used in non-weatherized gas furnaces, such as ECM blower motors, which suggests similar standby consumption for these components also. Finally, DOE examined the control boards, their power supplies, and the electrical systems of both electric and gas furnaces to examine potential differences in standby mode and off mode power consumption. DOE found that control boards for both electric and non-weatherized gas furnaces typically share many common features, such as linear and/or zener-style power supplies, relays, and microchip controllers. Additionally, both furnace types need a wiring harness and some sensors for safety and control. The two key differences are that electric furnace control boards tend to be simpler (no flame ignition/supervision, staging, and other combustion safety controls needed) and that electric furnace control boards use relays and/or sequencers that have higher capacity ratings than the relays typically found in gas furnaces. Sequencers are used to turn the electric furnace heating elements on incrementally to limit inrush currents and prevent nuisance trips of circuit breakers. DOE estimates that the additional standby power associated with the use of larger relays and/or sequencers of electric furnaces is balanced by the lack of need for controls/components for combustion initiation and control on gas furnaces.

As a result, DOE believes the evidence suggests that an electric furnace has a standby mode and off mode electrical consumption that is similar that of non-weatherized gas furnaces in similar models. Further, DOE believes the design options that were identified for reducing the standby mode and off mode power consumption of gas furnaces (i.e., a switching mode power supply and a toroidal transformer) will have the same impact on the standby mode and off mode power consumption of electric furnaces.

For central air conditioners and heat pumps, DOE measured off mode electrical energy consumption of units with and without crankcase heaters and with various crankcase heater control strategies in accordance with the test procedures specified in the DOE test procedure NOPR for central air conditioners and heat pumps. 75 FR 31224, 31260 (June 2, 2010). As was done for furnaces, DOE aggregated these measurements, in conjunction with nominal power ratings, to characterize the electrical energy use of each component operating in off mode. During manufacturer interviews, manufacturers provided feedback on these data, which DOE used to update its estimates. DOE also estimated the costs of individual components based on the same approach as furnaces and received feedback from manufacturers which was used to further refine these cost estimates.

b. Baseline Model

As noted above, the design-option approach that DOE is using for the standby mode and off mode energy conservation standards engineering analysis calculates the incremental costs for products with standby mode or off mode energy consumption levels above a baseline model in each standby mode and off mode product class covered in this rulemaking. Because standby mode and off mode electrical energy consumption of residential furnaces and central air conditioners and heat pumps is currently unregulated, DOE began by defining and identifying baseline components from the representative furnace teardowns that consumed the most electricity during standby mode and off mode operation. Baseline components were then "assembled" to model the electrical system of a furnace or central air conditioner or heat pump with the maximum system standby mode or off mode electrical energy consumption from DOE's representative test data. The baseline model defines the energy consumption and cost of the most energy-consumptive product on the market today (i.e., units with the highest standby mode and off mode electricity consumption) operating in standby mode or off mode. See chapter 5 of the direct final rule TSD for baseline model specifications.

ACEEE stated that it expects the average furnace to have a standby power consumption of 8 watts or about 50 kilowatt-hours per year based on a 2003 study by the Wisconsin Energy Center.[36] (FUR: ACEEE, No. 1.3.009 at p. 11) As noted above, DOE tested furnaces in standby mode using the procedure proposed in the July 2009 furnaces test procedure NOPR and later adopted in the October 2010 test procedure final rule. None of the furnaces tested were equipped with a "seasonal off switch," and as a result, DOE did not have any reason to expect a difference in standby mode and off mode power consumption, as the terms are defined in the test procedure.[37] As specified in the October 2010 test procedure final rule, DOE assumed that standby mode and off mode power consumption were equal, as the test procedure directs for units that do not have an

[36] Pigg, S., "Electricity Use by New Furnaces: A Wisconsin Field Study," Madison, WI: Energy Center of Wisconsin. (2003) (Available at: http://www.doa.state.wi.us/docs_view2.asp?docid=1812).

[37] The test procedure for furnaces and boilers defines "standby mode" as "the condition during the heating season in which the furnace or boiler is connected to the power source, and neither the burner, electric resistance elements, nor any electrical auxiliaries such as blowers or pumps, are activated," and "off mode" as "the condition during the non-heating season in which the furnace or boiler is connected to the power source, and neither the burner, electric resistance elements, nor any electrical auxiliaries such as blowers or pumps, are activated." 75 FR 64621, (Oct. 20, 2010); 10 CFR part 430, subpart B, appendix N, section 2.0.

expected difference between standby mode and off mode power consumption. 10 CFR Part 430, subpart B, appendix N, section 8.6.2. DOE's testing resulted in a range of values, both above and below 8 watts. Additional discussion of the results of DOE's furnace testing is in chapter 5 of the direct final rule TSD.

c. Cost-Power Consumption Results

The results of the engineering analysis are reported as cost-power consumption data (or "curves") in the form of power (in watts) versus MPC (in dollars). For furnaces, DOE developed two different data sets for standby mode and off mode: one to use for the non-weatherized gas, mobile home gas (DOE's testing showed that the standby mode and off mode power consuming components are the same in mobile home gas furnaces as non-weatherized gas furnaces), and electric furnace product classes, and one to use for non-weatherized and mobile home oil-fired furnace product classes. For central air conditioners and heat pumps, DOE developed six off mode data sets: four for air conditioners and two for heat pumps. The data sets were produced based on units with ECM fan motors, because they will have a slightly higher off mode power consumption due to the fact that ECM fan motors have some controls integrated into them.

The methodology for developing the cost-power consumption curves started with determining the energy use of baseline products and their full cost of production. For furnaces and central air conditioners and heat pumps, the baseline products contained the highest energy-consuming components, which included an ECM blower motor (rather than a PSC) when applicable. Above the baseline, DOE implemented design options based on cost-effectiveness. Design options were implemented until all available technologies were employed (i.e., at a max-tech level). For furnaces and central air conditioners and heat pumps, the design options are not all mutually exclusive, and, therefore, systems could incorporate multiple design options simultaneously.

After considering several potential designs to improve standby mode efficiency for furnaces, DOE ultimately examined two designs in addition to the baseline that passed the screening analysis (see chapter 4 of the direct final rule TSD for details). DOE first considered the use of a switch mode power supply instead of a linear power supply. DOE also considered the use of a toroidal transformer in addition to a switch mode power supply to further reduce standby mode and off mode energy consumption of a furnace. The power consumption levels analyzed for furnaces are shown in Table IV.6 below.

Table IV.6 Standby Mode and Off Mode Power Consumption Levels for Furnaces

	Non –weatherized Gas, Electric, and Mobile Home Gas Furnace Standby Power Consumption (W)	**Non-weatherized Oil-fired and Mobile Home Oil-Fired Furnace Standby Power Consumption (W)**
Baseline	11	12
Efficiency Level 1	10	11
Efficiency Level 2	9	10

Although DOE's test results for furnaces showed that the standby mode and off mode consumption could be reduced below efficiency level 2 by eliminating certain features (e.g., replacing an ECM blower motor with a PSC motor), DOE did not consider these as potential design options, because the elimination of such features and components would result in a reduction of consumer utility. In its analysis, DOE only considered designs that could be implemented with no noticeable impacts on the performance and utility of the unit.

For central air conditioners, DOE examined three designs (i.e., thermostatically-controlled fixed-resistance crankcase heaters, thermostatically-controlled variable-resistance crankcase heaters with compressor covers, and thermostatically-controlled variable-resistance crankcase heaters with compressor covers and a toroidal transformer) in addition to the baseline for split-system blower coil and packaged air conditioners equipped with crankcase heaters. DOE only examined two designs (i.e., thermostatically-controlled fixed-resistance crankcase heaters and thermostatically-controlled variable-resistance crankcase heaters with compressor covers) in addition to the baseline for coil-only air conditioners, because the transformer is contained in the furnace or air handler and is not a component of a coil-only system. DOE believes that the crankcase heater is the only source of off mode power consumption for the coil-only systems, and consequently, a coil-only split-system air conditioner will have no off mode power consumption without a crankcase heater unless it has an ECM motor in the condensing unit.

For heat pumps, DOE found during testing that heat pumps achieved a lower power consumption during the off mode period through the use of crankcase heaters with a control strategy based on outdoor ambient temperature, as opposed to compressor shell temperature. However, using this control strategy prevents a heat pump from achieving any additional energy savings with a compressor cover, because while a cover helps the compressor shell retain heat, it has no effect on the outdoor ambient temperature sensor. Additionally, DOE found that the fixed-resistance and variable-resistance crankcase heaters had similar test results in terms of energy consumption and believes that manufacturers will choose the fixed-resistance heaters because they are more cost-effective. Therefore, DOE did not include compressor covers as a design option for heat pumps because there is no benefit from them without the variable-resistance crankcase heaters and only considered thermostatically-controlled crankcase heaters and toroidal transformers.

DOE also found during testing that the crankcase heater accounts for the vast majority of off mode power consumption for air conditioners and heat pumps. However, not every unit has a crankcase heater and, to accurately reflect this in the analyses, DOE determined separate efficiency levels within each product class for units with and without a crankcase heater. Because two of the design options are only relevant with crankcase heaters, the only possible improvement to units without crankcase heaters is the toroidal transformer. Table IV.7 through Table IV.9 contain the off mode efficiency levels for central air conditioners and heat pumps.

Table IV.7. Split-System (Blower Coil), Packaged, and Space-Constrained Air Conditioner Off Mode Power Consumption

	Power Consumption with an ECM Motor and Crankcase Heater (W)	Power Consumption with an ECM Motor and No Crankcase Heater (W)
Baseline	48	11

Efficiency Level 1	36	10
Efficiency Level 2	30	
Efficiency Level 3	29	

Table IV.8. Split-System (Coil-Only) Air Conditioner Off Mode Power Consumption

	Power Consumption with an ECM Motor and Crankcase Heater (W)	Power Consumption with an ECM Motor and No Crankcase Heater (W)
Baseline	37	3
Efficiency Level 1	25	
Efficiency Level 2	19	

Table IV.9. Split-System, Packaged, and Space-Constrained Heat Pump Off Mode Power Consumption

	Power Consumption with an ECM Motor and Crankcase Heater (W)	Power Consumption with an ECM Motor and No Crankcase Heater (W)
Baseline	51	14
Efficiency Level 1	33	13
Efficiency Level 2	32	

For furnaces, the standby mode and off mode electrical energy consumption (in watts) of each design option was estimated based on test measurements performed on furnace electrical components, industry knowledge, and feedback from manufacturers during manufacturer interviews. For central air conditioners and heat pumps, the off mode energy consumption of each system design was calculated based on test measurements performed according to the off mode test procedure for central air conditioners and heat pumps that was proposed in the June 2010 test procedure NOPR (75 FR 31224 (June 2, 2010)), and information gathered during manufacturer interviews. See chapter 5 in the direct final rule TSD for additional detail on the engineering analyses and for complete cost-power consumption results for standby mode and off mode operation.

D. Markup Analysis

The markup analysis develops appropriate markups in the product distribution chain to convert the estimates of manufacturer selling price derived in the engineering analysis to consumer prices. At each step in the distribution channel, companies mark up the price of the product to cover business costs and profit margin. After establishing appropriate distribution channels, DOE relied on economic data from the U.S. Census Bureau and industry sources to estimate how prices are marked up as the products pass from the manufacturer to the consumer.

In the central air conditioners and heat pumps preliminary TSD, DOE determined two typical distribution channels for central air conditioners and heat pumps -- one for replacement products, and one for products installed in new homes. DOE then estimated the markups associated with the main parties in the distribution channels. For replacement products, these are distributors and mechanical contractors. For products installed in new homes, these are distributors, mechanical contractors, and general contractors (builders).

DOE based the distributor and mechanical contractor markups on company income statement data;[38] DOE based the general contractor markups on U.S. Census

[38] Heating, Air-conditioning & Refrigeration Distribution International (HARDI) 2010 Profit Report; Air Conditioning Contractors of America (ACCA) Financial Analysis (2005).

Deleted: Airconditioning

Bureau data[39] for the residential building construction industry. For distributors and contractors, DOE developed separate markups for baseline products (baseline markups) and for the incremental cost of more-efficient products (incremental markups). Thus, for these actors, the estimated total markup for more-efficient products is a blend of a baseline markup on the cost of a baseline product and an incremental markup on the incremental cost. No comments were received on the distribution markups contained in the preliminary TSD for central air conditioners and heat pumps, and DOE retained the approach used in the preliminary analysis for today's direct final rule.

In the furnaces RAP, DOE stated its intention to determine typical markups in the furnace distribution chain using publicly-available corporate and industry data, particularly Economic Census data from the U.S. Census Bureau[40] and input from industry trade associations such as HARDI. It described a similar approach for furnaces to estimate baseline and incremental markups as was used in the preliminary analysis for central air conditioners and heat pumps.

Commenting on the furnaces RAP, HARDI stated that distributors do not categorize costs into labor-scaling and non-labor-scaling costs, and it recommended that DOE should not use this approach when projecting distributor impacts. HARDI recommended that DOE should use the markups approach taken in chapter 17 of the TSD for central air conditioners and heat pumps. (FUR: HARDI, No. 1.3.016 at p. 9)

[39] 2007 Economics Census; available at: http://factfinder.census.gov/servlet/EconSectorServlet?caller=dataset&sv_name=*&_SectorId=23&ds_name=EC0700A1&_lang=en&_ts=309198552580.

[40] U.S. Census Bureau, Plumbing, Heating, and Air-Conditioning Contractors: 2002 (Report EC02-231-238220).

In response, DOE notes that the analysis described in chapter 17 of the TSD for central air conditioners and heat pumps only used baseline markups because its purpose was to estimate the impacts of regional standards and not to estimate the incremental costs of higher-efficiency products for the LCC and PBP analysis. To derive incremental markups for the LCC and PBP analysis, DOE distinguishes between costs that change when the distributor's cost for the appliances it sells changes due to standards and those that do not change. DOE agrees that the categorization of costs as non-labor-scaling and labor-scaling mentioned in the furnaces RAP may not be appropriate terminology. Accordingly, for the direct final rule, DOE refers to these two categories as variant and invariant costs.

Chapter 6 of the direct final rule TSD provides additional details on the markup analysis.

E. Energy Use Analysis

DOE's analysis of the energy use of furnaces and central air conditioners and heat pumps estimated the energy use of these products in the field (i.e., as they are actually used by consumers). The energy use analysis provided the basis for other follow-on analyses that DOE performed, particularly assessments of the energy savings and the savings in consumer operating costs that could result from DOE's adoption of potential amended standard levels. In contrast to the DOE test procedure, which provides standardized results that can serve as the basis for comparing the performance of different appliances used under the same conditions, the energy use analysis seeks to capture the range of operating conditions for furnaces and central air conditioners and heat pumps in U.S. homes and buildings.

In the central air conditioners and heat pumps preliminary TSD, to determine the field energy use of products that would meet possible amended standard levels, DOE used data from the EIA's 2005 Residential Energy Consumption Survey (RECS), which was the most recent such survey available at the time of DOE's analysis.[41] RECS is a national sample survey of housing units that collects statistical information on the consumption of and expenditures for energy in housing units along with data on energy-related characteristics of the housing units and occupants. The sample is selected to be representative of the population of occupied housing units in the U.S. RECS provides sufficient information to establish the type (product class) of furnace, central air conditioner, or heat pump used in each housing unit. As a result, DOE was able to develop discrete samples for each of the considered product classes. DOE uses these samples not only to establish each product's annual energy use, but also as the basis for conducting the LCC and PBP analysis. DOE described a similar approach for furnaces in the RAP.

Commenting on the furnaces RAP, Lennox stated that DOE should use more recent data for the energy consumption of furnaces than those in the 2005 RECS. Lennox asserted that using the 2005 RECS will overstate the savings associated with higher efficiency levels, because the market share of high-efficiency furnaces has increased

[41] For information on RECS, see http://www.eia.doe.gov/emeu/recs/.

since the time of the survey. (FUR: Lennox, No. 1.3.018 at p. 4) Ingersoll Rand made a similar point. (FUR: Ingersoll Rand, No. 1.3.006 at pp. 7-8) In response, DOE notes that the increase in the market share of high-efficiency furnaces since 2005 does not result in overstated savings because, as described below, DOE uses information on the furnace in the RECS housing units only to estimate the heating load of each sample building (i.e., the amount of heat needed to maintain comfort). Since the heating load is a characteristic of the dwelling and not the heating equipment, DOE's estimate of annual energy use of baseline and higher-efficiency furnaces (and the difference, which is the energy savings) is not affected if some households have acquired new, more-efficient furnaces since the time of the 2005 RECS.

Details on how DOE used RECS to determine the annual energy use of residential furnaces and central air conditioners and heat pumps are provided below. A more detailed description of DOE's energy use analysis is contained in chapter 7 of the direct final rule TSD.

1. Central Air Conditioners and Heat Pumps

In the central air conditioners and heat pumps preliminary TSD, DOE determined the annual energy use of central air conditioners and heat pumps at various efficiency levels using a nationally representative set of housing units that were selected from EIA's 2005 RECS. DOE began with the reported annual electric energy consumption for space cooling and space heating for each household in the sample. DOE then adjusted the

RECS household energy use data, which reflect climate conditions in 2005, to reflect normal (30-year average) climate conditions.

DOE used the reported cooling equipment vintage (i.e., the year in which it was manufactured) to establish the cooling efficiency (SEER) and corresponding heating efficiency (HSPF) of the household's air conditioner or heat pump. DOE estimated the energy consumption for each sample household at the baseline and higher efficiency levels using the 2005 RECS-reported cooling energy use multiplied by the ratio of the SEER of each efficiency level to the SEER of the household's equipment. Similarly, DOE calculated the heating energy use for each household in the sample using the 2005 RECS-reported heating energy use multiplied by the ratio of the HSPF of each efficiency level to the HSPF of the household's equipment.

DOE also estimated the energy consumption for central air conditioners and heat pumps shipped to commercial buildings, which DOE estimated at 7 percent of the market, using a model of a small office building, DOE's EnergyPlus building energy simulation software,[42] and weather data for 237 locations around the U.S. Four efficiency levels, starting with a baseline SEER 13 level, were modeled and the energy use at intermediate efficiency levels was estimated by interpolation between these four levels. Details of the energy analysis methodology are described in chapter 7 of the TSD.

[42] For more information on EnergyPlus refer to DOE's EnergyPlus documentation, available at: http://apps1.eere.energy.gov/buildings/energyplus/energyplus_documentation.cfm. EnergyPlus software is freely available for public download at: http://apps1.eere.energy.gov/buildings/energyplus/energyplus_about.cfm.

Commenting on the preliminary TSD, several commenters suggested that DOE use computer simulation models for the residential energy use estimates as well. (CAC: CA IOUs, No. 69 at p. 3; SCS, Public Meeting Transcript at p. 74) Commenters stated that using simulations is likely to be more accurate. (CAC: ACEEE, No. 72 at p. 6; NPCC, No. 74 at p. 3) Commenters noted that that RECS 2005 does not distinguish between heating and cooling used in the same 24-hour period (CAC: CA IOUs, No. 69 at p. 3), and that heat pump usage estimated using RECS data may be less accurate due to the small sample size, particularly when examining RECS statistics at the Census division level. (CAC: SCS, No. 73 at p. 3; NPCC, No. 74 at p. 2; ACEEE, No. 72 at p. 6) A commenter also noted that using RECS does not allow DOE to control for external system effects such as duct anomalies. (CAC: ACEEE, No. 72 at p. 6) More specifically with respect to heat pumps, NPCC commented that the approach used in the preliminary analysis assumed that improvements in efficiency result in comparable percentage savings across differing regions. NPCC noted that because HSPF is climate dependent, a simulation or bin temperature approach should be used to get at the right answer. (CAC: NPCC, No. 74 at p. 2; NPCC, Public Meeting Transcript at p. 44) NPCC also stated that presuming DOE moves to a simulation of the heat pump for the residential analysis, it should use a heat pump performance curve that reflects inverter-driven compressors because they perform quite differently at lower temperatures relative to the standard rating points that are now available. (CAC: NPCC, Public Meeting Transcript. at p. 70) Rheem commented that the proportional changes in SEER will reflect proportional changes in cooling energy use across climates, assuming similar characteristics for the underlying equipment design, but noted that SEER alone may not portray an accurate difference in relative energy consumption for disparate climates if the underlying systems have different characteristics such as two-stage compressors or variable-speed fans. (CAC: Rheem, No 76 at p. 6)

In response to these comments, DOE is aware that RECS observations for heat pumps are limited when analyzing geographic subsets at the Census division levels identified by commenters, but points out that it relies on larger regions with more observations for its regional or national analysis of heat pumps. In response to the comment that DOE does not distinguish between heating and cooling in a 24-hour period, DOE believes that this comment may be relevant to the energy analysis for heat pumps, but that its importance is overshadowed by the much larger concern of achieving household energy consumption estimates that are reflective of the variability in residential homes of different vintages and building characteristics, which is difficult to capture in modeling. With regard to controlling for duct anomalies, DOE points out that a simulation may allow DOE to presume some duct performance or, through a sensitivity study, understand how the assumptions for a duct system can impact the energy results, but in fact would not necessarily yield more accurate estimates of energy consumption than an analysis that is based on more empirical energy use data.

In response to the concern regarding the climate sensitivity of HSPF and the overall heating performance of heat pumps, DOE agrees that its approach to estimating energy savings should take into account how the heating HSPF would vary as a function of climate. DOE examined several strategies for doing this and relied for the direct final rule on an approach that estimates the change in seasonal heating efficiency for heat pumps based on equations developed from building simulation analysis across the U.S.[43] DOE also examined other possible methods, including alternative simulation approaches, and discusses these in chapter 7 of the direct final rule TSD. For the direct final rule, however, DOE did not rely on separate simulations for residential buildings to estimate the underlying energy use at different efficiency levels, due to the concerns mentioned above, and, thus, did not include heating performance curves for inverter-driven heat pump systems. DOE acknowledges that certain inverter-driven heat pumps, primarily found in mini-split systems, have increased heating capacity at low temperature (relative to the nominal 47 °F heating capacity) compared with non-inverter systems. DOE also acknowledges that this difference has potential heating energy benefits over the course of the year that, while captured in the HSPF rating, may differ depending on climate.

DOE also received a number of comments on the commercial analysis, which relied on the use of energy simulations. ACEEE commented that in the commercial energy analysis, it appreciated that DOE used realistic values for the total static pressure in the building modeling, but it was not confident that the motor efficiencies or combined efficiencies are realistic for residential equipment at these higher static pressures. (CAC: ACEEE, Public Meeting Transcript at p. 69) In addition, ACEEE stated that it believes that there should be some empirical data to underlie the assumption that constant air circulation is the predominant mode of operation in small commercial buildings that

[43] Fairey, P., D.S. Parker, B. Wilcox and M. Lombardi, "Climate Impacts on Heating Seasonal Performance Factor (HSPF) and Seasonal Energy Efficiency Ratio (SEER) for Air Source Heat Pumps," ASHRAE Transactions, American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (June 2004).

utilize residential equipment. NPCC echoed this point, adding that it had not seen controls that provided switching between this mode and heating/cooling modes of operation. (CAC: NPCC, No. 74 at p. 5) NPCC also suggested that DOE use the most recent weather data in its analysis and provided an analysis of differences in TMY2 and TMY3 weather data for the northwest.[44] (CAC: NPCC, No. 74 at p. 4)

DOE was not able to identify a specific source of information regarding the use of continuous air circulation for residential (single-phase) heat pumps in commercial buildings, but notes that a California study of 215 small air conditioners in commercial buildings found intermittent (cycling) ventilation operation during the occupied period in 38 percent of cases examined.[45] DOE also notes that a programmable residential thermostat that is set in a continuous-circulation fan mode will still shift into a cooling or heating mode on a call for cooling or heat. However, in recognition that intermittent ventilation is common in small buildings, DOE modified its simulation model to have 40 percent (two out of five) of the HVAC zones operate in intermittent-circulation mode during the occupied period. DOE maintained the fan power assumptions from the preliminary TSD. DOE acknowledges that higher fan static pressure may result in motor efficiency deviating from the values used, but it may also result in the actual air flow differing in the field, depending on both the type and size of motor used and on installation practices. DOE also notes that there may be variation in cooling and heating

[44] The TMY2 data are based on examination of weather data from 1961-1990 for 239 locations. See: National Renewable Energy Laboratory, User's manual for TMY2s (Typical meteorological years derived from the 1961-1990 national solar radiation database) (1995).
[45] Jacobs, P. *Small HVAC Problems and Potential Savings Reports*. 2003. California Energy Commission, Sacramento, California. Report No. CEC-500-03-082-A-25. Available at: http://www.energy.ca.gov/pier/project_reports/500-03-082.html.

efficiency when air flow rates deviate from nominal values. DOE has not attempted to systematically explore these variations in the commercial modeling. DOE has at this point not updated its commercial simulations to use TMY3 weather data but will consider doing so for the final rule. DOE believes that the impact of this change would be minimal with regard to the overall analysis. In the data provided by NPCC, the overall change for comparable TMY2 and TMY3 locations was on the order of a five percent reduction in heating degree days and no clear change in cooling degree days.

DOE received multiple comments on the SEER-EER relationship that was used in the commercial modeling. Commenters expressed concern that the relationship that was used in the preliminary analysis did not reflect the correct relationship between SEER and EER. Several commenters stated that the Wassmer-Brandemuehl[46] curve used in the preliminary analysis suggested a nearly linear relationship between SEER and EER, but that their review of the data in the AHRI directory suggested that this is not accurate. (CAC: CA IOUs, No. 69 at pp. 3-4; PG&E, Public Meeting Transcript at pp.63, 72; Ingersoll Rand, Public Meeting Transcript at p. 63; EEI, No. 75at p. 5) ACEEE suggested that the curve should include two lines, reflecting the slopes of this relationship for single-speed versus step-modulating compressors. (CAC: ACEEE, Public Meeting Transcript at p. 57; ACEEE, No. 72 at p. 4) ASAP noted that the relationship between SEER and EER may become clearer when set by a standard, and that the market migrates to the lowest-cost compliance path, although single-stage equipment will provide a

[46] Wassmer, M. and M.J. Brandemuehl, "Effect of Data Availability on Modeling of Residential Air Conditioners and Heat Pumps for Energy Calculations" (2006) ASHRAE Transactions 111(1), pp. 214-225.

different EER at a 16 SEER than will two-stage equipment. (CAC: ASAP, Public Meeting Transcript at p. 64)

EEI and NPCC reported concerns that the nearly linear relationship between EER and SEER would result in the analysis showing better apparent economic benefit than what might actually occur due to differences between estimated versus actual impacts on peak demand and calculated marginal price. EEI suggested that DOE should use AHRI's published EER values in the simulations. (CAC: EEI, Public Meeting Transcript at pp. 61, 104; EEI, No. 75 at p. 5; NPCC, Public Meeting Transcript at p. 130) Southern also agreed that a curve based on EER values representative of the current AHRI database should be used instead of the relationship used in the preliminary TSD, and further suggested that the SEER 16 and max-tech efficiency levels should be modeled as dual-speed or variable-speed equipment. (CAC: SCS, No. 73 at p. 4; SCS, Public Meeting Transcript at p. 60) PG&E commented that, based on their review of the equipment market, there is a decrease in EER at very high SEER. They emphasized that the impact of this relationship on peak performance is an important issue for utilities and is a reason why they are emphatic about not using SEER as the only efficiency metric in hot, dry regions. (CAC: PG&E, Public Meeting Transcript at p. 72)

In response to the above concerns, DOE modified its commercial simulations to use EER values that reflect the median values taken from the most recent AHRI database for the selected SEER levels that were simulated. In addition, 16 SEER and higher efficiency levels were modeled as two-stage equipment. Additional changes to the commercial modeling included the incorporation of new equipment performance curves from a 3-ton split system air conditioner that DOE believes to be more representative of residential central air conditioners and heat pumps.

DOE also received several comments suggesting that northern region heat pumps should not be sized based on cooling loads. (CAC: CA IOUs, No. 69 at p. 4; NPCC, No. 74 at p. 4) At the public meeting, ACEEE asked if sizing based on cooling loads for northern climates is a recommended practice that one would find in an ACCA manual. (CAC: ACEEE, Public Meeting Transcript at p. 55) Southern also questioned the sizing based on cooling loads for northern climates. (CAC: SCS, Public Meeting Transcript at p. 50)

DOE understands that, in the Northwest, utilities encourage sizing heat pumps based on the maximum of either the cooling load or the heating load at an ambient temperature between 30 °F and 35 °F, and that such sizing is one component of many Northwest heat pump rebate programs. DOE reviewed the current ACCA manual for sizing of equipment (Manual S),[47] which clearly states that sizing of heat pumps should be based on cooling loads. However, Manual S allows installers some additional flexibility by suggesting that they can consider sizing heat pumps up to 25 percent larger if the building balance point (i.e., where sensible heating loads equal compressor heating capacity) is relatively high. The manual specifically caveats this by pointing out that the

[47] Air Conditioning Contractors of America, Manual S Residential Equipment Selection (1995) (Available at: www.acca.org).

additional capacity may not translate into significant reduction in heating costs and may not justify the cost of a larger unit.

In a 2005 study of installation practices of heat pumps in the Northwest provided by NPCC,[48] the residential heat pump installations that were examined were undersized compared to the heating load in most of the locations examined except the sites in eastern Washington, which had higher cooling design temperatures and would be expected to have relatively comparable heating and cooling loads. (CAC: NPCC, No. 74, attachment 2 at p. 65) Sixty percent of the contractors consulted in the study reported that cooling sizing was the principle factor in equipment selection. The study also noted that, given the observed equipment sizes in the study, it would appear that a 30-percent increase in capacity would be required in order to be able to meet the design heating load at a 30 °F outside temperature, particularly given the drop in capacity of heat pumps at lower temperatures. Given the additional cost for larger equipment (estimated at $1,000 in the study) and Northwest utility rates, the study noted that consumers may be making an economic decision to not invest in the larger equipment (and therefore to not meet the 30°F heating load) at the expense of greater energy savings with the larger heat pump.

With respect to commercial buildings, DOE expects that for most new small commercial buildings in the northern U.S., cooling design loads used for sizing will typically be larger than heating design loads at 30-35°F due to internal gain assumptions. However, DOE notes that variation in both ventilation and internal gain assumptions used

[48] Baylon, D., et al., "Analysis of Heat Pump Installation Practices and Performance, Final Report" (2005) (Available at: www.neea.org/research/reports/169.pdf).

in sizing in the small commercial building market will result in variation in relative design cooling and 30-35°F heating loads among buildings. DOE also notes that to the extent that continuous circulation is used in commercial buildings, fan energy use and corresponding cooling impact for larger equipment will have an offsetting factor on heating energy savings from larger heat pump sizing. DOE has not passed judgment on the economic or energy value of sizing for heating loads in commercial buildings, but, for the reasons cited above, DOE did not modify the sizing methods for the commercial modeling for the direct final rule.

2. Furnaces

In the furnaces RAP, DOE stated its intention to use RECS data to estimate the annual energy consumption of residential furnaces used in existing homes, and further described its planned method for determining the range of annual energy use of residential furnaces at various efficiency levels.

For the direct final rule analysis, DOE followed the method described in the furnaces RAP. In addition to using the 2005 RECS data to estimate the annual energy consumption of residential furnaces used in existing homes, DOE estimated the furnace energy efficiencies in existing homes, again based primarily on data from the 2005 RECS. To estimate the annual energy consumption of furnaces meeting higher efficiency levels, DOE calculated the house heating load based on the RECS estimates of the annual energy consumption of the furnace for each household. For each household with a furnace, RECS estimated the equipment's annual energy consumption from the household's utility bills using conditional demand analysis. DOE estimated the house heating load by reference to the existing furnace's characteristics, specifically its capacity and efficiency (AFUE), as well as by the heat generated from the electrical components. The AFUE was determined using the furnace vintage from 2005 RECS and data on the market share of condensing furnaces published by AHRI.[49]

DOE then used the house heating load to calculate the burner operating hours, which is needed to calculate the fuel consumption and electricity consumption using section C of the current version of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) test procedure SPC 103-2007, "Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers." To calculate blower electricity consumption, DOE accounted for field data from several sources (as described in chapter 8 of the direct final rule TSD) on static pressures of duct systems, as well as airflow curves for furnace blowers from manufacturer literature.

To account for the effect of annual weather variations, the 2005 RECS household energy consumption values were adjusted based on 30-year average HDD data for the specific Census division or the large State location.[50] In addition, DOE made adjustments to the house heating load to reflect the expectation that housing units in the year in which compliance with the amended standards is required will have a somewhat different

[49] Air Conditioning, Heating & Refrigeration Institute Industry Statistics is the reference source for the shipped efficiency data by vintage year. Available at**:** http://www.ahrinet.org/Content/EquipmentStatistics_118.aspx.

[50] Census divisions are groupings of States that are subdivisions of the four census regions. The large States considered separately are New York, Florida, Texas, and California.

heating load than the housing units in the 2005 RECS. The adjustment considers projected improvements in building thermal efficiency (due to improvement in home insulation and other thermal efficiency practices) and projected increases in the square footages of houses between 2005 and the compliance date of today's standards.

Commenting on the furnaces RAP, Ingersoll Rand stated that in using furnace capacity to estimate energy consumption, DOE needs to account for the fact that furnaces are often over-sized to maintain comfort under extreme conditions. (FUR: Ingersoll Rand, No. 1.3.006 at p. 10) In response, DOE's approach does account for the over-sizing of furnace capacity, since the furnace capacity assignment is a function of historical shipments by furnace capacity, which reflects actual practice, as well as heating square footage and the outdoor design temperature for heating (i.e., the temperature that is exceeded by the 30-year minimum average temperature 2.5 percent of the time).

In the furnaces RAP, DOE described its plans to consider the potential for a "rebound effect" in its analysis of furnace energy use. A rebound effect could occur when a piece of equipment that is more efficient is used more intensively, so that the expected energy savings from the efficiency improvement may not fully materialize. DOE stated that the rebound effect for residential space heating appears to be highly variable, ranging from 10 to 30 percent. A rebound effect of 10 percent implies that 90 percent of the expected energy savings from more efficient equipment will actually occur.

DOE received comments about applying a rebound effect associated with higher-efficiency furnaces. ACEEE referred to a 1993 study by Nadel that suggests the rebound effect should be about one percent.[51] (FUR: ACEEE, No. 1.3.009 at p. 7) Based upon its experience, Southern stated that the rebound effect should not exceed 5 percent. (FUR: Southern, No. 1.2.006 at p. 189) Lennox expressed concern with DOE's value for the rebound effect. (FUR: Lennox, No. 1.3.018 at p. 4) Ingersoll Rand stated that a significant rebound effect is unlikely, because it implies that consumers are currently tolerating discomfort with existing furnaces. (FUR: Ingersoll Rand, No. 1.3.006 at p. 10)

In response, DOE examined a recently-published review of empirical estimates of the rebound effect.[52] The authors evaluated 12 quasi-experimental studies of household heating that provide mean estimates of temperature take-back (i.e., the increase in indoor temperature in the period after improvement in efficiency) in the range from 0.14 ˚C to 1.6 ˚C. They also reviewed nine econometric studies of household heating, each of which includes elasticity estimates that may be used as a proxy for the direct rebound effect. The authors conclude that "the econometric evidence broadly supports the conclusions of the quasi-experimental studies, suggesting a mean value for the direct rebound effect for household heating of around 20%."[53] Based on the above review, DOE incorporated a rebound effect of 20 percent for furnaces in the direct final rule analysis. The above-cited review found far fewer studies that quantified a direct rebound effect for household air conditioning. Two studies of household cooling identified in the review provide estimates

[51] S. Nadel, "The take-back effect: fact or fiction?" Proceedings of the 1993 Energy Program Evaluation Conference, Chicago, IL, pp. 556-566.
[52] S. Sorrell, J. Dimitropoulos, and M. Sommerville, "Empirical estimates of the direct rebound effect: a review," Energy Policy 37(2009) pp. 1356–71.
[53] Id. at p. 1363.

of the rebound effects that are roughly comparable to those for household heating (i.e., 1–26 percent).[54] Therefore, to maintain consistency in its analysis, DOE also used a rebound effect of 20 percent for central air conditioners and heat pumps.

3. Standby Mode and Off Mode

a. Central Air Conditioners and Heat Pumps

DOE established annual off mode energy consumption estimates for each off mode technology option identified in the engineering analysis for air conditioners and for heat pumps. DOE estimated annual off mode energy consumption for air conditioners based on the shoulder season off mode power consumption and heating season off mode power consumption multiplied by the representative shoulder season rating hours (739 hours) and heating season rating hours (5216 hours) established in the test procedure. DOE estimated annual energy consumption for heat pumps based only on the shoulder season off mode power consumption multiplied by the representative shoulder season rating hours (739 hours) established in the test procedure because heat pumps operate in active mode during the heating season. These seasonal hours are calculated to be consistent with the rating hours used in the SEER and HSPF ratings for air conditioners and heat pumps.

DOE is considering national standards for off mode energy consumption, but does not intend to set regional standards for off mode energy consumption. DOE recognizes

[54] Dubin, J.A., Miedema, A.K., Chandran, R.V., 1986. Price effects of energy-efficient technologies—a study of residential demand for heating and cooling. Rand Journal of Economics 17(3), 310–25. Hausman, J.A., 1979. Individual discount rates and the purchase and utilization of energy-using durables. Bell Journal of Economics 10(1), 33–54.

that there will be some variation in off mode hours depending on location and individual household usage, but believes that the defined off mode hours in the test procedure will represent a reasonable basis for calculation of energy savings from off mode energy conservation standards. In the case of heat pumps, the off mode period includes the shoulder period between the heating and cooling season. It is fairly constant across most of the U.S. and, on average, is close to the test procedure rating value for the DOE climate zones. In the case of air conditioners, the off mode period includes all non-cooling-season hours, so there is more variation across the nation. However, for the majority of the U.S. population, the off mode period is close to the test procedure rating value.

DOE does not include in the off mode period the time during the cooling season when a unit cycles off, because energy use during this period is captured in the seasonal SEER rating of the equipment. Similarly, DOE does not include in the off mode period the time during the heating season when a heat pump cycles off, because energy use during this period is captured in the seasonal HSPF rating of the equipment. To avoid double counting the benefits of design options which reduce energy consumption when equipment cycles off, DOE has defined the off mode time period for the energy analysis to be consistent with the operating periods used for the SEER and HSPF ratings

The component that uses the most power during off mode is the crankcase heater, but it is not found in all products. DOE established annual off mode energy use estimates for air conditioners and heat pumps using each considered off mode technology option for units with and without crankcase heaters.

DOE was not able to identify a data source establishing the fraction of central air conditioner or heat pump products in the U.S. market that would be tested with crankcase heaters or would be expected to have crankcase heaters installed in the field. However, a 2004 study of the Australian market estimated that one in six central air conditioners in that market utilized crankcase heaters.[55] Given that the need to provide for compressor protection for central air conditioners is driven by similar refrigerant migration concerns during cool weather, DOE estimated that the use of crankcase heaters in Australia was roughly similar to that in the U.S. at that time. DOE estimated that changes in compressor technology since 2004, in particular market growth in the use of scroll compressors, have likely reduced the fraction of the central air conditioner market with crankcase heaters. Based on the above considerations, for the direct final rule analysis, DOE assumed that 10 percent of central air conditioners within each air conditioner product class would utilize crankcase heaters. Discussion during manufacturer interviews and review of product literature suggest that crankcase heaters are most commonly used in heat pumps, which must be able to cycle on in cold weather. DOE assumed that two-thirds of heat pumps would utilize crankcase heaters in each heat pump product class.

[55] Australian Greenhouse Office, "Air Conditioners Standby Product Profile 2004/2006" (June 2004) (Available at: http://www.energyrating.gov.au/library/pubs/sb200406-aircons.pdf).

Because the technology options examined do not impact blower energy consumption in off mode, DOE determined that energy savings from equipment utilizing ECM or PSC blower motors would be identical for each off mode technology option.

See chapter 7 in the direct final rule TSD for additional detail on the energy analysis and results for central air conditioner and heat pump off mode operation.

b. Furnaces

As described in section IV.C.7, DOE analyzed two efficiency levels that reflect the design options for furnaces with ECM blower motors. The energy use calculations account only for the portion of the market with ECM blower motors, because the power use of furnaces with PCS motors is already below the power limits being considered for standby mode and off mode power, and, thus, would be unaffected by standards.

To project the market share of furnaces with ECM blower motors, for non-weatherized gas furnaces DOE relied on market research data from studies conducted in Vancouver, Canada[56] and the State of Oregon.[57] From these data, DOE estimated that non-weatherized gas furnaces with ECMs comprise approximately 29 percent of the market. For oil-fired, mobile home gas, and electric furnaces, DOE estimated that furnaces with ECMs comprise 10 percent of the market.

[56] Hood, Innes, "High Efficiency Furnace Blower Motors Market Baseline Assessment" (March 31, 2004) (Available at: http://www.cee1.org/eval/db_pdf/416.pdf).
[57] Habart, Jack, "Natural Gas Furnace Market Assessment" (August 2005) (Available at: http://www.cee1.org/eval/db_pdf/434.pdf).

DOE calculated furnace standby mode and off mode electricity consumption by multiplying the power consumption at each efficiency level by the number of standby mode and off mode hours. To calculate the annual number of standby mode and off mode hours for each sample household, DOE subtracted the estimated burner operating hours (calculated as described in section IV.E.2) from the total hours in a year (8,760).

Commenting on the furnaces RAP, Ingersoll Rand stated that standby mode and off mode power should not be included in DOE's calculation of furnace energy consumption during the cooling season, when the furnace may provide power for a central air conditioner. (Ingersoll Rand, No. 1.3.006 at p. 9) In response, DOE would clarify that for homes that have both a furnace and a split central air conditioner, during the cooling season, the furnace blower controls operate in standby mode and off mode in conjunction with the air conditioner, but such energy consumption is not accounted for in the energy use calculation for the air conditioner. Therefore, DOE included this energy use in the calculation of furnace standby mode and off mode energy use.

See chapter 7 in the direct final rule TSD for additional detail on the energy analysis and results for furnace standby mode and off mode operation.

F. Life-Cycle Cost and Payback Period Analyses

DOE conducts LCC and PBP analyses to evaluate the economic impacts on individual consumers of potential energy conservation standards for furnaces and central air conditioners and heat pumps. The LCC is the total consumer expense over the expected life of a product, consisting of purchase and installation costs plus operating costs (expenses for energy use, maintenance, and repair). To compute the operating costs, DOE discounted future operating costs to the time of purchase and summed them over the expected lifetime of the product. The PBP is the estimated amount of time (in years) it takes consumers to recover the increased purchase cost (including installation) of a more-efficient product through lower operating costs. DOE calculates the PBP by dividing the change in purchase cost (normally higher) due to a more-stringent standard by the change in average annual operating cost (normally lower) that results from the standard.

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

For each considered efficiency level in each product class, DOE calculated the LCC and PBP for a nationally-representative set of housing units. As discussed in section IV.E, DOE developed household samples from the 2005 RECS. For each sampled household, DOE determined the energy consumption for the furnace, central air conditioner, or heat pump and the appropriate energy prices in the area where the household is located. By developing a representative sample of households, the analysis captured the variability in energy consumption and energy prices associated with the use of residential furnaces, central air conditioners, and heat pumps.

Inputs to the calculation of total installed cost include the cost of the product—which includes manufacturer costs, 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, expected product lifetimes, discount rates, and the year in which compliance with new or amended standards is required. DOE created distributions of values for some inputs to account for their uncertainty and variability. Specifically, DOE used probability distributions to characterize product lifetime, discount rates, and sales taxes.

The computer model DOE uses to calculate the 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 sample input values from the probability distributions and furnace and central air conditioner and heat pump user samples. The model calculated the LCC and PBP for products at each efficiency level for 10,000 housing units per simulation run. Details of the LCC spreadsheet model, and of all the inputs to the LCC and PBP analyses, are contained in TSD chapter 8 and its appendices.

Table IV.10 and Table IV.11 summarize the inputs and methods DOE used for the LCC and PBP calculations for furnaces and central air conditioners and heat pumps, respectively. For central air conditioners and heat pumps, the table provides the data and approach DOE used for the preliminary TSD and the changes made for today's direct final rule. For furnaces, DOE has not conducted a preliminary analysis, so there are no changes to describe. The subsections that follow discuss the initial inputs and the changes DOE made to them.

Table IV.10 Summary of Inputs and Methods for the LCC and PBP Analysis for Furnaces*

Inputs	Direct Final Rule
Installed Product Costs	
Product Cost	Derived by multiplying manufacturer cost by manufacturer and retailer markups and sales tax, as appropriate. Used experience curve fits to develop a price scaling index to forecast product costs.
Installation Cost	Derived from RS Means data for 2010, the furnace installation model developed for the November 2007 Rule, and consultant reports.
Operating Costs	
Annual Energy Use	Used household sample from 2005 RECS data.
Energy Prices	Natural Gas: Based on EIA's Natural Gas Monthly data for 2009. Electricity: Based on EIA's Form 861 data for 2008. LPG and Oil: Based on data from EIA's State Energy Data System (SEDS) 2008. Variability: Separate energy prices determined for 13 geographic areas.
Energy Price Trends	Forecasted using AEO2010 data at the Census division level.
Repair and Maintenance Costs	Costs for annual maintenance derived using data from a proprietary consumer survey. Repair costs based on Consumer Reports data on frequency of repair for gas furnaces in 2000-06, and estimate that an average repair has a parts cost equivalent to one-fourth of the equipment cost.
Present Value of Operating Cost Savings	
Product Lifetime	Estimated using survey results from RECS (1990, 1993, 1997, 2001, 2005) and the U.S. Census American Housing Survey (2005, 2007), along with historic data on appliance shipments. Variability: characterized using Weibull probability distributions.
Discount Rates	Approach involves identifying all possible debt or asset classes that might be used to purchase the considered appliances, or might be affected indirectly. Primary data source was the Federal Reserve Board's Survey of Consumer Finances for 1989, 1992, 1995, 1998, 2001, 2004 and 2007.
Compliance Date of Standard	2016.

* References for the data sources mentioned in this table are provided in the sections following the table or in chapter 8 of the direct final rule TSD.

Table IV.11 Summary of Inputs and Methods for the LCC and PBP Analysis for Central Air Conditioners and Heat Pumps*

Inputs	Preliminary TSD	Changes for the Direct Final Rule
Installed Product Costs		
Product Cost	Derived by multiplying manufacturer cost by manufacturer and retailer markups and sales tax, as appropriate.	Incremental retail markup changed as described in section IV.D. Additional multi-speed fan kit cost added for coil only air conditioners at 15 SEER and above. Used experience curve fits to develop a price scaling index to forecast product costs.
Installation Cost	National average cost of installation derived from RS Means data for 2008, adjusted for regional labor price differences. Does not change with efficiency level or equipment size.	Derived from RS Means data for 2009. Does not change with efficiency level or equipment size.
Operating Costs		
Annual Energy Use	Residential: Derived using household sample from 2005 RECS data and reported energy use for space heating and cooling. Commercial: Derived using whole building simulations.	No change in approach.
Energy Prices	Electricity: Marginal and average prices based on residential and commercial electricity tariffs for 90 electric utilities in the Lawrence Berkeley National Lab Tariff Analysis Project database. Commercial prices incorporate demand and time of use rates calculated based on hourly electricity consumption.	No change in approach.
Energy Price Trends	Forecasted using the April 2009 update to Annual Energy Outlook 2009 (AEO2009).	Forecasts updated using AEO2010 forecasts at the Census division level.
Repair and Maintenance Costs	Repair and maintenance costs calculated for 3-ton (36,000 Btu/hr) units. Varies with efficiency level of equipment.	Repair costs calculated for 3-ton (36,000 Btu/hr) units. Varies with efficiency level and size of equipment (2-ton, 3-ton, or 5-ton). Preventative maintenance cost assumed to not vary with efficiency or size of equipment.

Present Value of Operating Cost Savings		
Product Lifetime	Estimated using survey results from RECS (1990, 1993, 1997, 2001, 2005) and the U.S. Census American Housing Survey (2005, 2007), along with historic data on appliance shipments. Variability: characterized using Weibull probability distributions.	No change.
Discount Rates	Approach involves identifying all possible debt or asset classes that might be used to purchase the considered appliances, or might be affected indirectly. Primary data source was the Federal Reserve Board's Survey of Consumer Finances for 1989, 1992, 1995, 1998, 2001, 2004 and 2007. For commercial installations used weighted average cost of capital derived from Value-Line listed firms at Damodaran Online website for 2008.	No change to residential rates. Commercial discount rates updated to 2009, using Damodaran Online for January 2010 and revised values for risk-free rates and market risk factor.
Compliance Date of New Standard	2016.	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 direct final rule TSD.

As discussed in section IV.E, DOE is taking into account the rebound effect associated with more-efficient residential furnaces, central air conditioners, and heat pumps. The take-back in energy consumption associated with the rebound effect provides consumers with increased value (e.g., enhanced comfort associated with a cooler or warmer indoor environment). The net impact on consumers is the sum of the change in the cost of owning the space-conditioning equipment (i.e., life-cycle cost) and the increased value of the more comfortable indoor environment. DOE believes that, if it were able to monetize the increased value to consumers of the rebound effect, this value would be similar in value to the foregone energy savings. Thus, for this standards rulemaking, DOE assumes that this value is equivalent to the monetary value of the energy savings that would have occurred without the rebound effect. Therefore, the economic impacts on consumers with or without the rebound effect, as measured in the LCC analysis, are the same.

1. Product Cost

To calculate the consumer product cost at each considered efficiency level, DOE multiplied the manufacturer costs developed in the engineering analysis by the supply-chain markups described above (along with applicable average sales taxes). For wholesalers and contractors, DOE used different markups for baseline products and higher-efficiency products, because DOE applies an incremental markup to the cost increase associated with higher-efficiency products.

During the direct final rule analysis, DOE determined that split-system coil-only air conditioners rated at or above 15 SEER often have two stages of cooling capacity. Realizing the full efficiency of the product would require a fan that can operate at multiple speeds. DOE included a cost for a “multi-speed fan kit” that could be used to adapt the existing furnace fan for two-speed cooling operation. DOE estimated the kit cost to the consumer at $798 on a national average basis. DOE applied this cost to half of the split system, coil-only installations at 15 SEER, and all of the installations at 15.5 SEER.

On February 22, 2011, DOE published a Notice of Data Availability (NODA, 76 FR 9696) stating that DOE may consider improving regulatory analysis by addressing equipment price trends. Consistent with the NODA, DOE sought to apply the experience curve approach to this rulemaking. To do so, DOE used historical shipments data together with historical producer price indices (PPI) for unitary air conditioners and warm-air furnace equipment. DOE recognizes the limitations of PPI as a proxy for manufacturing costs because it represents wholesale price.[58] However, the agency determined that even with this limitation, the use of PPI may offer some directionally-correct information related to the experience curve approach. DOE believes that the PPI data may indicate long-term declining real price trends for both products. Thus, DOE used experience curve fits to develop price scaling indices to forecast product costs for this rulemaking.

DOE also considered the public comments that were received in response to the NODA and refined its experience curve trend forecasting estimates. Many commenters were supportive of DOE moving from an assumption-based equipment price trend forecasting method to a data-driven methodology for forecasting price trends. Other commenters were skeptical that DOE could accurately forecast price trends given the many variables and factors that can complicate both the estimation and the interpretation of the numerical price trend results and the relationship between price and cost. DOE evaluated these concerns and determined that retaining the assumption-based approach is consistent when there are data gaps with the historical data for the products covered in

[58] U.S. Department of Labor, Bureau of Labor Statistics Handbook of Methods (Available at: http://www.bls.gov/opub/hom/homch14.htm).

this rule. As a result, DOE is presenting a range of estimates reflecting both the assumption-based approach and the experience curve approach.

DOE also performed an initial evaluation of the possibility of other factors complicating the estimation of the long-term price trend, and developed a range of potential price trend values that was consistent with the available data and justified by the amount of data that was available to DOE at this time. DOE recognizes that its price trend forecasting methods are likely to be modified as more data and information becomes available to enhance the statistical certainty of the trend estimate and the completeness of the model. Additional data should enable an improved evaluation of the potential impacts of more of the factors that can influence equipment price trends over time.

To evaluate the impact of the uncertainty of the price trend estimates, DOE performed price trend sensitivity calculations in the national impact analysis to examine the dependence of the analysis results on different analytical assumptions. DOE also included a constant real price trend assumption. DOE found that for the selected standard levels the benefits outweighed the burdens under all scenarios.

A more detailed discussion of DOE's development of price scaling indices is provided in appendix 8-J of the direct final rule TSD.

Comment [A8]: Change recommended by OIRA.

2. Installation Cost

Installation cost includes labor, overhead, and any miscellaneous materials and parts needed to install the equipment.

a. Central Air Conditioners and Heat Pumps

In its central air conditioners and heat pumps preliminary analysis, DOE calculated average installation costs for each class of equipment based on installation costs found in RS Means.[59] In the preliminary analysis, installation costs were assumed constant across efficiency levels, based on reported practices of installers in a limited telephone survey.

Commenting on the above approach, Carrier suggested that DOE further explore the variation in installation costs by efficiency level, because when an installation project changes from one-man to a two-man job because of the size of the unit, this change will impact contractor installation costs. (CAC: Carrier, Public Meeting Transcript at p. 140)

For the direct final rule analysis, DOE conducted some additional interviews with mechanical contractor/installers and learned that while some contractors use one-man crews for SEER 13 installations, generally two-man crews are dispatched. If extra labor is required beyond a two-man crew to move heavy components, additional laborers are brought to the site for the few minutes they are needed, resulting in minimal (less than $15) labor cost increase. Further, installation contractors reported that while installation costs vary due to specific differences among installation sites, they do not generally vary

[59] RS Means, Residential Cost Data 2010, Reed Construction Data, Kingston, MA.

by efficiency level. Larger equipment is needed to move some of the larger 5-ton units, but investments in such equipment generally have been made already. Installation labor costs differ by less than 20 percent between 2-ton or 3-ton units and the larger 5–ton units. The primary reason for the difference in installation cost is not related to the greater weight of 5-ton systems, but rather to the greater effort required to install larger duct systems and longer refrigeration line sets, which are not within the scope of the rulemaking. Therefore, DOE concluded that installation cost for central air conditioners and heat pumps generally does not increase with the efficiency or the size of equipment, so it retained the approach used in the preliminary analysis. DOE did include additional installation costs of $161 for the multi-speed fan kit used for split system coil-only air conditioners with ratings at 15 SEER and above.

b. Furnaces

In the furnaces RAP, DOE stated that it will: (1) estimate installation costs at each considered efficiency level using a variety of sources, including RS Means, manufacturer literature, and information from expert consultants; (2) account for regional differences in labor costs; and (3) estimate specific installation costs for each sample household based on building characteristics set forth in the 2005 RECS.

DOE received a number of comments concerning installation costs when a non-condensing furnace is replaced with a condensing furnace. AGA and APGA stated that DOE should consider important differences in classes of consumers, particularly northern consumers having to replace a non-condensing furnace with a condensing furnace. (FUR:

AGA, No.1.3.010 at p. 4; APGA, No.1.3.004 at p. 4) APGA and NPGA stated that DOE must consider venting issues and other considerations unique to the replacement market. (FUR: APGA, No.1.3.004 at p. 4; NPGA, No.1.3.005 at p. 3)

Several parties provided comments regarding the need for venting system modification when replacing a non-condensing furnace with a condensing gas furnace. Several comments referred to the venting considerations when installation of a condensing furnace no longer permits common venting with the pre-existing gas water heater. Ingersoll Rand stated that when a non-condensing furnace is replaced with a condensing furnace, the rework of gas appliance venting will add considerable cost; according to the commenter, it will have to include the cost of a dedicated vent for the condensing furnace, plus reworking the venting for a water heater, which was most likely on a common vent that will now be too large for the water heater. (FUR: Ingersoll Rand, No. 1.3.006 at p. 12) AGA, APGA, and NPGA made similar comments. (FUR: AGA, No. 1.3.010 at pp. 3 - 4; AGA, No. 1.2.006 at p. 41; APGA, No. 1.3.004 at p. 4; NPGA, No. 1.3.005 at p. 3) AGA added that DOE must also consider consumer and installer behaviors that favor inadequate venting system attention aimed at reducing installation costs; AGA cautioned that such practices may represent code violations, as well as threats to consumer safety from carbon monoxide poisoning, due to improper venting or venting system failure. (FUR: AGA, No. 1.3.010 at p. 3) HARDI stated that there are significant portions of existing gas furnace installations that could not use a condensing furnace without performing major renovations to the building. (FUR: HARDI, No. 1.3.016 at p. 3) ACCA stated that in a recent ACCA member survey, a majority of respondents said that 15-30 percent of furnace retrofits in the north would only accommodate non-condensing furnaces due to vent path issues or concerns about freezing condensate. (FUR: ACCA, No. 1.3.007 at pp. 3–4)

In contrast to some of the above comments, AHRI and Rheem stated that the venting issues resulting from the "orphaned" gas water heater can be resolved through power venting and new venting systems. (FUR: AHRI, No. 1.3.008 at p. 4; Rheem, No.1.3.022 at p. 4)

In response to these comments, for the direct final rule analysis, DOE conducted a detailed analysis of installation costs when a non-condensing gas furnace is replaced with a condensing gas furnace, with particular attention to venting issues in replacement applications. DOE gave separate consideration to the cost of installing a condensing gas furnace in new homes. As part of its analysis, DOE used information in the 2005 RECS to estimate the location of the furnace in each of the sample homes.

First, DOE estimated basic installation costs that are applicable to both replacement and new home applications. These costs, which apply to both condensing and non-condensing gas furnaces, include putting in place and setting up the furnace, gas piping, ductwork, electrical hookup, permit and removal/disposal fees, and where applicable, additional labor hours for an attic installation.

For replacement applications, DOE then included a number of additional costs ("adders") for a fraction of the sample households. For non-condensing gas furnaces, these additional costs included updating flue vent connectors, vent resizing, and chimney relining. For condensing gas furnaces, DOE included new adders for flue venting (PVC), combustion air venting (PVC), concealing vent pipes, addressing an orphaned water heater (by updating flue vent connectors, vent resizing, or chimney relining), and condensate removal. Freeze protection is accounted for in the cost of condensate removal. Table IV.12 shows the fraction of installations impacted and the average cost for each of the adders. The estimate of the fraction of installations impacted was based on the furnace location (primarily derived from information in the 2005 RECS) and a number of other sources that are described in chapter 8 of the direct final rule TSD. The costs were based on 2010 RS Means. Chapter 8 of the direct final rule TSD describes in detail how DOE estimated the cost for each installation item.

Table IV.12 Additional Installation Costs for Non-Weatherized Gas Furnaces in Replacement Applications

Installation Cost Adder	Replacement Installations Impacted	Average Cost (2009$)
	Non-Condensing Furnaces	
Updating Flue Vent Connectors	7%	$211
Vent Resizing	1%	$591
Chimney Relining	16%	$591
	Condensing Furnaces	
New Flue Venting (PVC)	100%	$308
Combustion Air Venting (PVC)	60%	$301
Concealing Vent Pipes	5%	$290
Orphaned Water Heater	24%	$447
Condensate Removal	100%	$49

DOE also included installation adders for fractions of new home applications. For non-condensing gas furnaces, a new flue vent (metal) is the only adder. For condensing gas furnaces, the adders include new flue venting (PVC), combustion air venting (PVC), accounting for a commonly-vented water heater, and condensate items. Table IV.13 shows the estimated fraction of new home installations impacted and the average cost for each of the adders. For details, see chapter 8 of the direct final rule TSD.

Table IV.13 Additional Installation Costs for Non-Weatherized Gas Furnaces in New Home Applications

Installation Cost Adder	New Construction Installations Impacted	Average Cost (2009$)
	Non-Condensing Furnaces	
New Flue Vent (Metal)	100%	$818
	Condensing Furnaces	
New Flue Venting (PVC)	100%	$249
Combustion Air Venting (PVC)	60%	$240
Accounting for Commonly Vented WH	50%	$402
Condensate Removal	100%	$7

Several parties provided comments regarding special considerations for installing condensing gas furnaces in manufactured homes. AGA, AGPA, and NPGA stated that replacement installation costs need to consider either: (1) freeze protection from condensate in the furnace as well as in the condensate handling system; or (2) altering the closet insulation system to put the furnace within the thermal boundary of the manufactured home. (FUR: AGA, No. 1.3.010 at p. 5; APGA, No. 1.3.004 at p. 4; NPGA, No. 1.3.005 at p. 4) ACEEE stated that furnace manufacturers signed the consensus agreement and, therefore, foresaw no problems with use of their condensing products in manufactured housing. ACEEE added that applicable codes require that furnaces in manufactured housing be installed in separate cabinets with outdoor air supply, which makes retrofitting with a condensing furnace relatively easy. (FUR: ACEEE, No. 1.3.009 at p. 8)

For the direct final rule analysis, DOE included basic installation costs for manufactured home gas furnaces similar to those described above for non-weatherized gas furnaces. DOE also included costs for venting and condensate removal. Freeze protection is accounted for in the cost of condensate removal. In addition, DOE considered the cost of dealing with space constraints that could be encountered when a condensing furnace is installed.

For oil-fired furnaces, DOE included basic installation costs similar to those described above for non-weatherized gas furnaces. DOE also included costs for venting (including stainless steel vent for some installations at 83-85 percent AFUE) and condensate removal. In addition, DOE assumed that condensing furnaces require two additional labor hours to tune up the combustion system. For further details on installation costs for both manufactured home gas furnaces and oil-fired furnaces, see chapter 8 of the direct final rule TSD.

3. Annual Energy Consumption

For each sample household, DOE determined the energy consumption for a furnace, central air conditioner, or heat pump at different efficiency levels using the approach described above in section IV.E.

4. Energy Prices

In its central air conditioners and heat pumps preliminary analysis, DOE developed marginal electricity prices to express the value of electricity cost savings from more-efficient central air conditioners and heat pumps. The marginal electricity price for a given consumer is the cost of the next increment of electricity use on his or her utility bill, and is the correct estimate of the value of savings that a consumer would see in the real world.

DOE developed residential marginal electricity prices from tariffs collected in 2008 from a representative sample of electric utilities throughout the United States. DOE collected data for over 150 residential tariffs from a sample of about 90 electric utilities. As described earlier, DOE developed samples of households using central air conditioners and heat pumps from the 2005 RECS. The location of each household can be identified within broad geographic regions (e.g., Census Divisions). DOE developed a weighted-average marginal electricity price for each household from all the possible utility tariffs that could be assigned to that household. DOE also developed commercial marginal electricity prices from tariffs for those commercial building applications that use residential central air conditioners and heat pumps. As with the residential household sample, DOE developed a weighted-average marginal electricity price for each commercial building from the utility tariffs that could possibly be assigned to that building. For further details, see chapter 8 of the direct final rule TSD.

Commenting on the central air conditioners and heat pumps preliminary TSD, the Joint Comment stated that the current impact analysis does not account for time-dependent valuation (TDV) of electricity,[60] which is expected to change significantly by 2015 due to smart grid technology. (CAC: CA IOUs, No. 69 at p. 5) PG&E stated that time-of-use (TOU) tariffs are going to be present and important with respect to the impact of the standards on these products. (CAC: PG&E, Public Meeting Transcript at p. 113)

In response, DOE determined in its preliminary analysis that many utilities in the U.S. offer optional time-of-use (TOU) tariffs that generally charge consumers more for electricity during peak periods, when it presumably costs the utility more to provide electrical service, in exchange for lower rates at other times. To determine the effect of TOU pricing structures on residential consumers, DOE collected data on TOU tariffs for those utilities in its sample that offered optional TOU tariffs. DOE found that approximately 50 percent of customers in the sample were offered TOU tariffs. Coupling hourly energy savings derived from typical residential household and central air conditioner/heat pump load profiles with TOU tariffs, DOE was able to derive TOU-based marginal electricity prices. These data show that, currently, there is no significant difference (on average less than 2 percent) between TOU and default tariffs for the

[60] TDV accounts for variations in electricity cost related to time of day, season, and geography. The concept behind TDV is that savings associated with energy efficiency measures should be valued differently at different times to better reflect the actual costs to users, the utility system, and society.

electricity costs used in the LCC and PBP analysis.

The consensus agreement includes EER standards in addition to SEER requirements in the hot-dry region for split-system and single-package central air conditioners. Efficiency requirements that would improve the EER of a central air conditioner in the hot-dry region are believed to improve the performance of the equipment at peak conditions when the equipment is operating at its full capacity. Because the TOU tariffs in hot-dry climates are likely to yield higher electricity prices during peak conditions, DOE placed renewed focus on deriving TOU-based marginal prices for the hot-dry region. DOE also investigated the impact of TDV of electricity in the hot-dry region, given that the most populous State in the region (California) has used TDV of electricity to evaluate efficiency measures in updates to its building code standards. TOU-based and TDV-based marginal prices are not significantly different from the marginal prices derived from default tariffs. Therefore, DOE determined that they would not have a significant effect on the economic justification of more-stringent efficiency standards. Appendix 8-D of the direct final rule TSD describes the analysis that compares marginal prices developed from TOU tariffs and TDV of electricity with marginal prices developed from non-TOU tariffs.

For commercial-sector prices, the existing tariff structures that DOE has used in it analysis of electricity prices already account for the effect that an end use, such as central air conditioning, has on marginal electricity prices. Because utilities bill their commercial customers with demand charges (i.e., charges on power demand expressed in $/kW) in addition to energy charges, the resulting marginal prices reflect the contribution that air conditioning has on peak demand.

In the furnaces RAP, DOE stated that it will derive average monthly energy prices using recent EIA data for each of 13 geographic areas, consisting of the nine U.S. Census divisions, with four large States (New York, Florida, Texas, and California) treated separately, to establish appropriate energy prices for each sample household. It added that in contrast to the situation with residential air conditioner and heat pumps, for which the appliance's load primarily occurs during utility peak periods during the summer, electricity consumption of furnaces is not concentrated during peak periods, so DOE did not see a compelling reason to use marginal electricity prices.

Commenting on the furnaces RAP, Ingersoll Rand stated that DOE's intention to use average, not marginal, energy prices for the furnace LCC analysis is reasonable and avoids much unnecessary complexity. Ingersoll Rand further stated that, to improve accuracy, DOE should use State-level energy prices rather than prices determined according to Census division. (FUR: Ingersoll Rand, No. 1.3.006 at p. 11) In response, DOE agrees that average energy prices are appropriate for the furnace LCC analysis for the reason described above. DOE does not use State-level energy prices in its analyses, because the location of each sample household in the 2005 RECS dataset can be identified only within broad geographic regions. Thus, it would not be possible to make use of State-level energy prices in the LCC and PBP analysis. Accordingly, for the direct final rule analysis of furnaces, DOE derived average energy prices for the 13 geographic areas mentioned above. For Census divisions containing one of these large States, DOE calculated the regional average excluding the data for the large State.

DOE calculated average residential electricity prices for each of the 13 geographic areas using data from EIA's Form EIA-861 Database (based on "Annual Electric Power Industry Report").[61] DOE calculated an average annual regional residential price by: (1) estimating an average residential price for each utility (by dividing the residential revenues by residential kilowatt-hour sales); and (2) weighting each utility by the number of residential consumers it served in that region. The direct final rule analysis used the data available for 2008.

DOE calculated average residential natural gas prices for each of the 13 geographic areas using data from EIA's "Natural Gas Monthly."[62] DOE calculated average annual regional residential prices by: (1) estimating an average residential price for each State; and (2) weighting each State by the number of residential consumers. The direct final rule analysis used the data for 2009.

DOE estimated average residential liquefied petroleum gas (LPG) and oil prices for each of the 13 geographic areas based on data from EIA's State Energy Data System (SEDS) 2008.[63]

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[61] Available at: http://www.eia.doe.gov/cneaf/electricity/page/eia861.html.
[62] Available at: http://www.eia.gov/oil_gas/natural_gas/data_publications/natural_gas_monthly/ngm.html.
[63] Table S2a, Residential Sector Energy Price Estimates by Source (June 2010) (Available at: http://www.eia.doe.gov/emeu/states/_seds.html).

For each of the above energy forms, DOE disaggregated the annual energy prices into monthly prices using factors that relate historical prices for each month to the average annual prices.

5. Energy Price Projections

To estimate energy prices in future years for the central air conditioners and heat pumps preliminary TSD, DOE multiplied the average marginal electricity prices in each of the 13 geographic areas by the forecast of annual average residential or commercial electricity price changes in the Reference Case[64] derived from AEO2009. In the furnaces RAP, DOE stated its intention to use projections of national average natural gas, LPG, electricity, and fuel oil prices for residential consumers to estimate future energy prices, and to use the most recent available edition of the AEO.

Commenting on the furnaces RAP, Ingersoll Rand stated that using national-average price changes to forecast future energy prices may distort the regional results. (FUR: Ingersoll Rand, No. 1.3.006 at p. 9) In response, DOE agrees that using regional energy price forecasts is appropriate for the analysis in this rulemaking. For today's rule, for central air conditioners and heat pumps as well as furnaces, DOE developed electricity price forecasts for the considered geographic areas using the forecasts by Census division for residential and commercial heating and cooling end uses from AEO2010. To estimate the electricity price trend after 2035 (the end year in AEO2010 projections) and through 2060, DOE assumed that prices would rise at the average annual

[64] The spreadsheet tool that DOE used to conduct the LCC and PBP analyses allows users to select price forecasts from either AEO's High Economic Growth or Low Economic Growth Cases. Users can thereby estimate the sensitivity of the LCC and PBP results to different energy price forecasts.

rate of change from 2020 to 2035 forecasted in AEO2010. To estimate the trends in natural gas, LPG, and fuel oil prices after 2035 and through 2060, DOE assumed that prices would rise at the average annual rate of change from 2020 to 2035 forecasted in AEO2010. DOE intends to update its energy price forecasts for the final rule based on the latest available AEO.

6. Maintenance and Repair Costs

Repair costs are associated with repairing or replacing components that have failed in the appliance, whereas maintenance costs are associated with maintaining the proper operation of the equipment.

a. Central Air Conditioners and Heat Pumps

In its central air conditioners and heat pumps preliminary analysis, DOE used RS Means and industry literature to obtain estimates of average repair costs and preventative maintenance costs. Both costs were scaled proportionately with equipment price for higher-efficiency equipment. DOE did not receive any significant comments on its procedure or findings. However, after further review, DOE determined that the actual functions carried out as part of annual preventative maintenance (such as coil cleaning or checking of system pressures) are tasks that are not affected by the cost of the equipment and, thus, would not be more expensive as efficiency increased. Therefore, for the direct final rule, maintenance costs were held constant as efficiency increased.

b. Furnaces

In the furnaces RAP, DOE stated that it will: (1) estimate maintenance and repair costs at each considered efficiency level using a variety of sources, including RS Means, manufacturer literature, and information from expert consultants; and (2) account for regional differences in labor costs. DOE did not receive any significant comments on this topic.

For the direct final rule, DOE estimated costs for annual maintenance using data from a proprietary consumer survey[65] on the frequency with which owners of different types of furnaces perform maintenance. For condensing oil furnaces, the high quantity of sulfur in the fuel results in frequent cleaning of the secondary heat exchanger, and DOE accounted for this cost.

DOE estimated that about three percent of furnaces are repaired annually based on Consumer Reports data on frequency of repair for gas furnaces installed between 2000 and 2006.[66] DOE assumed that an average repair has a parts cost equivalent to one-fourth of the equipment cost, marked up by a factor of two, and requires 1.5 hours of labor.

7. Product Lifetime

In the central air conditioners and heat pumps preliminary analysis, DOE conducted an analysis of actual product lifetime in the field using a combination of

65 Decision Analysts, "2008 American Home Comfort Study" (2009).

66 Consumer Reports, "Brand Repair History: Gas furnaces" (Jan. 2008) (Available at: http://www.consumerreports.org/cro/appliances/heating-cooling-and-air/gas-furnaces/furnaces-repair-history-205/overview/index.htm).

shipments data, responses in RECS on the age of household central air conditioner and heat pump products, and total installed stock data in the U.S. Census's American Housing Survey (AHS).[67] DOE used RECS data from surveys conducted in 1990, 1993, 1997, 2001, and 2005. DOE used AHS data from surveys conducted every other year from 1991 to 2007. By combining the results of RECS and AHS with the known history of appliance shipments, DOE estimated the percentage of central air conditioner and heat pump products of a given age still in operation. This analysis yielded distributions with a mean life of 19 years for central air conditioners and 16.3 years for heat pumps.

Commenting on the central air conditioners and heat pumps preliminary TSD, Southern stated that the impact of the hydrochlorofluorocarbon (HCFC) R22 refrigerant phase-out on equipment lifetimes needs to be considered. (CAC: SCS, No. 73 at p. 4) By way of background, effective January 1, 2010, the Montreal Protocol requires the U.S. to reduce its consumption of HCFCs by 75 percent below the U.S. baseline cap. As of January 1, 2010, HVAC system manufacturers may only produce or import HCFC-22 to service existing equipment. Virgin HCFC-22 may not be used in new equipment. As a result, HVAC system manufacturers may not produce new air conditioners and heat pumps containing HCFC-22. The timeline for the phase-out of HCFC-22 in new equipment has been known since the mid-1990s. Since that time, the industry has sponsored considerable research into the development of refrigerant alternatives with zero ozone depletion potential, and they eventually settled on R-410a as a replacement. Manufacturers have been producing products that utilize R-410a for the past decade in anticipation of the 2010 phase-out date. DOE concluded that given the lead time

[67] Available at: http://www.census.gov/hhes/www/housing/ahs/ahs.html.

accorded to the industry, and the fact that these products are widely distributed in the market, products manufactured with R-410a provide the same level of utility and performance, including product lifetime, as equipment utilizing HCFC-22.

In the furnaces RAP, DOE stated its intention to use an approach based on an analysis of furnace lifetimes in the field using a combination of shipments data, the stock of furnaces, RECS data on the age of the furnaces in the surveyed homes, and AHS data on the total installed furnace stock. The same survey years were utilized to determine furnace lifetimes as were used for central air conditioners and heat pumps. Commenting on the furnaces RAP, Ingersoll Rand requested that DOE review and refine its lifetime estimate for gas furnaces, because the often-cited 18-year to 20-year lifetime may be unrealistically long. Instead, Ingersoll Rand stated that the mean population life expectancy for furnaces is probably in the range of 15-20 years. (FUR: Ingersoll Rand, No. 1.3.006 at pp. 8 & 10)

For the direct final rule analysis, DOE derived probability distributions ranging from minimum to maximum lifetime for the products considered in this rulemaking. For central air conditioners and heat pumps, DOE used the same approach as it did in the preliminary analysis. For furnaces, it used the approach described in the RAP. The mean lifetimes estimated for the direct final rule are 23.6 years for non-weatherized gas furnaces, 18.7 years for mobile home gas furnaces, and 29.7 years for oil-fired furnaces. Regarding the comment by Ingersoll Rand, DOE believes that the method DOE used is reasonable because it relies on data from the field on furnace lifetimes. DOE was not able to substantiate the validity of the life expectancy mentioned by Ingersoll Rand, because the commenter did not provide any corroborating data in its comment.

Chapter 8 of the direct final rule TSD provides further details on the methodology and sources DOE used to develop product lifetimes.

8. Discount Rates

In the calculation of LCC, DOE applies discount rates to estimate the present value of future operating costs.

In its central air conditioners and heat pumps preliminary analysis, to establish consumer (residential) discount rates for the LCC analysis, DOE identified all debt or asset classes that might be used to purchase major appliances or that might be affected indirectly. It estimated the average percentage shares of the various debt or asset classes for the average U.S. household using data from the Federal Reserve Board's Survey of Consumer Finances (SCF) for a number of years.[68] Using the SCF and other sources, DOE then developed a distribution of rates for each type of debt and asset to represent the rates that may apply in the year in which amended standards would take effect. For the purchase of products for new homes, which are included in the sales price of the home, DOE uses finance costs based on a distribution of mortgage rates. DOE assigned each sample household a specific discount rate drawn from the distributions.

[68] Available at: http://www.federalreserve.gov/pubs/oss/oss2/scfindex.html. The surveys used range from 1989 to 2007.

In the central air conditioners and heat pumps preliminary analysis, DOE developed commercial discount rates based on the weighted average cost of capital (WACC) calculated for commercial businesses expected to occupy small commercial buildings. For the commercial cost of capital data, DOE relied on financial data found in the Damodaran Online website as of January 2009 (since updated to January 2010). In the furnaces RAP, DOE stated its intention to use the same approach for furnaces as it used in the central air conditioners and heat pumps preliminary analysis.

DOE did not receive any significant comments on consumer discount rates. Therefore, for the direct final rule, DOE used the same approach as it used in the central air conditioners and heat pumps preliminary analysis, with minor modifications to the estimation of risk-free rates and risk premiums that are needed to calculate WACC. See chapter 8 in the direct final rule TSD for further details on the development of discount rates for the LCC analysis.

9. Compliance Date of Amended Standards

In the context of EPCA, the compliance date is the future date when parties subject to a new or amended standard must meet its applicable requirements. DOE calculates the LCC and PBP for each of the considered efficiency levels as if consumers would purchase new products in the year compliance with the standard is required.

For the reasons discussed in section III.C, DOE determined that for all TSLs analyzed – except for the consensus agreement TSL – DOE is bound to calculate compliance dates in accordance with EPCA. For those TSLs, the analysis accounts for a five-year lead time between the publication of the final rule for furnaces and central air conditioners and heat pumps and the date by which manufacturers must comply with the amended standard.

A final rule for the products that are the subject of this rulemaking is scheduled to be completed by June 30, 2011. Thus, for most of the TSLs analyzed, compliance with amended standards for furnaces and central air conditioners and heat pumps would be required in 2016. Accordingly, for purposes of the LCC and PBP analysis, DOE used 2016 as the year compliance with the amended standards is required.

10. Base-Case Efficiency Distribution

To accurately estimate the share of consumers that would be affected by a standard at a particular efficiency level, DOE estimates the distribution of product efficiencies that consumers would purchase under the base case (i.e., the case without new or amended energy efficiency standards) in the year compliance with the standard is required. DOE refers to this distribution of product efficiencies as a base-case efficiency distribution. DOE develops base-case efficiency distributions for each of the considered product classes.

a. Energy Efficiency

In the central air conditioners and heat pumps preliminary analysis, DOE assumed that the base-case efficiency distributions in 2016 would be the same as in 2008.

Southern commented that it is not reasonable to assume efficiencies are going to stay frozen from 2008 to 2016, as there has been a huge increase in utility incentive programs for higher-efficiency units. Southern stated that there will be some increase in the shipment-weighted efficiency between 2008 and 2016. (CAC: SCS, Public Meeting Transcript at p. 196) HARDI commented that DOE must incorporate the role that energy efficiency incentive programs play in the sale and installation of higher-efficiency units. (CAC: HARDI, No. 70 at p. 1)

In the furnaces RAP, DOE stated that its development of base-case efficiency distributions will use available data on recent market trends in furnace efficiency and will take into account the potential impacts of the ENERGY STAR program and other policies that may affect the demand for more-efficient furnaces. Commenting on the furnaces RAP, several parties stated that DOE should consider the extent to which incentives and other market forces are expanding the market for high-efficiency furnaces even without new standards. (FUR: AGA, No. 1.3.010 at p. 2 & pp. 5–6; APGA, No. 1.3.004 at p. 4; and HARDI, No. 1.2.006 at pp. 168–70)

For the direct final rule analysis, DOE considered incentives and other market forces that have increased the sales of high-efficiency furnaces and central air conditioners and heat pumps to estimate base-case efficiency distributions for the considered products. DOE started with data provided by AHRI on historical shipments for each product class. For non-weatherized gas furnaces, the historical shipments data were further specified by region and type of furnace (i.e., non-condensing or condensing).

DOE then used data on the distribution of models in AHRI's Directory of Certified Product Performance: Furnaces (October 2010)[69] to disaggregate shipments among condensing efficiency levels for 2009. For central air conditioners and heat pumps, the historical shipments data were accompanied with annual shipment-weighted efficiency data by product class. DOE then used data from the Air-Conditioning, Heating, and Refrigeration (ACHR) News[70] to disaggregate shipments among efficiency levels for 2008.

DOE forecasted the non-weatherized gas furnace and central air conditioner and heat pump efficiency distributions to 2011 based on the average growth in efficiency from 2006 to 2009. The historical efficiency data from AHRI indicate a rapid growth in average equipment efficiency, based in large part on the availability of Federal tax credits for the purchase of high-efficiency products. The Federal tax credits expire on December 31, 2011. After the expiration, DOE believes that the demand for high-efficiency products is likely to decline somewhat initially, but it assumed that the average efficiency will then increase at the historic rate seen in the decade prior to availability of the Federal tax credits. For further information on DOE's estimation of the base-case efficiency distributions for non-weatherized gas furnaces and central air conditioners and heat pumps, see chapter 8 of the direct final rule TSD.

Table IV.14 shows the estimated base-case efficiency distributions in 2016 for non-weatherized gas furnaces. Table IV.15 shows the estimated base-case efficiency

[69] See: http://www.ahridirectory.org/.
[70] ACHR News, "Higher SEERs got popular" (Dec. 24, 2007) (Available at: http://www.achrnews.com/Articles/Web_Exclusive/BNP_GUID_9-5-2006_A_10000000000000222513).

distributions in 2016 for the four primary central air conditioner and heat pump product classes. DOE was unable to develop unique efficiency distributions by region, as data were not provided by AHRI on a regional basis. Therefore, DOE assumed that the efficiency distributions are the same in each region.

Table IV.14 Base-Case Efficiency Distribution in 2016 for Non-Weatherized Gas Furnaces

Efficiency	North	South	National
AFUE	***Market share in percent***		
80%	29.1	75.6	48.1
90%	13.7	4.7	10.0
92%	33.6	11.6	24.6
95%	23.0	7.9	16.9
98%	0.6	0.2	0.4

Table IV.15 Base-Case Efficiency Distribution in 2016 for Central Air Conditioners and Heat Pumps

Efficiency	Split CAC	Split HP	Single-Package CAC	Single-Package HP
SEER	***Market share in percent***			
13.0	24.0	13.0	62.7	32.1
13.5	47.0	40.0	20.0	32.0
14.0	4.0	10.0	14.3	28.9
14.5	7.3	13.0	2.0	5.0
15.0	5.8	11.5	1.0	2.0
15.5	2.0	3.5	0.0	0.0
16.0	7.0	5.0	0.0	0.0
16.5	0.5	2.0	0.0	0.0
17.0	1.0	1.5	0.0	0.0
18.0	0.7	0.5	0.0	0.0
19.0	0.3	0.0	0.0	0.0
20.0	0.2	0.0	0.0	0.0
21.0	0.2	0.0	0.0	0.0
22.0	0.1	0.0	0.0	0.0

For mobile home gas furnaces and oil-fired furnaces, DOE used data in the AHRI furnace models directory and manufacturer input to estimate current efficiency distributions. Because there is little indication of a trend in efficiency for these products, DOE assumed that the efficiency distributions in 2016 will be the same as in the current market (see Table IV.16).

Table IV.16 Base-Case Efficiency Distribution in 2016 for Mobile Home Gas Furnaces and Oil-Fired Furnaces

Mobile Home Furnaces		**Oil-fired Furnaces**	
Efficiency	**National**	**Efficiency**	**National**
AFUE	***Market share in percent***	***AFUE***	***Market share in percent***
80%	90	82%	42
90%	2	83%	20
92%	4	84%	6
96%	4	85%	32
		97%	1

b. Standby Mode and Off Mode Power

DOE also estimated base-case efficiency distributions for furnace standby mode and off mode power. As discussed in section IV.C.7.c, DOE considered efficiency levels only for furnaces with ECM motors. Baseline products contain the highest energy-consuming components, which include an ECM blower motor (rather than a PSC). Although DOE's test results for furnaces showed that the standby mode and off mode consumption could be reduced by eliminating certain features (e.g., replacing an ECM blower motor with a PSC motor), DOE did not consider these reductions because the elimination of such features and components would result in a reduction of consumer utility. (The ECM motor maintains constant airflow volume and is suited for two-speed equipment, which allows the consumer to maintain better comfort.) In its analysis, DOE only considered efficiency levels that could be implemented with no noticeable impacts on the performance and utility of the unit. As shown in Table IV.17 through Table IV.19, DOE estimated that all of the affected market would be at the baseline level in 2016.

Table IV.17 Standby Mode and Off Mode Base-Case Efficiency Distribution in 2016 for Non-Weatherized Gas Furnaces and Electric Furnaces

Efficiency Level	Motor Type	Standby/Off-Mode Watts	Market Share in percent*
Baseline	ECM	11.0	100
1	ECM	9.8	0
2	ECM	9.0	0

* Refers to share of furnaces with ECM motor.

Table IV.18 Standby Mode and Off Mode Base-Case Efficiency Distribution in 2016 for Oil-Fired Furnaces

Efficiency Level	Motor Type	Standby/Off-Mode Watts	Market Share in percent*
Baseline	ECM	12.0	100
1	ECM	10.8	0
2	ECM	10.0	0

* Refers to share of furnaces with ECM motor.

Table IV.19 Standby Mode and Off Mode Base-Case Efficiency Distribution in 2016 for Mobile Home Gas Furnaces

Efficiency Level	Motor Type	Standby/Off-Mode Watts	Market Share in percent*
Baseline	ECM	11.0	100
1	ECM	9.8	0
2	ECM	9.0	0

* Refers to share of furnaces with ECM motor.

DOE also estimated base-case efficiency distributions for central air conditioner and heat pump off mode power. As discussed in section IV.C.7.c, DOE considered efficiency levels only for air conditioning and heat pump equipment with crankcase heaters. DOE found that crankcase heaters account for the vast majority of off mode power consumption for air conditioners and heat pumps. However, not every unit has a crankcase heater and, to accurately reflect this in the analyses, DOE determined separate efficiency levels within each product class for units with and without a crankcase heater. Although DOE's test results for central air conditioners and heat pumps showed that the standby mode and off mode consumption could be reduced eliminating certain features (such as the crankcase heater), DOE did not consider such measures because the elimination of the features and components would result in a reduction of consumer utility.[71] In its analysis, DOE only considered designs that could be implemented with no noticeable impacts on the performance and utility of the unit.

As shown in Table IV.20, for split-system air conditioners, DOE estimated that 60 percent of the affected market would be at the baseline level, 30 percent at efficiency level 1, and 10 percent at efficiency level 2 in 2016. Because off mode power consumption is a function of system type (i.e., blower-coil or coil-only), the market share is further disaggregated by system type for each efficiency level. As a result of this further disaggregation, two different off mode power consumption levels are reported at each efficiency level.

[71] Crankcase heaters are used in some compressors and prevent refrigerant condensation in the crankcase of a compressor. Without the crankcase heater, the condensed refrigerant will mix with the crankcase oil, resulting in a watery mixture that can wash out compressor bearings, leading to premature compressor failure.

Table IV.20 Off Mode Base-Case Efficiency Distribution in 2016 for Split-System Central Air Conditioners

Efficiency Level	AC Type	Off-Mode Watts	Market Share of Affected Market in percent*	
			by Efficiency Level	by Efficiency Level and AC Type
Baseline	Blower-Coil	48	60	6
	Coil-Only	40		54
1	Blower-Coil	36	30	1
	Coil-Only	28		9
2	Blower-Coil	30	10	3
	Coil-Only	22		27
3	Blower-Coil	29	0	0
	Coil-Only	NA		0

* Refers to share of air conditioners with crankcase heaters.

As shown in Table IV.21, for single-package air conditioners, DOE estimated that 60 percent of the affected market would be at the baseline level, 30 percent at efficiency level 1, and 10 percent at efficiency level 2 in 2016. For split-system and single-package heat pumps (Table IV.22), DOE estimated that 50 percent of the affected market would be at the baseline level and 50 percent at efficiency level 1 in 2016. The off mode power consumption levels associated with ECM-equipped systems set the wattage limitations for each of the efficiency levels considered. Of further note, in the case of efficiency level 3 for single-package air conditioners and efficiency level 2 for heat pumps, only the fraction of the market equipped with ECMs is impacted. Single-package air conditioners with PSC motors that comply with the off mode power requirements in efficiency level 2 already meet the requirements in efficiency level 3. For heat pumps, units with PSC motors that comply with the off mode power requirements in efficiency level 1 already meet the requirements in efficiency level 2.

Table IV.21 Off Mode Base-Case Efficiency Distribution in 2016 for Single-Package Central Air Conditioners

Efficiency Level	Off-Mode Watts	Market Share of Affected Market in percent*
Baseline	48	60
1	36	30
2	30	10
3**	29	0

* Refers to fraction of central air conditioners with crankcase heaters.
** Impacts only that fraction of the market with ECMs; market with PSC motors meeting efficiency level 2 already meet efficiency level 3 off mode power requirements.

Table IV.22 Off Mode Base-Case Efficiency Distribution in 2016 for Split-System and Single-Package Heat Pumps

Efficiency Level	Off-Mode Watts	Market Share of Affected Market in percent*
Baseline	50	50
1	33	50
2**	32	0

* Refers to fraction of heat pumps with crankcase heaters.
** Impacts only that fraction of the market with ECMs; market with PSC motors meeting efficiency level 1 already meet efficiency level 2 off mode power requirements.

For further information on DOE's estimate of base-case efficiency distributions, see chapter 8 of the direct final rule 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. The simple payback period does not account for changes in operating expense over time or the time value of money. Payback periods are expressed in years. Payback periods that exceed the life of the product mean that the increase in 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 average annual operating expenditures for each efficiency level. The PBP calculation uses the same inputs as the LCC analysis, except that discount rates are not needed. The results of DOE's PBP analysis are presented in section V.B.1.

12. Rebuttable Presumption Payback Period

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 considered efficiency level, 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. The results of DOE's analysis are presented in section V.B.1.

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

The national impact analysis (NIA) assesses the national energy savings (NES) and the national net present value (NPV) of total consumer costs and savings that would be expected to result from new or amended standards at specific efficiency levels.

("Consumer" in this context refers to users of the product being regulated.) DOE calculates the NES and NPV based on projections of annual appliance shipments, along with the annual energy consumption and total installed cost data from the energy use and LCC analyses.

For most of the TSLs considered in the present analysis, DOE forecasted the energy savings from 2016 through 2045, and it calculated product costs, operating cost savings, and NPV of consumer benefits for products sold from 2016 through 2045. For TSL 4, which matches the recommendations in the consensus agreement, DOE forecasted the energy savings from 2015 through 2045 for central air conditioners and heat pumps, and from 2013 through 2045 for furnaces.[72] For TSL 4, it calculated product costs, operating cost savings, and NPV of consumer benefits for products sold in these periods.

DOE evaluates the impacts of new or amended standards by comparing base-case projections with standards-case projections. The base-case projections characterize energy use and consumer costs for each product class in the absence of new or amended energy conservation standards. DOE compares these projections with projections characterizing the market for each product class if DOE adopted new or amended standards at specific energy efficiency levels (i.e., the TSLs or standards cases) for that class. For the base-case forecast, DOE considers historical trends in efficiency and various forces that are likely to affect the mix of efficiencies over time. For the standards

[72] Compared to all other TSLs, the compliance date for TSL 4 is earlier for furnaces (in 2013) and for central air conditioners and heat pumps (in 2015). DOE used the same end year for TSL 4 as for all other TSLs to demonstrate the additional national impacts that would result from these earlier compliance dates.

cases, DOE also considers how a given standard would likely affect the market shares of products with efficiencies greater than the standard.

To make the analysis more accessible and transparent to all interested parties, DOE makes publicly available a spreadsheet model (in Excel format) to calculate the energy savings and the national consumer costs and savings from each TSL. The TSD and other documentation that DOE provides during the rulemaking explain the models and how to use them, and interested parties can review DOE's analyses and also change various input values within the spreadsheet. The NIA spreadsheet model uses typical values as inputs (as opposed to probability distributions).

For the current analysis, the NIA used projections of energy prices and housing starts from the AEO2010 Reference case. In addition, DOE analyzed scenarios that used inputs from the AEO2010 High Economic Growth and Low Economic Growth cases. These cases have higher and lower energy price trends compared to the Reference case, as well as higher and lower housing starts, respectively, which result in higher and lower appliance shipments to new homes. NIA results based on these cases are presented in appendix 10-A of the direct final rule TSD.

Table IV.23 summarizes the inputs and methodology DOE used for the NIA analysis for the central air conditioners and heat pumps preliminary analysis and the changes to the analyses for today's rule. For the direct final rule analysis, DOE used the same basic methodology for furnaces as it used for central air conditioners and heat pumps. Discussion of these inputs and methods follows the table. See chapter 10 of the direct final rule TSD for further details.

Table IV.23 Summary of Inputs and Methods for the National Impact Analysis

Inputs	Preliminary TSD	Changes for the Direct Final Rule
Shipments	Annual shipments from shipments model.	No change.
Compliance Date of Standard	2016.*	No change.
Base-Case Forecasted Efficiencies	Based on historical SWEF** growth rates from 1992 to 2005.	No change in basic approach; modified efficiency distributions based on new information from AHRI; historical SWEF growth rates from 1993 to 2002 (CAC and HP) or 2005 (Furnaces) used to forecast efficiencies.
Standards-Case Forecasted Efficiencies	Used a "roll-up" scenario to establish the distribution of efficiencies in the compliance year; forecasted efficiencies based on historical SWEF growth rates from 1992 to 2005 (same as base case).	Modified efficiency distributions based on new information. Retained "roll-up" scenario. Forecasted efficiencies based on maintaining constant per-unit total installed costs relative to base case.
Annual Energy Consumption per Unit	Annual weighted-average values as a function of SWEF.	No change.
Total Installed Cost per Unit	Annual weighted-average values as a function of SWEF.	Incorporated learning rate to forecast product prices.
Annual Energy Cost per Unit	Annual weighted-average values as a function of the annual energy consumption per unit and energy prices.	No change.
Repair and Maintenance Cost per Unit	Annual values as a function of efficiency level.	No change.
Energy Prices	AEO2009 forecasts (to 2035) and extrapolation through 2043.	Updated using AEO2010 forecasts.
Energy Site-to-Source Conversion Factor	Varies yearly and is generated by NEMS-BT.	No change.
Discount Rate	Three and seven percent real.	No change.
Present Year	Future expenses are discounted to 2010.	Future expenses are discounted to 2011, when the final rule will be published.

* The compliance date used for TSL 4 is 2013 for furnaces and 2015 for central air conditioners and heat pumps.
** Shipments-Weighted Energy Factor

Deleted: No change.

1. Shipments

The shipments portion of the NIA spreadsheet is a model that uses historical data as a basis for projecting future shipments of the products that are the subjects of this rulemaking. In DOE's shipments models, shipments of products are driven by replacement of the existing stock of installed products, new home or building construction, and existing households or buildings that do not already own the product (referred to hereafter as "new owners"). Central air conditioners and heat pumps are used in some commercial buildings as well as for residences. Based on industry input, DOE estimated that 7 percent of central air conditioner and heat pump shipments are to commercial applications, and accounted for these shipments in the shipments model.

The shipments model takes an accounting approach, tracking market shares of each product class and the vintage of units in the existing stock. Stock accounting uses product shipments as inputs to estimate the age distribution of in-service product stocks for all relevant years. The age distribution of in-service product stocks is a key input to NES and NPV calculations because operating costs for any year depend on the age distribution of the stock. DOE used historical product shipments to assist in calibrating the shipments model.

For the central air conditioners and heat pumps preliminary analysis, AHRI provided historical shipments data for each of the four primary product classes—split-system air conditioners, single-package air conditioners, split-system heat pumps, and single-package heat pumps. AHRI also provided regional shipments data for each product class for two years—2008 and 2009. The limited regional shipments data, in combination with calibration of the resulting product stock saturations to the values specified by past RECS surveys and U.S. Census Bureau American Housing Survey (AHS) data, allowed DOE to develop historical residential shipments disaggregated by region. Commercial shipments were allocated regionally based on the percentage allocations determined for residential shipments.

In the furnaces RAP, DOE stated its intention to: (1) develop base-case shipments forecasts for each of the four Census regions that, in turn, could be aggregated to produce regional or national forecasts; and (2) to project shipments of residential furnaces by primarily accounting for sales to the replacement market and new homes.

For the direct final rule analysis, DOE's base-case shipments forecasts used the same approach for central air conditioners and heat pumps as was used in the preliminary analysis, and used the approach described in the RAP for furnaces. For details on the shipments analysis, see chapter 9 of the direct final rule TSD.

a. Impact of Potential Standards on Shipments

For the central air conditioners and heat pumps preliminary analysis, to estimate the impact that potential standards would have on product shipments, DOE analyzed the impact that purchase price, operating costs, and household income have had on historical central air conditioner and heat pump shipments. From this analysis, DOE derived a relative price elasticity that estimates shipments impacts as a function of the increase in purchase price, operating cost savings, and household income. Although the correlation among historical shipments and the above three parameters is not strong, there is enough evidence to suggest a connection. Of the three parameters, purchase price has the most significant impact on product shipments (an increase in product purchase price will lead to a decrease in product shipments). DOE only considered shipments decreases in the replacement and new owner markets.[73] In the case of the replacement market, DOE assumed that any drop in shipments would be caused by consumers deciding to repair rather than replace their products. DOE estimated that the extended repair would last 6 years, after which time the products would be replaced.

Commenting on the central air conditioners and heat pumps preliminary TSD, HARDI expressed concern that increases in the minimum efficiency required of residential central air conditioner units could lead to increased repair of legacy units, which would impact sales of new units. (CAC: HARDI, No. 56 at p. 3) Ingersoll Rand expressed a similar view, arguing that such a trend was noticeable after the implementation of the 13-SEER central air conditioner standard. (CAC: Ingersoll Rand, No. 66 at p. 3)

In the furnaces RAP, DOE stated its intention to develop standards-case forecasts that reflect the projected impacts of potential standards on product shipments. In the planned approach, the magnitude of the difference between the standards-case and base-case shipment forecasts depends on the estimated purchase price increase, as well as the

[73] Because most new construction is now routinely equipped with either a central air conditioner or heat pump, DOE assumed that any increase in purchase price caused by standards would not affect the decision to install a central air conditioner or heat pump system in new construction.

operating cost savings caused by the considered energy conservation standard, relative to household income.

Commenting on the furnaces RAP, several parties stated that DOE should consider that high installed costs resulting from amended energy conservation standards might cause some consumers to repair their existing furnaces instead of replacing them with higher-efficiency units. Specifically, AGA stated that DOE has not considered the likelihood of repair over replacement of existing furnaces, particularly where replacement of non-condensing furnaces with condensing furnaces has potentially high venting system upgrade costs. (FUR: AGA, No. 1.3.010 at p. 2) Carrier stated that the economic burden of a 90-percent AFUE standard may lead some consumers in some areas not to replace a furnace that they might otherwise replace. (FUR: Carrier, No. 1.2.006 at p. 207) APGA made the same point, adding that the installation cost adders (i.e., costs over and above typical costs) of furnaces at 90-percent AFUE and above could even lead to the need for replacement of heat exchangers. (FUR: APGA, No. 1.3.004 at p. 3) Ingersoll Rand stated that preservation of the existing HVAC system is a very real prospect if the price for increased efficiency is not deemed warranted by the consumer. It added that if amended standards would require a condensing furnace with an ECM blower in a climate where consumers do not feel the added expense is warranted, they will be disposed to extend the life of the existing furnace, even to the point of replacing a heat exchanger and burners if that is necessary. (FUR: Ingersoll Rand, No. 1.3.006 at p. 12) AGA and APGA stated that DOE particularly needs to consider the likelihood of higher rates of repair over replacement in manufactured housing, where owners may have limited ability to afford a condensing furnace as a replacement. (FUR: AGA, No. 1.3.010 at p. 5; APGA, No. 1.3.004 at p. 4) HARDI stated that increases in minimum efficiency standards for HVAC systems could encourage repair of existing systems in need of replacement, which could risk the health and safety of homeowners. (FUR: HARDI, No. 1.3.016 at p. 3)

DOE agrees that amended standards that result in considerably higher installed costs could lead some consumers to repair their existing furnace, central air conditioner, or heat pump instead of replacing it with a new, higher-efficiency unit. However, DOE is not aware of a satisfactory approach for estimating the extent of this phenomenon. There exists considerable uncertainty regarding the metric that consumers might use to make the decision to repair rather than replace their HVAC equipment. In addition, there are a variety of potential repair possibilities, each having different costs and impacts on extending equipment lifetime, and DOE has no way to estimate which types of repair would be most likely. Thus, DOE was not able to explicitly model the extent to which consumers might repair their existing furnace (or central air conditioner or heat pump) instead of replacing it with a higher-efficiency unit. Instead, for the direct final rule analysis, DOE used the same approach as in the central air conditioners and heat pumps preliminary TSD to estimate the impact that standards may have on shipments of central air conditioners, heat pumps, and also furnaces. That is, DOE applied a relative price elasticity that estimates shipments impacts as a function of the increase in purchase price, operating cost savings, and household income. Application of this elasticity parameter likely captures some of the effects of “extended repair” by some consumers. Although the elasticity parameter was estimated using data on historical central air conditioner and heat pump shipments, DOE believes that it is reasonable to apply it to the case of furnaces as well, given the broad similarities in the markets for residential central air conditioning and heating equipment.

Regarding the expressed concern that repair of existing systems in need of replacement could risk the health and safety of homeowners, DOE notes that contractors have a legal responsibility to perform repairs according to the requirements of applicable codes. Further, issues about sub-standard repair practices could as well arise in the absence of amended standards.

Because home builders are sensitive to the cost of HVAC equipment, a standard level that significantly increases purchase price may induce some builders to switch to a different heating system than they would have otherwise installed. Such an amended standard level may also induce some home owners to replace their existing furnace at the end of its useful life with a different type of heating product, although in this case, switching may incur additional costs to accommodate the different product. The decision to switch is also affected by the prices of the energy sources for competing equipment. For the central air conditioners and heat pumps preliminary analysis, DOE used the relative price elasticity described above to account for any equipment switching that may result from standards requiring higher-efficiency products. That is, equipment switching was implicitly included in the response to higher equipment prices that is modeled using the elasticity parameter. In the furnaces RAP, DOE stated its intention to account for fuel and equipment switching that may result from amended standards requiring higher-efficiency furnaces.

Commenting on the furnaces RAP, some parties stated that a standard requiring condensing furnaces could cause some consumers to switch from gas furnaces to electric resistance heating systems. (FUR: AGA, No. 1.3.010 at p. 6; APGA, No. 1.3.004 at p. 3; NPGA, No. 1.3.005 at p. 3) NPGA stated that in existing homes with central air conditioning and gas furnaces, switching to a heat pump represents a feasible option. (FUR: NPGA, No. 1.3.005 at p. 3) AGA and APGA also stated that a standard requiring condensing furnaces could cause some consumers with hybrid heat pump/furnace-backup heating systems to switch to all-electric heat pump systems. (AGA, No. 1.3.010 at p. 7; APGA, No. 1.3.004 at p. 3)

Several parties regarded fuel switching as unlikely for a variety of reasons. ACEEE stated that the barriers to fuel switching in the retrofit market are high enough that few cases will be encountered. As an example, it stated that switching from a heat pump to a gas furnace is prohibitively expensive if gas service is not already available at the curb or in the house. With respect to fuel switching in new construction, ACEEE stated that it expects builders to seek favorable terms for installing gas heat and water heat rather than switch to electric heating. (FUR: ACEEE, No.1.3.009 at pp. 7-8) NEEP stated they found no reason consumers would switch from gas-fueled to either oil-fueled or electric technologies in response to standards. (NEEP, No. 1.3.021 at pp. 2–3) HARDI stated that a change in efficiency standards is unlikely to spur fuel switching, which more commonly is driven by energy costs. (HARDI, No. 1.3.016 at p. 10) Ingersoll Rand stated that consumers tend to heat with gas if it is available. It added that retail gas suppliers can be expected, on the whole, to maintain gas prices at a level to discourage switching in existing homes, and with new construction, to strive to remain competitive in areas they wish to serve. (FUR: Ingersoll Rand, No. 1.3.006 at p. 14)

For the direct final rule, DOE did not explicitly quantify the potential for fuel switching from gas furnaces to electric heating equipment, based upon the following reasoning. DOE conducted a thorough review of the 2005 RECS to assess the type of space-heating system utilized by consumers as a function of house heating load. Gas furnaces are primarily utilized in households with high heating loads, while electric space heating systems are almost exclusively used in households with low heating loads. Generally, this is because the operating costs of electric space heating systems are relatively high due to the price of electricity, so using an electric system in a cold climate is significantly more expensive than using a gas furnace. Based on the above finding, DOE inferred that consumers with high heating loads would be unlikely to switch to electric space heating systems as a result of amended standards. In addition, for a household with a gas furnace to switch to electric space heating, a separate circuit up to 30-amps would need to be installed at a cost of approximately $300 to power the electric resistance heater within an electric furnace or heat pump system.[74] On average, the electrical circuit cost is approximately 60 percent of the added installation cost of a more

[74] Based on RS Means, Residential Cost Data 2010, Reed Construction Data, Kingston, MA.

expensive venting system required for high-efficiency, condensing furnaces, further diminishing the likelihood of a consumer switching from gas to electric heating.

As briefly described above, for the direct final rule, DOE conducted an analysis of the potential for equipment switching between a split system heat pump and the combination of a split system central air conditioner and electric furnace. To estimate the likelihood of equipment switching between these two systems, DOE utilized proprietary data from Decision Analysts,[75] which identified for a representative sample of consumers their willingness to purchase more-efficient space-conditioning systems. From these data, DOE deduced the payback period that consumers would expect for a more-expensive but more-efficient product. For each pairing of split heat pump and split air conditioner efficiency levels, DOE applied the payback period criterion to estimate the fraction of consumers who would be expected to switch to the other type of equipment. For example, when comparing a 15 SEER split system heat pump and a combination of a 14 SEER split air conditioner and an electric furnace, DOE calculated the payback period of the more-efficient split system heat pump relative to the less-expensive combination of split air conditioner and electric furnace. If the resulting payback period for the split system heat pump exceeded the expected payback period deduced from the Decision Analysts' data, DOE forecasted that the consumer would switch to the combination of split air conditioner and electric furnace. For every possible pairing of split system heat pump and split system air conditioner efficiencies, DOE calculated the fraction of consumers who would be expected to switch from one type of split system to the other. The fraction of

[75] Decision Analysts, "2008 American Home Comfort Study" (2009).

consumers switching was in turn used by DOE to forecast split system heat pump and split system air conditioner shipments in specific standards cases, as well as the increase in electric furnace shipments. Including the latter in accounting for the impacts of equipment switching is important for proper determination of national energy savings and national economic impacts.

Because measures to limit standby mode and off mode power consumption have a very small impact on equipment total installed cost, and thereby would have a minimal effect on consumer purchase decisions, DOE did not analyze the impact to central air conditioner, heat pumps, and furnace shipments due to potential standards limiting standby mode and off mode power consumption. In other words, DOE estimated that base-case product shipments would be unaffected by standards to limit standby mode and off mode power consumption.

For details on DOE's analysis of the impacts of standards on shipments, see chapter 9 of the direct final rule TSD. For details on DOE's analysis of equipment and fuel switching, see appendix 9-A of the direct final rule TSD.

2. Forecasted Efficiency in the Base Case and Standards Cases

A key component of the NIA is the trend in energy efficiency forecasted for the base case (without new or amended standards) and each of the standards cases. Section IV.F.10 describes how DOE developed a base-case energy efficiency distribution (which yields a shipment-weighted average efficiency (SWEF)) for each of the considered product classes for the compliance year used in the LCC analysis (2016). To forecast base-case efficiencies over the entire forecast period for the direct final rule, DOE extrapolated from the historical trends in efficiency, as described below.

For central air conditioners and heat pumps, DOE reviewed historical SWEF data from 1990 to 2009 provided by AHRI. The historical data, which encompassed years when new standards for central air conditioners and heat pumps required compliance (1992 and 2006), specified SWEFs for each of the four primary central air conditioner and heat pump product classes. DOE considered only the 1993 to 2002 time period to forecast SWEF growth rates in order to factor out: (1) any lingering effects on equipment SWEFs from industry efforts to comply with the 1992 standards; (2) any anticipatory efforts by the industry to comply with the 2006 standards that DOE issued in 2001; and (3) the effects of recent Federal tax credits to promote the purchase of high-efficiency central air conditioners and heat pumps. From 1993 to 2002, central air conditioner and heat pump efficiency increased, on average, by 0.5 to 0.7 SEER, depending on product class, which is an efficiency growth rate of approximately 0.06 to 0.07 SEER per year.

For non-weatherized gas furnaces, DOE was provided historical data from 1990 to 2009 by AHRI, detailing the market shares of non-condensing (80 percent AFUE and less) and condensing (90 percent AFUE and greater) equipment.[76] Similar to its approach for central air conditioners and heat pumps, DOE used only the data from 1993 to 2002 to factor out the lingering effects of new furnace standards that required compliance in 1992 as well as the effects of market-pull programs, including recent Federal tax credits, to

[76] The market share of furnaces with AFUE between 80 and 90 percent is well below 1 percent due to the very high installed cost of 81-percent AFUE furnaces, compared with condensing designs, and concerns about safety of operation.

promote the purchase of high-efficiency condensing furnaces. From 1993 to 2002, non-weatherized gas furnace efficiency increased, on average, by 0.5 AFUE and 1.5 AFUE percentage points in the southern and northern U.S., respectively, which implies efficiency growth rates of approximately 0.05 and 0.17 AFUE percentage points per year.

DOE used the above growth rates for central air conditioners and heat pumps and furnaces to forecast base-case SWEFs over the forecast period. Due to the lack of historical efficiency data for mobile home and oil-fired furnaces, DOE estimated that product efficiency distributions would remain the same throughout the forecast period.

To estimate efficiency trends in the standards cases, DOE has used "roll-up" and/or "shift" scenarios in its standards rulemakings. Under the "roll-up" scenario, DOE assumes: (1) product efficiencies in the base case that do not meet the standard level under consideration would "roll-up" to meet the new standard level; and (2) product efficiencies above the standard level under consideration would not be affected. Under the "shift" scenario, DOE retains the pattern of the base-case efficiency distribution but reorients the distribution at and above the potential new minimum energy conservation standard.

In the central air conditioners and heat pumps preliminary TSD, DOE concluded that amended standards will cause baseline models to roll up to the standard efficiency level in the year of compliance, but that some fraction of shipments will remain above the minimum. DOE calculated the SWEFs from the resulting efficiency distribution. In the years following the year of compliance, DOE estimated that SWEFs will continue to grow at the rate observed between 1992 and 2005 until the max-tech efficiency level is attained, at which point the SWEF was held constant.

Commenting on the furnaces RAP, NRDC and ASAP stated that market penetration in standards cases will resemble the shift scenario more than the roll-up scenario. (FUR: NRDC, No. 1.3.020 at p. 10; ASAP, No. 1.2.006 at p. 216) NRDC added that the existence of successful Federal tax incentives for furnaces with 95 percent AFUE indicates that sales of these units are likely to continue to increase. (FUR: NRDC, No. 1.3.020 at p. 11) In contrast, HARDI commented that roll-up and shift scenarios are unlikely under an amended energy conservation standard, and stated that an increase in minimum efficiency standards for furnaces or central air conditioners and heat pumps is likely to negatively impact the other energy efficiency programs that have been vital to achieving the growing penetration of higher-efficiency HVAC systems. (FUR: HARDI, No.1.3.016 at p. 3) ACEEE stated there is no strong reason to choose a roll-up scenario instead of a shift scenario based on the available evidence, and ACEEE encouraged DOE to consider both scenarios, premised on the likelihood of the continuation of incentives if there is a 90-percent AFUE furnace efficiency standard for the north. (FUR: ACEEE, No.1.3.009 at p. 8) The California IOUs also supported the use of both the roll-up and shift scenarios. (FUR: CA IOUs, No. 1.3.017 at p. 5)

In response, DOE again reviewed the historical efficiency data for central air conditioners and heat pumps and furnaces from AHRI. It did not find any evidence to support a shift in the efficiency distribution in the year of compliance with amended standards. Therefore, for the direct final rule analysis, DOE decided to continue to utilize the roll-up scenario for central air conditioners and heat pumps in order to forecast the impact of standards for the year of compliance. DOE applied the roll-up scenario to furnaces as well. However, DOE agrees with the suggestion by some of the commenters that the efficiency distribution will shift after compliance with amended standards is required. DOE captured this expected market change in its forecast of efficiency in the standards cases, as described below.

To forecast standards-case SWEFs after the year of compliance, rather than use the same efficiency growth rate as the base case, DOE developed growth trends for each candidate standard level that reflect the likelihood that the consumer willingness to pay for an increment of efficiency will be the same in the base case and the standards case. In revising its analysis, DOE found that the cost of a relatively small efficiency improvement over the most common product in the standards case is much higher than in the base case. Therefore, assuming the same efficiency increment in the base case and standards case would imply that the consumer willingness to pay for an increment of efficiency would dramatically increase under standards without the addition of any incentives or information. This is a phenomenon that DOE has not observed in any of its efficiency market analysis or modeling investigations. Therefore, for the direct final rule, DOE developed an approach in which the growth rate slows over time in response to the increasing incremental cost of efficiency improvements. DOE assumed that the rate of adoption of more-efficient products under a standards case occurs at a rate which ensures

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that the average total installed cost difference between the standards case and base case over the entire forecast period is constant.

DOE modified the general approach for split-system coil-only air conditioner replacement units at 15 SEER and above, for which many consumers would incur a very large additional cost (an average of $959) to install a furnace fan kit (as explained in section IV.F.1). DOE believes that for much of the market, this cost would constrain demand for split-system coil-only air conditioner replacement units at 15 SEER and above. Thus, in analyzing standards cases below 15 SEER, as well as the base case, DOE forecast that the market shares of units at 15 SEER and above would remain at the 2016 level.

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For split-system coil-only air conditioner replacement units, DOE also analyzed a sensitivity case that reflects a more sophisticated model of efficiency market shares than the reference case analysis. In this case, there is a gradual shift of efficiency in the base case, with the rate of shift dependent on the price difference between an efficiency market share and the next highest efficiency market share. DOE calibrated the parameters of this model to the observed historical shift rate without tax incentives. The result of this model is that while there is more market shifting over the long term forecast to the very high efficiency levels, there is slower market shifting at the lower efficiency levels earlier in the forecast period. In analyzing standards cases below 15 SEER, DOE forecast that the market shares of units at 15 SEER and above would be no greater than the base case.

The results of this sensitivity in terms of the consumer NPV are presented in section V.B.3.a. More discussion along with detailed results from the sensitivity calculation are provided in appendix 10-D of the TSD.

For single package air conditioners and heat pumps, DOE observes that the market conditions are somewhat distinct from split system air conditioners as more than 90 percent of the single package market is comprised of low efficiency products of 13 to 14 SEER. In addition, DOE observes that higher efficiency single-package systems are more expensive relative to the lower efficiency models compared to the general cost structure for split system units. This indicates that efficiency trends for single-package systems are likely to be smaller than those for split systems. Nonetheless, DOE modeled the efficiency trends for single-package units the same as it modeled the trends for blower-coil split systems. While DOE believes that this approach is conservative, DOE did not have the data available to calibrate a more precise forecast of efficiency trends for this product class. An overestimate of the efficiency trend will likely lead to an overestimate of equipment costs resulting from a standard for these products. As a result, net consumer benefits from a standard are likely to be higher the DOE estimate provided in this notice.

Comment [A9]: Changes recommended by OIRA.

In the case of standby mode and off mode power consumption, DOE used a roll-up scenario to forecast the impact of potential standards for the year of compliance. Due to the lack of historical information on standby mode and off mode power consumption in central air conditioners, heat pumps, and furnace equipment, DOE estimated that efficiency distributions of standby mode and off mode power consumption would remain the same until 2045.

For further details about the forecasted efficiency distributions, see chapter 10 of the direct final rule TSD.

3. Installed Cost Per Unit

In the preliminary analysis, DOE assumed that the manufacturer costs and retail prices of products meeting various efficiency levels remain fixed, in real terms, after 2009 (the year for which the engineering analysis estimated costs) and throughout the period of the analysis. As discussed in section IV.F.1, examination of historical price data for certain appliances and equipment that have been subject to energy conservation standards indicates that the assumption of constant real prices and costs may, in many cases, over-estimate long-term appliance and equipment price trends.

On February 22, 2011, DOE published a Notice of Data Availability (NODA, 76 FR 9696) stating that DOE may consider improving regulatory analysis by addressing equipment price trends. Consistent with the NODA, DOE used historical producer price indices (PPI) for room air conditioners and household laundry equipment as a proxy for price data. DOE does not have price data for this equipment. DOE believes that PPI might shed some directionally-correct light on the price trend, recognizing that PPI is not a good proxy for price information because it incorporates shipment information, among other reasons. DOE found a long-term declining real price trend for both products. DOE used experience curve fits to forecast a price scaling index to forecast product costs into the future for this rulemaking. DOE also considered the public comments that were received in response to the NODA and refined the evaluation of its experience curve trend forecasting estimates. Many commenters were supportive of DOE moving from an assumption-based equipment price trend forecasting method to a data-driven methodology for forecasting price trends. Other commenters were skeptical that DOE could accurately forecast price trends given the many variables and factors that can complicate both the estimation and the interpretation of the numerical price trend results and the relationship between price and cost. DOE evaluated these concerns and determined that retaining the assumption-based approach of a constant real price trend is consistent with the NODA when data gaps are sufficient. DOE presents the estimates based on a constant real price trend as a reasonable upper bound on the future equipment price trend. DOE also performed an initial evaluation of the possibility of other factors complicating the estimation of the long-term price trend, and developed a range of potential price trend values that were consistent with the available data and justified by the amount of data that was available to DOE at this time. DOE recognizes that its price trend forecasting methods are likely to be modified as more data and information becomes available to enhance the rigor and robustness of the trend estimate and the completeness of the model. Additional data should enable an improved evaluation of the potential impacts of more of the factors that can influence equipment price trends over time.

To evaluate the impact of the uncertainty of the price trend estimates, DOE performed price trend sensitivity calculations in the national impact analysis to examine the dependence of the analysis results on different analytical assumptions. DOE also included a constant real price trend assumption as an upper bound on the forecast price trend. DOE found that for the selected standard levels the benefits outweighed the burdens under all scenarios.

A more detailed discussion of price trend modeling and calculations is provided in Appendix 8-J of the TSD.

Comment [A10]: Changes recommended by OIRA.

4. National Energy Savings

For each year in the forecast period, DOE calculates the NES for each considered standard level by multiplying the stock of equipment affected by the energy conservation standards by the per-unit annual energy savings. As discussed in section IV.E, DOE incorporated the rebound effect utilized in the energy use analysis into its calculation of national energy savings.

To estimate the national energy savings expected from amended appliance standards, DOE used a multiplicative factor to convert site energy consumption (at the home or commercial building) into primary or source energy consumption (the energy required to convert and deliver the site energy). These conversion factors account for the energy used at power plants to generate electricity and losses in transmission and distribution, as well as for natural gas losses from pipeline leakage and energy used for pumping. For electricity, the conversion factors vary over time due to changes in generation sources (i.e., the power plant types projected to provide electricity to the country) projected in AEO2010. The factors that DOE developed are marginal values, which represent the response of the electricity sector to an incremental decrease in consumption associated with potential appliance standards.

In the central air conditioners and heat pumps preliminary analysis, DOE used annual site-to-source conversion factors based on the version of NEMS that corresponds to AEO2009. For today's direct final rule, DOE updated its conversion factors based on the NEMS that corresponds to AEO2010, which provides energy forecasts through 2035. For 2036-2045, DOE used conversion factors that remain constant at the 2035 values.

Section 1802 of the Energy Policy Act of 2005 (EPACT 2005) directed DOE to contract a study with the National Academy of Science (NAS) to examine whether the goals of energy efficiency standards are best served by measurement of energy consumed, and efficiency improvements, at the actual point-of-use or through the use of the full-fuel-cycle, beginning at the source of energy production (Pub. L. No. 109-58 (Aug. 8, 2005)). NAS appointed a committee on "Point-of-Use and Full-Fuel-Cycle Measurement Approaches to Energy Efficiency Standards" to conduct the study, which was completed in May 2009. The NAS committee defined "full-fuel-cycle energy consumption" as including, in addition to site energy use, the following: (1) energy consumed in the extraction, processing, and transport of primary fuels such as coal, oil, and natural gas; (2) energy losses in thermal combustion in power generation plants; and (3) energy losses in transmission and distribution to homes and commercial buildings.[77]

In evaluating the merits of using point-of-use and full-fuel-cycle measures, the NAS committee noted that DOE currently uses what the committee referred to as "extended site" energy consumption to assess the impact of energy use on the economy, energy security, and environmental quality. The extended site measure of energy consumption includes the energy consumed during the generation, transmission, and distribution of electricity but, unlike the full-fuel-cycle measure, does not include the energy consumed in extracting, processing, and transporting primary fuels. A majority of the NAS committee concluded that extended site energy consumption understates the total energy consumed to make an appliance operational at the site. As a result, the NAS committee recommended that DOE consider shifting its analytical approach over time to use a full-fuel-cycle measure of energy consumption when assessing national and environmental impacts, especially with respect to the calculation of greenhouse gas emissions. The NAS committee also recommended that DOE provide more comprehensive information to the public through labels and other means, such as an enhanced website. For those appliances that use multiple fuels (e.g., water heaters), the NAS committee indicated that measuring full-fuel-cycle energy consumption would provide a more complete picture of energy consumed and permit comparisons across many different appliances, as well as an improved assessment of impacts.

[77] The National Academies, Board on Energy and Environmental Systems, Letter to Dr. John Mizroch, Acting Assistant Secretary, U.S. DOE, Office of EERE from James W. Dally, Chair, Committee on Point-of-Use and Full-Fuel-Cycle Measurement Approaches to Energy Efficiency Standards (May 15, 2009).

In response to the NAS recommendations, DOE published in the Federal Register, on August 20, 2010, a Notice of Proposed Policy proposing to incorporate a full-fuel cycle analysis into the methods it uses to estimate the likely impacts of energy conservation standards on energy use and emissions. 75 FR 51423. Specifically, DOE proposed to use full-fuel-cycle (FFC) measures of energy and GHG emissions, rather than the primary (extended site) energy measures it currently uses. Additionally, DOE proposed to work collaboratively with the Federal Trade Commission (FTC) to make FFC energy and GHG emissions data available to the public so as to enable consumers to make cross-class comparisons. On October 7, 2010, DOE held an informal public meeting at DOE headquarters in Washington, DC to discuss and receive comments on its planned approach. The Notice of Proposed Policy, a transcript of the public meeting, and all public comments received by DOE are available at: http://www.regulations.gov/search/Regs/home.html#docketDetail?R=EERE-2010-BT-NOA-0028. DOE intends to develop a final policy statement on these subjects and then take steps to begin implementing that policy in rulemakings and other activities that are undertaken during 2011.

5. Net Present Value of Consumer Benefit

The inputs for determining the NPV of the total costs and benefits experienced by consumers of the considered appliances are: (1) total annual installed cost; (2) total annual savings in operating costs; and (3) a discount factor. DOE calculates net savings each year as the difference between the base case and each standards case in total savings in operating costs and total increases in installed costs. DOE calculates operating cost savings over the life of each product shipped in the forecast period.

DOE multiplies the net savings in future years by a discount factor to determine their present value. For the central air conditioners and heat pumps preliminary analysis and today's direct final rule, DOE estimated the NPV of appliance consumer benefits using both a 3-percent and a 7-percent real discount rate. DOE uses these discount rates in accordance with guidance provided by the Office of Management and Budget (OMB) to Federal agencies on the development of regulatory analysis.[78] The 7-percent real value is an estimate of the average before-tax rate of return to private capital in the U.S. economy. The 3-percent real value represents the "societal rate of time preference," which is the rate at which society discounts future consumption flows to their present value. The discount rates for the determination of NPV are in contrast to the discount rates used in the LCC analysis, which are designed to reflect a consumer's perspective

As noted above, DOE is accounting for the rebound effect associated with more-efficient furnaces, central air conditioners, and heat pumps in its determination of national energy savings. As previously discussed in section IV.F, because the rebound effect provides consumers with increased value (i.e., a more comfortable environment), DOE believes that, if it were able to monetize the increased value to consumers added by the rebound effect, this value would be similar in value to the foregone energy savings. For this standards rulemaking, DOE estimates that this value is equivalent to the

[78] OMB Circular A-4, section E, "Identifying and Measuring Benefits and Costs" (Sept. 17, 2003) (Available at: http://www.whitehouse.gov/omb/memoranda/m03-21.html).

monetary value of the energy savings that would have occurred without the rebound effect. Therefore, DOE concluded that the economic impacts on consumers with or without the rebound effect, as measured in the NPV, are the same.

6. Benefits from Effects of Standards on Energy Prices

In the furnaces RAP, DOE described its plans to use NEMS-BT to analyze the impact on natural gas prices resulting from amended standards on furnaces, and the associated benefits for all natural gas consumers in all sectors of the economy. Commenting on the RAP, EarthJustice stated that DOE must consider standards' economic benefit to the nation through reductions in natural gas prices resulting from gas furnace efficiency improvements. (FUR: EarthJustice, No. 1.3.014 at p. 7) In contrast, Ingersoll Rand stated that standards may bring gas users no cost savings, and that DOE should not incorporate any potential savings into its considerations. (FUR: Ingersoll Rand, No. 1.3.006 at p. 13)

For the direct final rule analysis, DOE used NEMS-BT to model the impact of the natural gas savings associated with possible standards on natural gas prices. The response of price observed in the NEMS-BT output changes over the forecast period based on the model's dynamics of natural gas supply and demand. For each year, DOE calculated the nominal savings in total natural gas expenditures by multiplying the estimated annual change in the national-average end-user natural gas price by the annual total U.S. natural gas consumption projected in AEO2010, adjusted for the estimated natural gas savings associated with each TSL. DOE then calculated the NPV of the savings in natural gas expenditures for 2016-2045 (or 2013-2045 for TSL 4), using 3-percent and 7-percent discount rates for each scenario.

Although amended standards for furnaces may yield benefits to all consumers associated with reductions in natural gas prices, DOE retains the position (recently set forth in the final rule for residential heating products (75 FR 20112, 20175 (April 16, 2010)) that it should not place a heavy emphasis on this factor in its consideration of the economic justification of standards. EPCA specifically directs DOE to consider the economic impact of an amended standard on manufacturers and consumers of the products subject to the standard. (42 U.S.C. 6295(o)(2)(B)(i)(I)) While it is true that EPCA directs DOE to consider other factors the Secretary considers relevant, in so doing, DOE takes under advisement the guidance provided by OMB on the development of regulatory analysis. Specifically, Circular A-4 states, "You should not include transfers in the estimates of the benefits and costs of a regulation."[79] When gas prices drop in response to lower demand and lower output of existing natural gas production capacity, consumers benefit but producers suffer. In economic terms, the situation represents a benefits transfer to consumers (whose expenditures fall) from producers (whose revenue falls equally). On the other hand, when gas prices decrease because extraction costs decline, however, consumers and producers both benefit, and the change in natural gas prices represents a net gain to society. Consumers benefit from the lower prices, and producers, whose revenues and costs both fall, are no worse off. DOE is continuing to investigate the extent to which a change in natural gas prices projected to result from

[79] OMB Circular A-4, section E, "Identifying and Measuring Benefits and Costs" (Sept. 17, 2003), p.38. (Available at: http://www.whitehouse.gov/omb/memoranda/m03-21.html).

potential standards represents a net gain to society. At this time, however, it is not able to reasonably determine the extent of transfers associated with a decrease in gas prices resulting from appliance standards.

Reduction in electricity consumption associated with amended standards for central air conditioners and heat pumps could reduce the electricity prices charged to consumers in all sectors of the economy and thereby reduce total electricity expenditures. In chapter 2 of the central air conditioners and heat pumps preliminary TSD, DOE explained that, because the electric power industry is a complex mix of fuel and equipment suppliers, electricity producers, and distributors, and because it has a varied institutional structure, DOE did not plan to estimate the value of potentially-reduced electricity costs for all consumers associated with amended standards for central air conditioners and heat pumps.

Commenting on the preliminary TSD, NPCC stated that the economic benefits of the reduced need for new power plants should be estimated using the NEMS-BT forecast. (FUR: NPCC, No. 74 at p. 6) ACEEE made a similar point. (ACEEE, No. 72 at p. 7)

For the direct final rule, DOE used NEMS-BT to assess the impacts of the reduced need for new electric power plants and infrastructure projected to result from amended standards. In NEMS-BT, changes in power generation infrastructure affect utility revenue requirements, which in turn affect electricity prices. DOE estimated the impact on electricity prices associated with each considered TSL. Although the aggregate benefits for electricity users are potentially large, there may be negative effects on some of the actors involved in the electricity supply chain, particularly power plant providers and fuel suppliers. Because there is uncertainty about the extent to which the benefits for electricity users from reduced electricity prices would be a transfer from actors involved in the electricity supply chain to electricity consumers, DOE has concluded that, at present, it should not place a heavy emphasis on this factor in its consideration of the economic justification of new or amended standards. DOE is continuing to investigate the extent to which electricity price changes projected to result from amended standards represent a net gain to society.

H. Consumer Subgroup Analysis

In analyzing the potential impacts of new or amended standards on consumers, DOE evaluates the impacts on identifiable subgroups of consumers that may be disproportionately affected by a national standard. DOE evaluates impacts on particular subgroups of consumers primarily by analyzing the LCC impacts and PBP for those particular consumers from alternative standard levels.

In the central air conditioners and heat pumps preliminary TSD, DOE stated that it will evaluate impacts on consumer subgroups, especially low-income and small-business consumers. For the direct final rule, DOE also analyzed a consumer subgroup consisting of households occupied solely by senior citizens (senior-only households) for national standards. However, in the 2005 RECS sample used for the subgroup analysis, the number of low-income and senior-only households with a central air conditioner was too small to produce reliable results at the regional level, and the number of low-income and senior-only households with a heat pump was too small to produce reliable results at either the national or the regional level. Accordingly, DOE performed the analysis for these subgroups only at the national level and only for air conditioners.

During the development of the preliminary TSD, it was thought that an analysis could be done of small businesses. However, DOE was not able to locate information on the energy use or economic characteristics of commercial users of residential air conditioning units in commercial buildings, so no analysis was done of a small business subgroup.

In the furnaces RAP, DOE stated its intention to evaluate impacts of amended furnace standards on low-income and senior-only households, because the potential higher first cost of products that meet amended standards may lead to negative impacts for these particular groups. In response to the furnaces RAP, DOE received comments about which subgroups should be included in the consumer subgroup analysis. AGA and APGA stated that DOE should analyze the new construction and replacement markets separately for the subgroup analysis. (FUR: AGA, No. 1.3.010 at pp. 3-4; APGA, No. 1.3.004 at p. 4) Southern stated that DOE should consider multi-family housing units and dwellings that require significant venting system work to accommodate a new furnace. (FUR: Southern, No. 1.2.006 at pp. 227–28) Ingersoll Rand stated that DOE should consider landlords and tenants as subgroups for the analysis. (FUR: Ingersoll Rand, No.

1.3.006 at p. 15) NPGA stated that owners of manufactured homes should be considered as a subgroup. (FUR: NPGA, No. 1.3.005 at p. 4)

For the direct final rule analysis, DOE evaluated the impacts of the considered energy efficiency standard levels for non-weatherized gas furnaces on low-income consumers and senior citizens (i.e., senior-only households). DOE did not analyze these subgroups for mobile home gas furnaces or oil-fired furnaces because of the small sample sizes in the 2005 RECS database. In response to comments, for non-weatherized gas furnaces, DOE analyzed the impacts for three other subgroups: (1) multi-family housing units; (2) new homes; and (3) replacement applications.

DOE did not consider dwellings that require significant venting system work to accommodate a new furnace as a subgroup, because there is no way to define "significant" venting system work that would not be arbitrary. DOE did not consider landlords and tenants as subgroups because DOE's LCC and payback period calculation method implicitly assumes that either the landlord purchases an appliance and also pays its energy costs, or in those cases where the tenant pays the energy costs, the landlord purchases an appliance and passes on the expense in the rent. If a landlord passes on the expense in the rent, which is the more common situation, he or she is not a "consumer" in the context of DOE's methodology, so landlords are not a meaningful consumer subgroup. DOE does not consider tenants (renters) as a consumer subgroup because: (1) DOE is not able to evaluate the pace at which the incremental purchase cost of a covered product is passed on in the rent, and (2) not all tenants pay the energy costs for their dwelling.

DOE did not consider owners of manufactured homes as a subgroup because the impacts of potential amended standards on these consumers are addressed in the LCC and PBP analysis of mobile home gas furnaces.

DOE did not perform a subgroup analysis for the standby mode and off mode efficiency levels. The standby mode and off mode LCC analysis relied on the test procedure to assess energy savings for the off mode efficiency levels, and, thus, energy savings are not different for population subgroups. In addition, the analysis was done with national average energy prices and national average markups for residential and commercial users, and thus, these inputs would not vary for the subgroups. The information sources for the other parameters affecting LCC (e.g., repair and maintenance cost) also did not differ by subgroup.

Results of the subgroup analysis are presented in section V.B.1.b of today's direct final rule. For further information, consult chapter 11 of the direct final rule TSD, which describes the consumer subgroup analysis and its results.

I. Manufacturer Impact Analysis

1. Overview

DOE performed a manufacturer impact analysis (MIA) to estimate the financial impact of amended energy conservation standards on manufacturers of residential furnaces and central air conditioners and heat pumps, and to calculate the impact of such standards on direct employment and manufacturing capacity. The MIA has both quantitative and qualitative aspects. The quantitative component of the MIA primarily relies on the Government Regulatory Impact Model (GRIM), an industry cash-flow model customized for this rulemaking. The key GRIM inputs are data on the industry cost structure, product costs, shipments, and assumptions about markups and conversion expenditures. The key output is the industry net present value (INPV). Different sets of assumptions (markup scenarios) will produce different results. The qualitative component of the MIA addresses factors such as product characteristics, industry and market trends, and includes an assessment of the impacts of standards on sub-groups of manufacturers. Chapter 12 of the direct final rule TSD describes the complete MIA.

DOE conducted the MIA for this rulemaking in three phases. In Phase 1, "Industry Profile," DOE prepared an industry characterization. In Phase 2, "Industry Cash Flow," DOE focused on the financial aspects of the industry as a whole. In this phase, DOE used the publicly-available information gathered in Phase 1 to prepare an industry cash flow analysis using the GRIM model. DOE adapted the GRIM structure specifically to analyze the impact of new and amended standards on manufacturers of residential furnace and central air conditioner and heat pump products. In Phase 3, "Sub-

Group Impact Analysis," the Department conducted structured, detailed interviews with a representative cross-section of manufacturers that represent approximately 75 percent of furnace and central air conditioning sales. During these interviews, DOE discussed engineering, manufacturing, procurement, and financial topics specific to each company, and obtained each manufacturer's view of the industry as a whole. The interviews provided valuable information that the Department used to evaluate the impacts of potential amended standards on manufacturers' cash flows, manufacturing capacities, and employment levels. Each of these phases is discussed in further detail below.

a. Phase 1: Industry Profile

In Phase 1 of the MIA, DOE prepared a profile of the residential furnace and central air conditioner and heat pump industry based on the Market and Technology Assessment (MTA) prepared for this rulemaking. Before initiating detailed impact studies, DOE collected information on the present and past structure and market characteristics of the industry. This information included market share, product shipments, markups, and cost structure for various manufacturers. The industry profile includes: (1) detail on the overall market and product characteristics; (2) estimated manufacturer market shares; (3) financial parameters such as net plant, property, and equipment (i.e., after accounting for depreciation), SG&A expenses, cost of goods sold, etc.; and (4) trends in the residential furnace and central air conditioner and heat pump industry, including the number of firms, technology, sourcing decisions, and pricing.

The industry profile included a top-down cost analysis of residential furnace and central air conditioner and heat pump manufacturers that DOE used to derive preliminary financial inputs for the GRIM (e.g., revenues; SG&A expenses; research and development (R&D) expenses; and tax rates). DOE also used public sources of information to further calibrate its initial characterization of the industry, including company SEC 10–K filings, Moody's company data reports, corporate annual reports, the U.S. Census Bureau's 2008 Economic Census, and Dun & Bradstreet reports.

b. Phase 2: Industry Cash Flow Analysis

Phase 2 of the MIA focused on the financial impacts of the potential amended energy conservation standards on the industry as a whole. New or more-stringent energy conservation standards can affect manufacturer cash flow in three distinct ways: (1) by creating a need for increased investment; (2) by raising production costs per unit; and (3) by altering revenue due to higher per-unit prices and possible changes in sales volumes. To quantify these impacts, in Phase 2, DOE used the GRIM to perform a cash-flow analysis of the residential furnace and central air conditioner and heat pump industry. In performing this analysis, DOE used the financial values determined during Phase 1, which were updated based on industry feedback and additional research, and the shipment projections used in the NIA. The GRIM modeled both impacts from energy efficiency standards (standards based on SEER, HSPF, and AFUE ratings) and impacts from standby mode and off mode standards (standards based on standby mode and off mode wattage). The GRIM results from the two standards were evaluated independent of one another.

c. Phase 3: Sub-Group Impact Analysis

In Phase 3, DOE conducted interviews with manufacturers and refined its preliminary cash flow analysis. Many of the manufacturers interviewed also participated in interviews for the engineering analysis. As indicated above, the MIA interviews broadened the discussion from primarily technology-related issues to include finance-related topics. One key objective for DOE was to obtain feedback from the industry on the assumptions used in the GRIM and to isolate key issues and concerns. See section IV.I.3 for a description of the key issues manufacturers raised during the interviews.

Using average-cost assumptions to develop an industry cash-flow estimate may not adequately assess differential impacts of new or amended standards among manufacturer sub-groups. For example, small manufacturers, niche players, or manufacturers exhibiting a cost structure that largely differs from the industry average could be more negatively affected. Thus, during Phase 3, DOE used the results of the industry characterization analysis in Phase 1 to evaluate how groups of manufacturers could be differentially affected by potential standards, and to group manufacturers that exhibited similar production and cost structure characteristics. The manufacturer interviews provided additional, valuable information on manufacturer subgroups.

DOE investigated whether small business manufacturers should be analyzed as a manufacturer subgroup. During its research, DOE identified multiple companies that manufacture products covered by this rulemaking and qualify as a small business under the applicable Small Business Administration (SBA) definition. The SBA defines a "small business" as having 750 employees or less for NAICS 333415, "Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing." As a result of this inquiry, DOE decided to analyze small business manufacturers as a separate subgroup in this direct final rule. The small businesses were further sub-divided by product class to understand the impacts of the rulemaking on those entities. The small business subgroup is discussed in chapter 12 of the direct final rule TSD and in section VI.B.1 of today's notice.

2. GRIM Analysis

As discussed previously, DOE uses the GRIM to quantify the changes in cash flow that result in a higher or lower industry value due to amended standards. The GRIM uses a discounted cash-flow analysis that incorporates manufacturer costs, markups, shipments, and industry financial information as inputs. The GRIM models changes in costs, distribution of shipments, investments, and manufacturer margins that could result from amended energy conservation standards. The GRIM spreadsheet uses the inputs to arrive at a series of annual cash flows, beginning in 2010 (the base year of the analysis) and continuing to 2045 (the last year of the analysis period). DOE calculated INPVs by summing the stream of annual discounted cash flows during these periods.

The GRIM calculates cash flows using standard accounting principles and compares changes in INPV between the base case and each TSL (the standards case). The difference in INPV between the base case and standards case represents the financial impact of the amended standard on manufacturers. The GRIM results are shown in section V.B.2. Additional details about the GRIM can be found in chapter 12 of the direct final rule TSD.

DOE typically presents its estimates of industry impacts by grouping the major product classes served by the same manufacturers. In the residential HVAC industry, split-system air conditioning, split-system heat pumps, single-package air conditioning, single-package heat pumps, and non-weatherized gas furnaces make up 95 percent of total shipments, according to the NIA shipment model for 2010. These five product classes are considered to be “conventional” products. Manufacturers that compete in the marketplace for conventional products generally produce products in all five conventional product classes.

Additionally, consumer selection of conventional products is often interdependent. As discussed in section IV.G.1 of the NIA methodology, the shipments forecasts that are an input to the GRIM incorporate product switching among the split-system air conditioning, split-system heat pumps, and non-weatherized gas furnaces product classes. To better capture the impacts of this rulemaking on industry, DOE aggregates results for split-system air conditioning, split-system heat pumps, single-package air conditioning, single-package heat pumps, and non-weatherized gas furnaces into a single “conventional” product grouping.

In section V.B.2.d pertaining to the MIA analysis, DOE discusses impacts on subgroups of manufacturers that produce niche products. Niche products, which serve much smaller segments of the market with unique needs, are produced by different manufacturers and include niche furnace products and niche central air conditioning and heat pumps products. Niche furnace products include weatherized gas furnaces, oil furnaces, and mobile home furnaces. Niche central air conditioning and heat pump products consist of the space-constrained and the small-duct, high-velocity (SDHV) product classes.

For the weatherized gas furnaces product class and the space-constrained product class, the current energy efficiency standard was determined to be equal to the max-tech efficiency level in the engineering analysis. Based on DOE's screening analysis, teardown analysis, and market research, DOE determined it would be unable to raise the energy efficiency standards on these products due to the state of technology and the design constraints inherent to these products. Therefore, DOE concluded that there is no need to perform an additional analysis for these products given that the current standard already meets the max-tech efficiency. For these product classes, no manufacturer impact analysis for energy efficiency standards was performed.

For the small-duct, high-velocity product class, limited information was available for this market niche. DOE had insufficient information to build a shipments forecast model, and thus, did not perform a quantitative analysis using the GRIM for this product class. However, DOE did conduct interviews with manufacturers of this product class and has performed a qualitative analysis of the impacts on manufacturers of SDHV products.

For consideration of standby mode and off mode regulations, DOE modeled the impacts of the design options for reducing electricity usage discussed in section IV.C.7 pertaining to the engineering analysis. The GRIM analysis incorporates the additional MPC cost of standby mode and off mode features and the resulting impacts on markups.

Due to the small cost of standby mode and off mode components relative to the overall cost of a furnace, central air conditioner, or heat pump, DOE assumes that standards regarding standby mode and off mode features alone will not impact product shipment numbers. Additionally, DOE does not believe the incremental cost of standby mode and off mode features will have a differentiated impact on manufacturers of different product classes. DOE models the impact of standby mode and off mode for the industry as a whole.

The GRIM results for standby mode and off mode standards include the electric furnace product class. Based on product catalogue information, DOE concluded that the major manufacturers of conventional products are also the major manufacturers of electric furnaces.

The space-constrained and SDHV product classes were not analyzed in the GRIM for energy efficiency standards. As a result, quantitative numbers are also not available for the GRIM analyzing standby mode and off mode standards. However, the standby mode and off mode design options considered for space-constrained and SDHV products are identical to the design options for split-systems air conditioning and heat pump products. DOE expects the standby mode and off mode impacts on space-constrained and SDHV products to be of the same order of magnitude as the impacts on split-system air conditioning and heat pump products.

a. GRIM Key Inputs

i. Manufacturer Production Costs

Manufacturing a higher-efficiency product is typically more expensive than manufacturing a baseline product due to the use of more complex components and higher-cost raw materials. The changes in the manufacturer production cost (MPC) of the analyzed products can affect revenues, gross margins, and cash flow of the industry, making these product cost data key GRIM inputs for DOE's analysis.

In the MIA, DOE used the MPCs for each considered efficiency level calculated in the engineering analysis, as described in section IV.C.1 pertaining to the engineering analysis and further detailed in chapter 5 of the direct final rule TSD. In addition, DOE used information from its teardown analysis, described in section IV.C.1, to disaggregate the MPCs into material, labor, and overhead costs. To calculate the MPCs for products above the baseline, DOE added the incremental material, labor, and overhead costs from the engineering cost-efficiency curves to the baseline MPCs. These cost breakdowns and product mark-ups were validated with manufacturers during manufacturer interviews.

ii. Base-Case Shipments Forecast

The GRIM estimates manufacturer revenues based on total unit shipment forecasts and the distribution of shipments by product class and efficiency level. Changes in the efficiency mix at each potential standard level affect manufacturer finances. For this analysis, the GRIM uses the NIA shipments forecasts from 2010, the base year for the MIA analysis, to 2045, the last year of the analysis period. In the shipments analysis, DOE estimates the distribution of efficiencies in the base case for all product classes. See section IV.G.1, above, for additional details.

iii. Shipment Forecasts

The GRIM used shipments figures developed in the NIA for residential furnace and central air conditioner and heat pump products. To determine efficiency distributions for the standards case, DOE used a "roll-up + market shift" scenario. DOE assumed that product efficiencies in the base case that did not meet the standard under consideration would "roll up" to meet the new standard in the standard year, when compliance with amended standards is required. DOE further assumed that revised standards would result in a market shift such that market shares of products with efficiencies better than the standard would gradually increase because "market-pull" programs, such as ENERGY STAR, would continue to promote efficient appliances after amended standards are introduced.

The shipment forecasts account for possible product switching that may occur among split-system air conditioning, split-system heat pumps, non-weatherized gas furnaces, and electric furnaces. The product switching calculations incorporate considerations of consumer climate zones, existing equipment, equipment costs, and installation costs. In the MIA results discussion in section V.B.2, the presentation of INPV and the MIA analysis of conventional products incorporate the impacts of product switching. See section IV.G.1 of this direct final rule and chapter 10 of the direct final rule TSD for more information on the standards-case shipment scenario.

iv. Product and Capital Conversion Costs

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

DOE assessed the product conversion costs at each considered standard level by integrating data from multiple sources. Those R&D expenditures, and other components of product conversion cost, were validated through manufacturer interviews. DOE considered feedback from multiple manufacturers at each level. Manufacturer numbers were averaged using market share weighting of each company to provide a number that better reflects the industry as a whole.

DOE also evaluated the level of capital conversion expenditures manufacturers would incur to comply with energy conservation standards. DOE used the manufacturer interviews to gather data on the level of capital investment required at each possible efficiency level. Manufacturer values were aggregated and scaled using market share weighting to better reflect the industry. Additionally, DOE validated manufacturer comments through estimates of capital expenditure requirements derived from the product teardown analysis and engineering model described in section IV.C.1.

In general, DOE assumes that all conversion-related investments occur between the announcement year and the standards compliance year. For evaluation of the TSL corresponding to the consensus agreement, DOE used the accelerated timeframes to reflect the compliance dates recommended in the agreement. The GRIM models all furnace conversion costs occurring during the period between 2011 and 2013 for the TSL corresponding to the consensus agreement. Similarly, DOE assumed all central air conditioner and heat pump conversion costs would occur between 2011 and 2015 for the TSL corresponding to the consensus agreement.

For standby mode and off mode, DOE did not receive quantitative feedback during MIA interviews on the conversion costs associated with standby mode and off mode features. Based on the design options from the engineering analysis, DOE assumed that the standby mode and off mode capital conversion costs would be small relative to the capital conversion cost for meeting energy efficiency standards. However, DOE did incorporate product conversion costs for R&D, testing, and revision of marketing materials. The product conversion costs were based on product testing cost quotations and on market information about the number of platforms and product families for each manufacturer.

The investment figures used in the GRIM can be found in section V.B.2.a of today's notice. For additional information on the estimated product conversion and capital conversion costs, see chapter 12 of the TSD.

b. Markup Scenarios

As discussed above, manufacturer selling prices (MSPs) include direct manufacturing production costs (i.e., labor, material, and overhead estimated in DOE's MPCs) and all non-production costs (i.e., SG&A, R&D, and interest), along with profit. To calculate the MSPs in the GRIM, DOE applied markups to the MPCs estimated in the engineering analysis for each product class and efficiency level. Modifying these markups in the standards case yields different sets of impacts on manufacturers. For the MIA, DOE modeled three standards-case markup scenarios to represent the uncertainty regarding the potential impacts on prices and profitability for manufacturers following the implementation of amended energy conservation standards: (1) a tiered markup scenario, (2) a preservation of earnings before interest and taxes (EBIT), and (3) a preservation of gross margin percentage. These scenarios lead to different markups values which, when applied to the inputted MPCs, result in varying revenue and cash flow impacts. The first and second scenarios were determined to best represent the impacts of potential energy efficiency standards on industry mark ups. The second and third scenarios were used to model potential standby mode and off mode standards, because pricing tiers would not likely be impacted by standby mode and off mode standards.

Under the "preservation of gross margin percentage" scenario, DOE applied a single uniform "gross margin percentage" markup across all efficiency levels. As production costs increase with efficiency, this scenario implies that the absolute dollar markup will increase as well. DOE assumed the non-production cost markup—which includes SG&A expenses, R&D expenses, interest, and profit—stays constant at the base-case percentage even as the standards-case efficiency increases. This markup is consistent with the one DOE assumed in the base case for the GRIM. Manufacturers noted in interviews that it is optimistic to assume that as their production costs increase in response to an amended energy conservation standard, they would be able to maintain the same gross margin percentage markup. Therefore, DOE assumed that this scenario represents a high bound to industry profitability under an energy conservation standard.

The tiered markup scenario models the situation in which manufacturers set markups based on three tiers of products. The tiers described by manufacturers in MIA interviews were defined as "good, better, best," or "value, standard, premium." The high-volume "value" product lines typically have fewer features, lower efficiency, and lower markups, while "premium" product lines typically have more features, higher efficiency, and higher markups. In the standards case, the tiered markups scenario considers the situation in which the breadth of a manufacturer's portfolio of products shrinks and amended standards "demote" higher-tier products to lower tiers. As a result, higher-efficiency products that previously commanded "standard" and "premium" mark-ups are assigned "value" and "standard" markups, respectively.

In the preservation of earnings before interest and taxes (EBIT) scenario, the manufacturer markups are set so that EBIT one year after the compliance date of the amended energy conservation standards is the same as in the base case. Under this scenario, as the cost of production and the cost of sales go up, manufacturers are generally required to reduce their markups to a level that maintains base-case operating profit. The implicit assumption behind this markup scenario is that the industry can only maintain its operating profit in absolute dollars after the amended standards. Operating margin in percentage terms is squeezed (reduced) between the base case and standards case.

During the March 2010 public meeting for residential furnaces and the May 2010 public meeting for central air conditioners and heat pumps and in the written comments for those public meetings, there were no comments on the assumptions of the preliminary MIA.

3. Manufacturer Interviews

As part of the MIA interviews, DOE discussed potential impacts of standards with five of the seven leading manufacturers of residential furnaces, central air conditioners, and heat pumps.[80] DOE also interviewed six niche product manufacturers.

In the interviews, DOE asked manufacturers to describe their major concerns about this rulemaking. The following sections discuss manufacturers' concerns about the most significant issues they identified.

a. Consensus Agreement

All manufacturers interviewed either strongly supported or were amenable to the consensus agreement that was recommended and signed by a number of manufacturers, advocacy organizations, and trade groups. Most interviewees were signatories and urged the Department to act as quickly as possible to adopt the consensus agreement. Manufacturers indicated that the consensus agreement provides regulatory certainty, manageable conversion costs, and accelerated compliance dates that provide energy savings earlier than would otherwise be achieved. Due to the tight timelines outlined in the agreement, manufacturers stated their desire for DOE to adopt the agreement as soon as possible in order to have sufficient time to meet the agreement's energy conservation standards and associated compliance dates.

80 The remaining two major manufacturers were approached, but they declined to be interviewed.

b. Potential for Significant Changes to Manufacturing Facilities

During interviews, several manufacturers indicated that central air conditioning and heat pump conversion costs are not linear, but would step up dramatically at various efficiency levels. In general, manufacturers were concerned that a national baseline energy conservation standard above 14 SEER for split-system air conditioners and split-system heat pumps would require extensive and costly product line redesigns. At various higher efficiency levels, system designs would have to incorporate additional or more complex technologies, including two-stage compressors, ECM fan motors, and larger heater exchangers. Therefore, to reach higher levels, units would have to increase in size, necessitating larger cabinet sizes and the purchase of new equipment and tooling. Several large manufacturers indicated that offshore production or completely new production facilities would be considered above 14 SEER due to the scope of changes required to meet an amended standard. Manufacturer estimates for the total investment required to meet national standards in the 14.5 to 16 SEER range varied widely, often depending on the current state of each manufacturer's production lines and whether a completely new production facility was required.

c. Increase in Product Repair and Migration to Alternative Products

Several manufacturers stated that the higher cost of more-efficient systems resulting from amended energy conservation standards would need to be passed on to consumers, absorbed by manufacturers, or some combination of both. If manufacturers were to attempt to pass on higher costs, the industry is concerned higher prices would result in consumers pursing lower-cost, less-efficient alternatives. In addition, manufacturers believe that consumers, facing higher first costs, would be more likely to repair older, less-efficient heating and cooling systems rather than replace those units with new, more-efficient models. Similarly, manufacturers expressed concern that consumers would be more likely to switch to lower up-front cost, lower-efficiency technologies such as room air conditioners and electric space heaters. Manufacturers agreed that these alternatives would reduce energy savings and reduce energy conserved.

As evidence, manufacturers cited market trends following the 2006 compliance date of the 2004 central air conditioners and heat pump energy conservation rulemaking. 69 FR 50997 (Aug. 14, 2004). Since 2006, manufacturers have noted a decline in central air conditioner and heat pump sales coupled with an increase in room air conditioner sales and an increase in orders for repair components. In general, the manufacturers are concerned that the decline in shipments from 2006 to 2010 will continue, and that a revised energy conservation standard will exacerbate the decline in unitary air conditioner shipments.

d. HFC Phase-Out Legislation

Manufacturers expressed strong concerns about legislation proposed in Congress that would phase out HFC refrigerants, including R-410A and R-134a. Any phase-out would require extensive redesign of all central air conditioners and heat pump products to make use of an alternative refrigerant. Manufacturers asserted that there is no clear replacement for HFC refrigerants today. Without a clear replacement, the manufacturers stated that any phase-out would create a period of uncertainty as the industry identifies suitable alternatives and then redesigns products around the replacement. It is unclear what efficiency levels could be achieved at reasonable cost without HFC refrigerants. Manufacturers observed that past phase-outs generally have led to more-expensive and less-efficient refrigerant replacements. Additionally, manufacturers stated that alternative refrigerants may require substantially larger systems to achieve the same levels of performance.

e. Physical Constraints

Multiple manufacturers expressed concern that an increase in appliance efficiency standards would leave older homes, and multi-family homes in particular, with few cost-effective options for replacing their cooling systems. As the efficiency of air conditioning increases, the physical sizes of the units also increase. Manufacturers are concerned because central air conditioner and heat pump units are already so large that they can be difficult to fit into some end-user homes. Attic entry ways, basement doors, and condensing unit pads all present physical constraints when replacing an air conditioner with a larger, more-efficient system. Multifamily homes are particularly restricted due to the limited space in utility closets and due to the limited options for renovation. These physical constraints lead to higher installation costs, which may encourage customers to repair existing systems rather than replace them.

f. Supply Chain Constraints

Some manufacturers expressed concern about the impact of more-stringent standards on their supply chain. Changes in energy conservation standards could affect the competitive positioning and dominance of component suppliers. One manufacturer cited the example of the 2001 central air conditioner rulemaking (66 FR 7170 (Jan. 22, 2001)), after which one of two critical compressor suppliers nearly went bankrupt (because the change in standards led most manufacturers to choose design options that favored the technology of one supplier over the other). According to the manufacturer, having the industry rely on a single supplier for critical components, even just a few, puts the entire industry at risk.

Additionally, manufacturers stated that more-stringent energy conservation standards would increase the demand for some key components over current levels. Given that most manufacturers rely on the same set of suppliers, amended standards could result in long lead times for obtaining critical components, such as high-efficiency compressors, ECM motors, modulating gas valves, advanced control systems, and new production tooling.

J. Employment Impact Analysis

DOE considers employment impacts in the domestic economy as one factor in selecting a standard. Employment impacts consist of both direct and indirect impacts. Direct employment impacts are any changes in the number of employees of manufacturers of the appliance products which are the subject of this rulemaking, their suppliers, and related service firms. Indirect employment impacts are changes in national employment that occur due to the shift in expenditures and capital investment caused by the purchase and operation of more-efficient appliances. The MIA addresses the direct employment impacts that concern manufacturers of furnaces, central air conditioners, and heat pumps. The employment impact analysis addresses the indirect employment impacts.

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

One method for assessing the possible effects on the demand for labor of such shifts in economic activity is to compare sectoral employment statistics developed by the Labor Department's BLS.[81] The BLS regularly publishes its estimates of the number of jobs per million dollars of economic activity in different sectors of the economy, as well

[81] Data on industry employment, hours, labor compensation, value of production, and the implicit price deflator for output for these industries are available upon request by calling the Division of Industry Productivity Studies (202-691-5618) or by sending a request by e-mail to dipsweb@bls.gov. (Available at: http://www.bls.gov/news.release/prin1.nr0.htm.)

as the jobs created elsewhere in the economy by this same economic activity. Data from BLS indicate that expenditures in the utility sector generally create fewer jobs (both directly and indirectly) than expenditures in other sectors of the economy. There are many reasons for these differences, including wage differences and the fact that the utility sector is more capital-intensive and less labor-intensive than other sectors.[82]

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

For the standards considered in today's direct final rule, DOE estimated indirect national employment impacts using an input/output model of the U.S. economy called Impact of Sector Energy Technologies (ImSET). ImSET is a spreadsheet model of the U.S. economy that focuses on 187 sectors most relevant to industrial, commercial, and residential building energy use.[83] ImSET is a special purpose version of the "U.S.

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

[83] M.J. Scott, O.V. Livingston, J.M. Roop, R.W. Schultz, and P.J. Balducci, ImSET 3.1: Impact of Sector Energy Technologies; Model Description and User's Guide (2009) (Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-18412.pdf).

Benchmark National Input-Output" (I–O) model,[84] which has been designed to estimate the national employment and income effects of energy-saving technologies. The ImSET software includes a computer-based I–O model with structural coefficients to characterize economic flows among the 187 sectors. ImSET's national economic I–O structure is based on a 2002 U.S. benchmark table, specially aggregated to the 187 sectors. DOE estimated changes in expenditures using the NIA spreadsheet. Using ImSET, DOE then estimated the net national, indirect employment impacts by sector of potential amended efficiency standards for furnaces, central air conditioners, and heat pumps.

No comments were received on the preliminary TSD for central air conditioners and heat pumps or the furnaces RAP concerning the employment impacts analysis. For more details on the employment impact analysis, see chapter 13 of the direct final rule TSD.

K. Utility Impact Analysis

The utility impact analysis estimates several important effects on the utility industry that would result from the adoption of new or amended energy conservation standards. For the direct final rule analysis, DOE used the NEMS-BT model to generate forecasts of electricity and natural gas consumption, electricity generation by plant type, and electric generating capacity by plant type, that would result from each considered TSL. DOE obtained the energy savings inputs associated with efficiency improvements to the subject products from the NIA. DOE conducts the utility impact analysis as a

[84] R.L. Stewart, J.B. Stone, and M.L. Streitwieser. U.S. Benchmark Input-Output Accounts, 2002. Survey of Current Business, October 2007. (Available at http://www.bea.gov/scb/pdf/2007/10%20October/1007_benchmark_io.pdf)

scenario that departs from the latest AEO Reference case. For this direct final rule, the estimated impacts of amended energy conservation standards are the differences between values forecasted by NEMS–BT and the values in the AEO2010 Reference case (which does not contemplate amended standards).

As part of the utility impact analysis, DOE used NEMS-BT to assess the impacts on natural gas prices of the reduced demand for natural gas projected to result from the considered standards. DOE also used NEMS-BT to assess the impacts on electricity prices of the reduced need for new electric power plants and infrastructure projected to result from the considered standards. In NEMS-BT, changes in power generation infrastructure affect utility revenue, which in turn affects electricity prices. DOE estimated the change in electricity prices projected to result over time from each considered TSL. The benefits associated with the impacts of today's standards on energy prices are discussed in section IV.G.5.

For more details on the utility impact analysis, see chapter 14 of the direct final rule TSD.

L. Environmental Assessment

Pursuant to the National Environmental Policy Act of 1969 and the requirements of 42 U.S.C. 6295(o)(2)(B)(i)(VI), DOE has prepared an environmental assessment (EA) of the impacts of the potential standards for residential furnaces, central air conditioners, and heat pumps in today's rule, which it has included as chapter 15 of the direct final rule TSD.

In the EA, DOE estimated the reduction in power sector emissions of CO_2, NO_X, and Hg using the NEMS–BT computer model. In the EA, NEMS–BT is run similarly to the AEO NEMS, except that furnace, central air conditioner, and heat pump energy use is reduced by the amount of energy saved (by fuel type) due to each TSL. The inputs of national energy savings come from the NIA spreadsheet model, while the output is the forecasted physical emissions. The net benefit of each TSL in today's rule is the difference between the forecasted emissions estimated by NEMS–BT at each TSL and the AEO 2010 Reference Case. NEMS–BT tracks CO_2 emissions using a detailed module that provides results with broad coverage of all sectors and inclusion of interactive effects. Because the on-site operation of non-electric heating products requires use of fossil fuels and results in emissions of CO_2, $NO_{X,}$ and sulfur dioxide (SO_2), DOE also accounted for the reduction in these emissions due to potential amended standards at the sites where these appliances are used. For today's direct final rule, DOE used NEMS-BT based on AEO 2010. For the final rule, DOE intends to revise the emissions analysis using the most current version of NEMS-BT.

DOE determined that SO_2 emissions from affected fossil-fuel-fired combustion devices (also known as Electric Generating Units (EGUs)) are subject to nationwide and regional emissions cap-and-trade programs that create uncertainty about the potential amended standards' impact on SO_2 emissions. Title IV of the Clean Air Act, 42 U.S.C.

7401-7671q, sets an annual emissions cap on SO_2 for all affected EGUs in the 48 contiguous States and the District of Columbia (DC). SO_2 emissions from 28 eastern States and DC are also limited under the Clean Air Interstate Rule (CAIR, 70 FR 25162 (May 12, 2005)), which created an allowance-based trading program. Although CAIR has been remanded to the EPA by the U.S. Court of Appeals for the District of Columbia (DC Circuit), see North Carolina v. EPA, 550 F.3d 1176 (DC Cir. 2008), it remains in effect temporarily, consistent with the D.C. Circuit's earlier opinion in North Carolina v. EPA, 531 F.3d 896 (DC Cir. 2008). On July 6, 2010, EPA issued the Transport Rule proposal, a replacement for CAIR, which would limit emissions from EGUs in 32 States, potentially through the interstate trading of allowances, among other options. 75 FR 45210 (Aug. 2, 2010).

The attainment of the emissions caps is flexible among EGUs and is enforced through the use of emissions allowances and tradable permits. Under existing EPA regulations, and under the Transport Rule if it is finalized, any excess SO_2 emission allowances resulting from the lower electricity demand caused by the imposition of an efficiency standard could be used to permit offsetting increases in SO_2 emissions by any regulated EGU. However, if the amended standard resulted in a permanent increase in the quantity of unused emission allowances, there would be an overall reduction in SO_2 emissions from the standards. While there remains some uncertainty about the ultimate effects of efficiency standards on SO_2 emissions covered by the existing cap and trade system, the NEMS-BT modeling system that DOE uses to forecast emissions reductions currently indicates that no physical reductions in power sector emissions would occur for SO_2.

A cap on NO_X emissions, affecting electric generating units in the CAIR region, means that energy conservation standards may have little or no physical effect on NO_X emissions in the 28 eastern States and the D.C. covered by CAIR, or any States covered by the proposed Transport Rule if the Transport Rule is finalized. The standards would, however, reduce NO_X emissions in those 22 States not affected by the CAIR. As a result, DOE used NEMS–BT to forecast emission reductions from the standards considered for today's direct final rule.

Similar to emissions of SO_2 and NO_X, future emissions of Hg would have been subject to emissions caps. In May 2005, EPA issued the Clean Air Mercury Rule (CAMR). 70 FR 28606 (May 18, 2005). CAMR would have permanently capped emissions of mercury for new and existing coal-fired power plants in all States by 2010. However, on February 8, 2008, the DC Circuit issued its decision in New Jersey v. Environmental Protection Agency, 517 F.3d 574 (DC Cir. 2008), in which it vacated CAMR. EPA has decided to develop emissions standards for power plants under Section 112 of the Clean Air Act, consistent with the DC Circuit's opinion on the CAMR. See http://www.epa.gov/air/mercuryrule/pdfs/certpetition_withdrawal.pdf. Pending EPA's forthcoming revisions to the rule, DOE is excluding CAMR from its environmental assessment. In the absence of CAMR, a DOE standard would likely reduce Hg emissions, and DOE is using NEMS-BT to estimate these emission reductions. However, DOE continues to review the impact of rules that reduce energy consumption on Hg emissions, and may revise its assessment of Hg emission reductions in future rulemakings.

The operation of non-electric heating products requires use of fossil fuels and results in emissions of CO_2, NO_X, and SO_2 at the sites where these appliances are used. NEMS-BT provides no means for estimating such emissions. DOE calculated the effect of potential standards in today's rule on the above site emissions based on emissions factors that are described in chapter 15 of the direct final rule TSD.

Commenting on the furnaces RAP, EEI stated that DOE should include the environmental impacts of furnace production, especially if higher standards involve more equipment being manufactured in and transported from other countries. (FUR: EEI, No. 1.3.015 at p. 6) APPA made a similar point. (FUR: APPA, No. 1.3.011 at p. 5)

In response, DOE notes that the inputs to the EA for national energy savings come from the NIA. In the NIA, DOE only accounts for primary energy savings associated with considered standards. In so doing, EPCA directs DOE to consider (when determining whether a standard is economically justified) "the total projected amount of energy . . . savings likely to result directly from the imposition of the standard." (42 U.S.C. 6295(o)(2)(B)(i)(III)) DOE interprets the phrase "directly from the imposition of the standard" to include energy used in the generation, transmission, and distribution of fuels used by appliances. In addition, DOE is evaluating the full-fuel-cycle measure, which includes the energy consumed in extracting, processing, and transporting primary fuels (see section IV.G.3). Both DOE's current accounting of primary energy savings and the full-fuel-cycle measure are directly linked to the energy used by appliances. In contrast, energy used in manufacturing and transporting appliances is a step removed from the energy used by appliances. Thus, DOE did not consider such energy use in either the NIA or the EA.

EEI commented that DOE's environmental assessment should consider the standards' effect on emissions associated with the extraction, refining, and transport of oil and natural gas. (FUR: EEI, No. 1.3.015 at p. 7) As noted in chapter 15 of the TSD, DOE developed only qualitative estimates of effects on upstream fuel-cycle emissions because NEMS-BT does a thorough accounting only of emissions at the power plant due to downstream energy consumption. In other words, NEMS-BT does not account for upstream emissions. Therefore, the environmental assessment for today's rule did not estimate effects on upstream emissions associated with oil and natural gas. As discussed in section IV.G.3, however, DOE is in the process of developing an approach that will allow it to estimate full-fuel-cycle energy use associated with products covered by energy conservation standards.

M. Monetizing Carbon Dioxide and Other Emissions Impacts

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

For today's direct final rule, DOE relied on a set of values for the social cost of carbon (SCC) that was developed an interagency process. A summary of the basis for these values is provided below, and a more detailed description of the methodologies used is provided as in chapter 16 of the direct final rule TSD.

1. Social Cost of Carbon

Under section 1(b) of Executive Order 12866, "Regulatory Planning and Review," 58 FR 51735 (Oct. 4, 1993), agencies must, to the extent permitted by law, "assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs." The purpose of the SCC estimates presented here is to allow agencies to incorporate the monetized social benefits of reducing CO_2 emissions into cost-benefit analyses of regulatory actions that have small, or "marginal," impacts on cumulative global emissions. The estimates are presented with an acknowledgement of the many uncertainties involved and with a clear understanding that they should be updated over time to reflect increasing knowledge of the science and economics of climate impacts.

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

a. Monetizing Carbon Dioxide Emissions

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

When attempting to assess the incremental economic impacts of carbon dioxide emissions, the analyst faces a number of serious challenges. A recent report from the National Research Council[85] points out that any assessment will suffer from uncertainty, speculation, and lack of information about: (1) future emissions of greenhouse gases; (2) the effects of past and future emissions on the climate system; (3) the impact of changes in climate on the physical and biological environment; and (4) the translation of these environmental impacts into economic damages. As a result, any effort to quantify and monetize the harms associated with climate change will raise serious questions of science, economics, and ethics and should be viewed as provisional.

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

Despite the serious limits of both quantification and monetization, SCC estimates can be useful in estimating the social benefits of reducing carbon dioxide emissions. Consistent with the directive in Executive Order 12866 quoted above, the purpose of the SCC estimates presented here is to make it possible for agencies to incorporate the social benefits from reducing carbon dioxide emissions into cost-benefit analyses of regulatory actions that have small, or "marginal," impacts on cumulative global emissions. Most Federal regulatory actions can be expected to have marginal impacts on global emissions.

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

At the time of the preparation of this notice, the most recent interagency estimates of the potential global benefits resulting from reduced CO_2 emissions in 2010, expressed in 2009$, were $4.9, $22.1, $36.3, and $67.1 per metric ton avoided. For emission reductions that occur in later years, these values grow in real terms over time. Additionally, the interagency group determined that a range of values from 7 percent to 23 percent should be used to adjust the global SCC to calculate domestic effects,[86] although preference is given to consideration of the global benefits of reducing CO_2 emissions.

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

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

To date, economic analyses for Federal regulations have used a wide range of values to estimate the benefits associated with reducing carbon dioxide emissions. In the final model year 2011 CAFE rule, the Department of Transportation (DOT) used both a "domestic" SCC value of $2 per ton of CO_2 and a "global" SCC value of $33 per ton of CO_2 for 2007 emission reductions (in 2007 dollars), increasing both values at 2.4 percent

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

per year.[87] See *Average Fuel Economy Standards Passenger Cars and Light Trucks Model Year 2011*, 74 FR 14196 (March 30, 2009) (Final Rule); Final Environmental Impact Statement Corporate Average Fuel Economy Standards, Passenger Cars and Light Trucks, Model Years 2011-2015 at 3-90 (Oct. 2008) (Available at: http://www.nhtsa.gov/fuel-economy). It also included a sensitivity analysis at $80 per ton of CO_2. A domestic SCC value is meant to reflect the value of damages in the United States resulting from a unit change in carbon dioxide emissions, while a global SCC value is meant to reflect the value of damages worldwide.

A 2008 regulation proposed by DOT assumed a domestic SCC value of $7 per ton of CO_2 (in 2006 dollars) for 2011 emission reductions (with a range of $0-$14 for sensitivity analysis), also increasing at 2.4 percent per year. See *Average Fuel Economy Standards, Passenger Cars and Light Trucks, Model Years 2011-2015*, 73 FR 24352 (May 2, 2008) (Proposed Rule); Draft Environmental Impact Statement Corporate Average Fuel Economy Standards, Passenger Cars and Light Trucks, Model Years 2011-2015 at 3-58 (June 2008) (Available at: http://www.nhtsa.gov/fuel-economy). A regulation for packaged terminal air conditioners and packaged terminal heat pumps finalized by DOE in October of 2008 used a domestic SCC range of $0 to $20 per ton CO_2 for 2007 emission reductions (in 2007 dollars). 73 FR 58772, 58814 (Oct. 7, 2008). In addition, EPA's 2008 Advance Notice of Proposed Rulemaking for Greenhouse Gases identified what it described as "very preliminary" SCC estimates subject to revision. See *Regulating Greenhouse Gas Emissions Under the Clean Air Act*, 73 FR 44354 (July 30, 2008) (Advance Notice of Proposed Rulemaking). EPA's global mean values were $68

[87] Throughout this section, the term "tons of CO_2" refers to metric tons.

and \$40 per ton CO_2 for discount rates of approximately 2 percent and 3 percent, respectively (in 2006 dollars for 2007 emissions). See id. at 44416.

In 2009, an interagency process was initiated to offer a preliminary assessment of how best to quantify the benefits from reducing carbon dioxide emissions. To ensure consistency in how benefits are evaluated across agencies, the Administration sought to develop a transparent and defensible method, specifically designed for the rulemaking process, to quantify avoided climate change damages from reduced CO_2 emissions. The interagency group did not undertake any original analysis. Instead, it combined SCC estimates from the existing literature to use as interim values until a more comprehensive analysis could be conducted. The outcome of the preliminary assessment by the interagency group was a set of five interim values: global SCC estimates for 2007 (in 2006 dollars) of \$55, \$33, \$19, \$10, and \$5 per ton of CO_2.

These interim values represent the first sustained interagency effort within the U.S. government to develop an SCC for use in regulatory analysis. The results of this preliminary effort were presented in several proposed and final rules and were offered for public comment in connection with proposed rules, including the joint EPA-DOT fuel economy and CO_2 tailpipe emission proposed rules. See CAFE Rule for Passenger Cars and Light Trucks Draft EIS and Final EIS, cited above.

c. Current Approach and Key Assumptions

Since the release of the interim values, the interagency group reconvened on a regular basis to generate improved SCC estimates, which were considered in the evaluation of today's rule. Specifically, the group considered public comments and further explored the technical literature in relevant fields. The interagency group relied on three integrated assessment models (IAMs) commonly used to estimate the SCC: the FUND, DICE, and PAGE models.[88] These models are frequently cited in the peer-reviewed literature and were used in the last assessment of the Intergovernmental Panel on Climate Change. Each model was given equal weight in the SCC values that were developed.

Each model takes a slightly different approach to model how changes in emissions result in changes in economic damages. A key objective of the interagency process was to enable a consistent exploration of the three models while respecting the different approaches to quantifying damages taken by the key modelers in the field. An extensive review of the literature was conducted to select three sets of input parameters for these models: (1) climate sensitivity; (2) socio-economic and emissions trajectories; and (3) discount rates. A probability distribution for climate sensitivity was specified as an input into all three models. In addition, the interagency group used a range of scenarios for the socio-economic parameters and a range of values for the discount rate. All other model features were left unchanged, relying on the model developers' best estimates and judgments.

[88] The models are described in appendix 16-A of the direct final rule TSD.

The interagency group selected four SCC values for use in regulatory analyses. Three values are based on the average SCC from three integrated assessment models, at discount rates of 2.5, 3, and 5 percent. The fourth value, which represents the 95th-percentile SCC estimate across all three models at a 3-percent discount rate, is included to represent higher-than-expected impacts from temperature change further out in the tails of the SCC distribution. For emissions (or emission reductions) that occur in later years, these values grow in real terms over time, as depicted in Table IV.24.

Table IV.24 Social Cost of CO_2, 2010–2050 (in 2007 dollars per metric ton)

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

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

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

In summary, in considering the potential global benefits resulting from reduced CO_2 emissions, DOE used the most recent values identified by the interagency process, adjusted to 2009$ using the GDP price deflator values for 2008 and 2009. For each of the four cases specified, the values used for emissions in 2010 were $4.9, $22.1, $36.3, and $67.1 per metric ton avoided (values expressed in 2009$). To monetize the CO_2 emissions reductions expected to result from amended standards for furnaces, central air conditioners, and heat pumps, DOE used the values identified in Table A1 in the "Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866," which is reprinted as appendix 16A of the direct final rule TSD, appropriately adjusted to 2009$.[89]

[89] Table A1 in appendix 16-A presents SCC values through 2050. For DOE's calculation, it derived values after 2050 using the 3-percent per year escalation rate used by the interagency group.

To calculate a present value of the stream of monetary values, DOE discounted the values in each of the four cases using the specific discount rate that had been used to obtain the SCC values in each case.

2. Valuation of Other Emissions Reductions

DOE investigated the potential monetary benefit of reduced NO_X emissions from the TSLs it considered. As noted above, new or amended energy conservation standards would reduce NO_X emissions in those 22 States that are not affected by the CAIR, in addition to the reduction in site NO_X emissions nationwide. DOE estimated the monetized value of NO_X emissions reductions resulting from each of the TSLs considered for today's direct final rule based on environmental damage estimates from the literature. Available estimates suggest a very wide range of monetary values, ranging from $370 per ton to $3,800 per ton of NO_X from stationary sources, measured in 2001$ (equivalent to a range of $447 to $4,591 per ton in 2009$).[90] In accordance with OMB guidance, DOE conducted two calculations of the monetary benefits derived using each of the economic values used for NO_X, one using a real discount rate of 3 percent and another using a real discount rate of 7 percent.[91]

DOE is aware of multiple agency efforts to determine the appropriate range of values used in evaluating the potential economic benefits of reduced Hg emissions. DOE

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

[91] OMB, Circular A-4: Regulatory Analysis (Sept. 17, 2003).

has decided to await further guidance regarding consistent valuation and reporting of Hg emissions before it once again monetizes Hg emissions reductions in its rulemakings.

Commenting on the central air conditioners and heat pumps preliminary TSD, Southern stated that the incremental climate change from a rulemaking is too uncertain to be included in the decision-making for energy conservation standard levels, and the benefits of reduced carbon emissions should not be included. (CAC: SCS, No. 73 at p. 2) Commenting on the furnaces RAP, several parties provided comments regarding the economic valuation of CO_2 emissions. EEI objected to using the global value for the social cost of carbon because the rest of DOE's analyses use domestic values. (FUR: EEI, No. 1.3.015 at pp. 8–9) APPA recommended that DOE use a set of hyperbolic discount rates for the value of CO_2. It also stated that the wide range of values for the SCC could adversely impact the calculation of benefits from amended energy conservation standards, and that DOE should consider the value of carbon reduction separately from the NIA analysis. (FUR: APPA, No. 1.3.011 at p. 5)

DOE acknowledges that the economic value of future CO_2 emissions reductions is uncertain, and for this reason, it uses a wide range of potential values, and a range of discount rates, as described above. DOE further notes that the estimated monetary benefits of reduced CO_2 emissions are only one factor among many that DOE considers in evaluating the economic justification of potential standard levels.

As to whether DOE should consider the value of carbon reduction separately from the NIA, the NIA assesses the national energy savings and the national net present value of total consumer costs and savings expected to result from standards at specific efficiency levels. Thus, DOE does not aggregate the estimated economic benefits of avoided CO_2 emissions (and other emissions) into the NIA. However, it does believe that the NPV of the monetized benefits associated with emissions reductions can be viewed as a complement to the NPV of the consumer savings expected to result from new or amended energy conservation standards. Therefore, in section V of this notice, DOE presents the NPV values that result from adding the estimates of the potential economic benefits resulting from reduced CO_2 and NO_X emissions in each of four valuation scenarios to the NPV of consumer savings calculated for each TSL considered in this rulemaking.

Commenting on the furnaces RAP, EEI stated that utilities have embedded the cost of complying with existing environmental legislation in the price for electricity and that DOE must not double-count the benefits of reduced emissions related to standards. (FUR: EEI, No. 1.3.015 at p. 6) In response, DOE calculates emissions reductions associated with potential standards relative to an AEO Reference case that includes the costs of complying with existing environmental legislation. The AEO Reference case still has emissions, of course, which are reduced in the case of standards. The reduction in emissions avoids impacts on human health or other damages, and DOE's monetization of emissions reductions seeks to quantify the value of those avoided damages.

V. Analytical Results

The following section addresses the results from DOE's analyses with respect to potential energy conservation standards for the products examined as part of this rulemaking. It addresses the trial standard levels examined by DOE, the projected impacts of each of these levels if adopted as energy conservation standards for furnaces, central air conditioners, and heat pumps, and the standards levels that DOE is adopting in today's direct final rule. Additional details regarding the analyses conducted by DOE are contained in the publicly-available direct final rule TSD supporting this notice.

A. Trial Standard Levels

DOE analyzed the benefits and burdens of a number of TSLs for the furnaces, central air conditioners, and heat pumps that are the subject of today's rule. A description of each TSL DOE analyzed is provided below. DOE attempted to limit the number of TSLs considered for the direct final rule by excluding efficiency levels that do not exhibit significantly different economic and/or engineering characteristics from the efficiency levels already selected as TSLs. While DOE only presents the results for those efficiency levels in TSL combinations in today's direct final rule, DOE presents the results for all efficiency levels that it analyzed in the direct final rule TSD.

1. TSLs for Energy Efficiency[92]

Table V.1 presents the TSLs and the corresponding product class efficiency levels that DOE considered for furnace, central air conditioner, and heat pump energy

[92] In the context of presenting TSLs and results for each of them, DOE uses the term "energy efficiency" to refer to potential standards on SEER, HSPF, and AFUE throughout section V of this notice. TSLs for standby mode and off mode are addressed separately in the next section.

efficiency. Eight product classes are specified in Table V.1: (1) split-system central air conditioners (SAC); (2) split-system heat pumps (SHP); (3) single-package central air conditioners (PAC); (4) single-package heat pumps (PHP); (5) SDHV systems; (6) non-weatherized gas furnaces (NWGF); (7) oil furnaces (OF); and (8) mobile home gas furnaces (MHF).

TSL 7 consists of the max-tech efficiency levels. For split-system central air conditioners and heat pumps, max-tech levels vary by capacity (tonnage) and, in the case of air conditioners, the type of unit (i.e., coil-only or blower-coil). Specifically, for split-system central air conditioners, the max-tech level specified in Table V.1of 22 SEER pertains only to 3-ton blower-coil units. The max- tech levels for the other tonnages and unit types are: 24.5 SEER for 2-ton, blower-coil; 18 SEER for 5-ton, blower-coil and 2-ton, coil-only; 17 SEER for 3-ton, coil-only; and 16 SEER for 5-ton, coil-only. For split-system heat pumps, the max-tech level specified in Table V.1 of 21 SEER / 9.9 HSPF pertains only to 3-ton units. The max-tech levels for the other tonnages are: 22 SEER / 9.9 HSPF for 2-ton; and 17 SEER / 9.0 HSPF for 5-ton.

TSL 6 consists of a cooling efficiency level of 15 SEER for all central air conditioner and heat pump product classes with the exception of specifying a cooling efficiency level of 14 SEER for split-system central air conditioners in the "rest of country" region (i.e., the North) and SDHV systems. For furnaces, TSL 6 consists of efficiency levels for each product class which are one level below the max-tech level.

TSL 5 consists of cooling efficiency levels for each central air conditioner and heat pump product class which are one level below the efficiencies in TSL 6. This corresponds to a cooling efficiency level of 14 SEER for all product classes with the exception of specifying a cooling efficiency at the baseline level (13 SEER) for split-system central air conditioners in the "rest of country" region (i.e., the North) and SDHV systems. For furnaces, TSL 5 consists of the same efficiency levels as TSL 6 (i.e., each product class has an efficiency level which is one level below the max-tech level).

TSL 4 consists of the efficiency levels included in the consensus agreement, including accelerated compliance dates (i.e., by 3 years for furnaces and 1.5 years for central air conditioners and heat pumps) and requirements for a second metric (EER) applicable to split-system air conditioners and packaged air conditioners in the hot-dry region. For SDHV systems, TSL 4 consists of the baseline efficiency level.

TSL 3 consists of the same efficiency levels as specified in TSL 4, except with a lead time for compliance of five years after the final rule publication, and no EER requirements for split system air conditioners and packaged air conditioners in the hot-dry region. TSL 2 consists of the efficiency levels within each region that correspond to those products which currently have the largest market share. TSL 1 refers to a single national standard and consists of the efficiency levels in each product class with the largest market share. For SDHV systems, TSLs 1, 2, and 3 consist of the baseline efficiency level.

Table V.1. Trial Standard Levels for Central Air Conditioners, Heat Pumps, and Furnaces (Energy Efficiency)

		SAC	**SHP**	**PAC**	**PHP**	**SDHV**	**NWGF**	**OF**	**MHF**
TSL	**Region Applicable**	*SEER*	*SEER/HSPF*	*SEER*	*SEER/HSPF*	*SEER/HSPF*	*AFUE*	*AFUE*	*AFUE*
7	Rest of Country*	22**	21 / 9.9[†]	16.5	16.5 / 9.0	14.5 / 8.6	98%	97%	96%
	North (Furnace)						98%		96%
	Hot Humid (CAC-HP)	22**	21 / 9.9[†]	16.5	16.5 / 9.0	14.5 / 8.6			
	Hot Dry (CAC-HP)	22**	21/ 9.9[†]	16.5	16.5 / 9.0	14.5 / 8.6			
6	Rest of Country*	14	15 / 8.5	15	15 / 8.4	14 / 8.5	80%	85%	80%
	North (Furnace)						95%		96%
	Hot Humid (CAC-HP)	15	15 / 8.5	15	15 / 8.4	14 / 8.5			
	Hot Dry (CAC-HP)	15	15 / 8.5	15	15 / 8.4	14 / 8.5			
5	Rest of Country*	13	14 / 8.2	14	14 / 8.0	13 / 7.7	80%	85%	80%
	North (Furnace)						95%		96%
	Hot Humid (CAC-HP)	14	14 / 8.2	14	14 / 8.0	13 / 7.7			
	Hot Dry (CAC-HP)	14	14 / 8.2	14	14 / 8.0	13 / 7.7			
4[††]	Rest of Country*	13	14 / 8.2	14	14 / 8.0	13 / 7.7	80%	83%	80%
	North (Furnace)						90%		90%
	Hot Humid (CAC-HP)	14	14 / 8.2	14	14 / 8.0	13 / 7.7			
	Hot Dry (CAC-HP)	14 / 12.2 & 11.7 EER	14 / 8.2	14 / 11 EER	14 / 8.0	13 / 7.7			
3	Rest of Country*	13	14 / 8.2	14	14 / 8.0	13 / 7.7	80%	83%	80%
	North (Furnace)						90%		90%
	Hot Humid (CAC-HP)	14	14 / 8.2	14	14 / 8.0	13 / 7.7			
	Hot Dry (CAC-HP)	14	14 / 8.2	14	14 / 8.0	13 / 7.7			
2	Rest of Country*	13.5	13.5 / 8.1	13	13 / 7.7	13 / 7.7	80%	82%	80%
	North (Furnace)						92%		80%
	Hot Humid (CAC-HP)	13.5[‡]	13.5 / 8.1[‡]	13[‡]	13 / 7.7[‡]	13 / 7.7			
	Hot Dry (CAC-HP)	13.5[‡]	13.5 / 8.1[‡]	13[‡]	13 / 7.7[‡]	13 / 7.7			
1	Nation	13.5	13.5 / 8.1	13	13 / 7.7	13 / 7.7	80%	82%	80%

* The values presented under "Rest of Country" are the national standards, but they effectively apply to those States not subject to regional standards. Rest of Country refers to the Northern region for SAC, SHP and SDHV and to the Southern region for NWGF and MHF. For PAC, PHP and OF, the value refers to the entire Nation.

** Max-tech of 22 SEER pertains to 3-ton blower-coil units only, which is the most common cooling capacity of products on the market. Max-tech efficiencies vary by tonnage and type. See chapter 5 of the direct final rule TSD or section III.G.2 of this direct final rule for more information on the max-tech efficiency levels.

[†] Max- tech of 21 SEER / 9.9 HSPF pertains to 3-ton units only, which is the most common cooling capacity of products on the market. Max-tech efficiencies vary by tonnage. See chapter 5 of the direct final rule TSD or section III.G.2 of this direct final rule for more information on the max-tech efficiency levels.

[††] Compliance date is 1/1/2015 for central air conditioners and heat pumps and 5/1/2013 for furnaces. For the Hot Dry region, TSL 4 has separate EER levels for SAC of 12.2 and 11.7 based on capacity (see section III.B.2).

[‡] Largest market share unknown; assumed to be equal to the market share for entire Nation.

2. TSLs for Standby Mode and Off Mode Power

Table V.2 presents the TSLs and the corresponding product class efficiency levels (expressed in watts) that DOE considered for furnace, central air conditioner, and heat pump standby mode and off mode power consumption. For the central air conditioner product classes, DOE considered three efficiency levels, while for the heat pump and furnace product classes, two efficiency levels were considered.

TSL 3 consists of the max-tech efficiency levels. For the central air conditioner product classes, the max-tech level is efficiency level 3, which specifies a maximum off mode power consumption of 29 watts. (For split-system central air conditioners, only blower-coil systems equipped with ECMs would be affected; the other system types are already below this level.) For the heat pump and furnace product classes, the max-tech level is efficiency level 2, which specifies a maximum standby mode and off mode power consumption of 9 watts for gas and electric furnaces and 10 watts for oil furnaces, and a maximum off mode power consumption of 32 watts for heat pumps.

TSL 2 represents the efficiency level from each product class that is just below the max-tech efficiency level. TSL 2 consists of efficiency level 2 for the central air conditioner product classes, which specifies a maximum off mode power consumption of 30 watts. . (For split-system central air conditioners, only blower-coil systems equipped with ECMs would be affected; the other system types are already below this level.) For the heat pump and furnace product classes, TSL 2 consists of efficiency level 1, which specifies a maximum standby mode and off mode power consumption of 10 watts for gas and electric furnaces and 11 watts for oil furnaces, and a maximum off mode power consumption of 33 watts for heat pumps.

TSL 1 consists of efficiency level 1 for all product classes. TSL 1 consists of efficiency level 1 for the central air conditioner product classes, which specifies a maximum off mode power consumption of 36 watts. For the heat pump and furnace product classes, it consists of efficiency level 1, which specifies a maximum standby mode and off mode power consumption of 10 watts for gas and electric furnaces and 11 watts for oil furnaces, and a maximum off mode power consumption of 33 watts for heat pumps. Because the heat pump and furnace product classes have only two considered efficiency levels, TSL 1 for these classes is no different than TSL 2.

Coil-only systems at efficiency level 1 would comply with off mode power requirements set at either efficiency levels 2 or 3 based on the blower-coil market. Of further note, in the case of efficiency level 3, only the fraction of the blower-coil market equipped with ECMs is impacted. Blower-coil systems with PSC motors and coil-only systems equipped with either ECMs or PSC motors that comply with the off mode power requirements in efficiency level 2 already meet the requirements in efficiency level 3.

Table V.2. Trial Standard Levels for Central Air Conditioners, Heat Pumps, and Furnaces (Standby Mode and Off Mode Power)

TSL	SAC	SHP	PAC	PHP	SDHV	SCAC*	SCHP*	NWGF	OF	MHF	EF
	Efficiency Level (Watts)										
3	29	32	29	32	29	29	32	9	10	9	9
2	30	33	30	33	30	30	33	10	11	10	10
1	36	33	36	33	36	36	33	10	11	10	10

*SCAC = Space-Constrained Air Conditioner; SCHP = Space-Constrained Heat Pump; and EF = electric furnace.

B. Economic Justification and Energy Savings

1. Economic Impacts on Individual Consumers

a. Life-Cycle Cost and Payback Period

Consumers affected by new or amended standards usually experience higher purchase prices and lower operating costs. DOE evaluates these impacts on individual consumers by calculating changes in life-cycle costs (LCC) and the payback period (PBP) associated with potential standard levels. Using the approach described in section IV.F, DOE calculated the LCC impacts and PBPs for the efficiency levels considered in this rulemaking. For each product class, DOE's analysis provided several outputs for each efficiency level. For energy efficiency, these results are reported for central air conditioners and heat pumps in Table V.3 through Table V.8, and for furnaces in Table V.9 through Table V.11. For standby mode and off mode, these results are reported for central air conditioners and heat pumps in Table V.12, and for furnaces in Table V.13. Each table includes the average total LCC and the average LCC savings, as well as the fraction of product consumers for which the LCC will either decrease (net benefit), or increase (net cost), or exhibit no change (no impact) relative to the product purchased in the base case. The last output in the tables is the median PBP for the consumer purchasing a design that complies with each TSL.

The results for each TSL are relative to the energy efficiency distribution in the base case (no amended standards). The average LCC savings and payback period presented in the tables were calculated only for those consumers that would be affected by a standard at a specific efficiency level. At some lower efficiency levels, no consumers would be impacted by a potential standard, because the products they would purchase in the base case are as efficient, or more efficient, than the specific efficiency level. In the cases where no consumers would be impacted, calculation of LCC savings or payback period is not applicable.

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

In its regional analysis, DOE used the same technology designs to describe the baseline and other considered efficiency levels in each region. However, the total installed cost varies among regions because the installation cost varies by region (due to labor cost differences), and in addition, there is some variation in the equipment price due to differences in the overall markup (including sales tax) among regions.

(i) Central Air Conditioners and Heat Pumps

Table V.3. LCC and PBP Results for Split-System Air Conditioners (Coil-Only)

Trial Standard Level	Efficiency Level <u>SEER</u>	Life-Cycle Cost (*2009$*)			Life-Cycle Cost Savings (*2009$*)				Paybac Period (years
						% of Consumers that Experience			
		Installed Cost	Discounted Operating Cost	LCC	Average Savings	Net Cost	No Impact	Net Benefit	Mediar
	Nation								
	Baseline	2,026	4,872	6,898	n/a	0	100	0	n/
1	13.5	2,074	4,770	6,844	55	11	75	14	9.
	Hot-Humid								
	Baseline	1,834	5,649	7,484	n/a	0	100	0	n/
2	13.5	1,880	5,514	7,393	86	7	75	18	5.
3,4,5	14	1,934	5,393	7,326	93	26	27	46	7.
6	15	2,515	5,188	7,702	(303)	73	16	12	34.
7	18*	3,365	4,923	8,288	(797)	90	0	10	46.
	Hot-Dry								
	Baseline	2,582	6,134	8,716	n/a	0	100	0	n/
2	13.5	2,642	5,977	8,619	104	10	75	14	8.
3,4,5	14	2,713	5,837	8,550	107	37	27	36	10.
6	15	3,510	5,598	9,108	(468)	75	16	9	49.
7	18*	4,673	5,288	9,960	(1,182)	91	0	9	71.
	North (Rest of Country)								
3,4 5	Baseline	2,127	3,476	5,603	n/a	0	100	0	n/
2	13.5	2,175	3,434	5,609	(8)	17	75	8	23.
6	14	2,231	3,401	5,633	(26)	56	27	16	33.
7	18*	3,753	3,360	7,113	(1,343)	99	0	1	100.

* Varies by size of equipment: 2-ton units are 18 SEER; 3-ton units are 17 SEER; and 5-ton units are 16 SEER.

Parentheses indicate negative (-) values. For LCCs, a negative value means an increase in LCC by the amount indicated.

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Table V.4. LCC and PBP Results for Split-System Air Conditioners (Blower-Coil)

Trial Standard Level	Efficiency Level SEER	Life-Cycle Cost (*2009$*) Installed Cost	Discounted Operating Cost	LCC	Life-Cycle Cost Savings (*2009$*) Average Savings	% of Consumers that Experience Net Cost	No Impact	Net Benefit	Payback Period (years) Median
	Nation								
	Baseline	3,015	4,869	7,884	n/a	0	100	0	n/
1	13.5	3,078	4,762	7,840	46	9	82	9	11.
	Hot-Humid								
	Baseline	2,774	5,640	8,413	n/a	0	100	0	n/
2	13.5	2,833	5,500	8,333	77	6	82	12	7.
3, 4, 5	14	2,894	5,371	8,265	89	21	45	34	7.
6	15	3,015	5,139	8,154	177	25	37	39	8.
7	24.5*	4,069	4,298	8,367	(130)	70	1	29	20.
	Hot-Dry								
	Baseline	3,825	6,171	9,995	n/a	0	100	0	n/
2	13.5	3,903	6,009	9,912	90	9	82	10	9.
3, 4, 5	14	3,984	5,860	9,844	101	28	45	27	10.
6	15	4,142	5,592	9,734	196	33	37	31	10.
7	24.5*	5,559	4,606	10,166	(311)	76	1	23	30.
	North (Rest of Country)								
3, 4, 5	Baseline	3,110	3,468	6,577	n/a	0	100	0	n/
2	13.5	3,172	3,422	6,594	(18)	14	82	4	26.
6	14	3,236	3,381	6,617	(30)	43	45	12	27.
7	24.5*	4,410	3,193	7,603	(903)	96	1	3	100.

*Varies by size of equipment: 2-ton units are 24.5 SEER; 3-ton units are 22 SEER; and 5-ton units are 18 SEER.

Parentheses indicate negative (-) values. For LCCs, a negative value means an increase in LCC by the amount indicated.

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Table V.5. LCC and PBP Results for Split-System Heat Pumps

Trial Standard Level	Efficiency Level SEER	Life-Cycle Cost (*2009$*)			Life-Cycle Cost Savings (*2009$*)				Payback Period (years)
		Installed Cost	Discounted Operating Cost	LCC	Average Savings	% of Consumers that Experience: Net Cost	No Impact	Net Benefit	Median
	Nation								
	Baseline	2,934	6,882	9,816	n/a	0	100	0	n/
1	13.5	2,999	6,743	9,742	71	5	86	9	6.
	Hot-Humid								
	Baseline	2,804	6,943	9,747	n/a	0	100	0	n/
2	13.5	2,867	6,791	9,658	82	4	86	10	6.
3, 4, 5	14	2,932	6,644	9,576	102	17	45	38	6.
6	15	3,114	6,383	9,496	137	29	23	48	7.
7	22*	3,983	5,513	9,496	103	60	0	40	12.
	Hot-Dry								
	Baseline	3,808	9,221	13,029	n/a	0	100	0	n/
2	13.5	3,890	8,987	12,877	148	4	86	11	4.
3, 4, 5	14	3,973	8,763	12,735	175	15	45	40	4.
6	15	4,212	8,348	12,560	274	25	23	52	5.
7	22*	5,387	6,894	12,280	477	51	0	49	9.
	North (Rest of Country)								
	Baseline	3,065	5,927	8,993	n/a	0	100	0	n/
2	13.5	3,129	5,861	8,990	5	9	86	5	13.
3, 4, 5	14	3,193	5,792	8,986	4	35	45	20	13.
6	15	3,380	5,693	9,073	(89)	58	23	19	20.
7	22*	4,262	5,362	9,624	(604)	87	0	13	32.

* Varies by size of equipment: 2-ton units are 22 SEER; 3-ton units are 21 SEER; and 5-ton units are 18 SEER.
Parentheses indicate negative (-) values. For LCCs, a negative value means an increase in LCC by the amount indicated.

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Table V.6. LCC and PBP Results for Single-Package Air Conditioners

Trial Standard Level	Efficiency Level <u>SEER</u>	Life-Cycle Cost (*2009$*)			Life-Cycle Cost Savings (*2009$*)				Payback Period (years)
						% of Consumers that Experience			
		Installed Cost	Discounted Operating Cost	LCC	Average Savings	Net Cost	No Impact	Net Benefit	Median
	Nation								
1, 2	Baseline 13	3,040	5,303	8,343	n/a	0	100	0	n/
3, 4, 5	14	3,223	5,077	8,301	37	50	17	33	15.
6	15	3,492	4,908	8,400	(68)	72	1	27	24.
7	16.5	4,064	4,760	8,825	(492)	84	0	16	46.

Parentheses indicate negative (-) values. For LCCs, a negative value means an increase in LCC by the amount indicated.

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Table V.7. LCC and PBP Results for Single-Package Heat Pumps

Trial Standard Level	Efficiency Level SEER	Life-Cycle Cost (*2009$*)			Life-Cycle Cost Savings (*2009$*)				Payback Period (years)
		Installed Cost	Discounted Operating Cost	LCC	Average Savings	% of Consumers that Experience			Median
						Net Cost	No Impact	Net Benefit	
	Nation								
1, 2	Baseline	3,623	7,834	11,457	n/a	0	100	0	n/
3, 4, 5	14	3,828	7,463	11,291	104	29	36	35	8.
6	15	4,163	7,182	11,345	15	63	2	35	13.
7	16.5	4,866	6,856	11,722	(363)	79	0	21	20.

Parentheses indicate negative (-) values. For LCCs, a negative value means an increase in LCC by the amount indicated.

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Table V.8. LCC and PBP Results for Small-Diameter High Velocity (SDHV) Air Conditioners

Trial Standard Level	Efficiency Level SEER	Life-Cycle Cost (*2009$*) Installed Cost	Discounted Operating Cost	LCC	Life-Cycle Cost Savings (*2009$*) Average Savings	% of Consumers that Experience Net Cost	No Impact	Net Benefit	Payback Period (years) Median
	Nation								
1	Baseline 13	4,915	4,853	9,768	n/a	0	100	0	n/
	Hot-Humid								
2-5	Baseline 13	4,610	5,643	10,253	n/a	0	100	0	n/
6	14	4,883	5,385	10,268	(14)	68	0	32	17.
7	14.5	5,029	5,250	10,279	(25)	67	0	33	17
	Hot-Dry								
2-5	Baseline 13	6,302	6,105	12,407	n/a	0	100	0	n/
6	14	6,665	5,807	12,472	(65)	74	0	26	26
7	14.5	6,859	5,654	12,513	(106)	74	0	26	23
	North (Rest of Country)								
2-5	Baseline 13	4,919	3,447	8,367	n/a	0	100	0	n/
6	14	5,198	3,370	8,568	(202)	95	0	5	74
7	14.5	5,347	3,313	8,660	(294)	92	0	8	74

Parentheses indicate negative (-) values. For LCCs, a negative value means an increase in LCC by the amount indicated.

(ii) Furnaces

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Table V.9. LCC and PBP Results for Non-Weatherized Gas Furnaces

Trial Standard Level	Efficiency Level AFUE	Life-Cycle Cost (*2009$*) Installed Cost	Discounted Operating Cost	LCC	Life-Cycle Cost Savings (*2009$*) Average Savings 2009$	% of Households that Experience Net Cost	No Impact	Net Benefit	Payback Period (years) Median
	Nation								
1	Baseline 80%	1,786	9,551	11,337	n/a	0	100	0	n/a
	South (Rest of Country)								
2-6	Baseline 80%	1,614	6,566	8,180	n/a	0	100	0	n/a
7	98%	2,661	5,624	8,286	(181)	72.3	0.2	27.4	28.9
	North								
3,4	90%	2,474	10,409	12,883	155	10.0	71.4	18.6	10.1
2	92%	2,536	10,206	12,742	215	10.9	56.5	32.6	7.7
5,6	95%	2,685	9,916	12,601	323	22.8	22.9	54.3	9.4
7	98%	2,943	9,784	12,727	198	58.7	0.6	40.7	17.1

Parentheses indicate negative (-) values. For LCCs, a negative value means an increase in LCC by the amount indicated.

Table V.10. LCC and PBP Results for Mobile Home Gas Furnaces

Trial Standard Level	Efficiency Level AFUE	Life-Cycle Cost (*2009$*)			Life-Cycle Cost Savings (*2009$*)				Payback Period (years)
						% of Households that Experience			
		Installed Cost	Discounted Operating Cost	LCC	Average Savings	Net Cost	No Impact	Net Benefit	Median
	Nation								
1	Baseline 80%	1,432	11,749	13,181	n/a	0	100	0	n/a
	South (Rest of Country)								
2-6	Baseline 80%	1,340	11,453	12,793	n/a	0	100	0	n/a
7	96%	2,415	9,780	12,194	391	51.0	3.8	45.2	13.0
	North								
2	Baseline 80%	1,488	13,060	14,548	n/a	0	100	0	n/a
3,4	90%	2,112	11,974	14,086	419	43.6	9.7	46.7	10.7
5-7	96%	2,611	11,301	13,912	585	46.2	7.7	46.1	11.5

Table V.11. LCC and PBP Results for Oil-fired Furnaces

Trial Standard Level	Efficiency Level AFUE	Life-Cycle Cost (*2009$*) Installed Cost	Discounted Operating Cost	LCC	Life-Cycle Cost Savings (*2009$*) Average Savings	% of Households that Experience Net Cost	No Impact	Net Benefit	Payback Period (years) Median
	Nation								
1, 2	Baseline 82%	3,008	30,287	33,295	n/a	0	100	0	n/a
3, 4	83%	3,157	29,946	33,103	15	9.9	58.3	31.8	1.0
5,6	85%	3,622	29,287	32,909	(18)	34.6	33.0	32.4	19.8
7	97%	4,810	27,809	32,619	272	51.0	0.9	48.1	18.2

(iii) Results for Standby Mode and Off Mode

Table V.12 and Table V.13 present the LCC and PBP results for the standby mode and off mode power efficiency levels considered for central air conditioners/heat pumps and furnaces, respectively.

Table V.12. LCC and PBP Results for Central Air Conditioner and Heat Pump Standby Mode and Off Mode Power

Trial Standard Level	Efficiency Level	Life-Cycle Cost (*2009$*) Installed Cost	Life-Cycle Cost (*2009$*) Discounted Operating Cost	Life-Cycle Cost (*2009$*) LCC	Life-Cycle Cost Savings (*2009$*) Average Savings	% of Households that Experience Net Cost	% of Households that Experience No Impact	% of Households that Experience Net Benefit	Payback Period (years) Median
	Split-System Air Conditioners (Blower-Coil)								
	Baseline	17	105	122	n/a	0	100	0	n/a
1	1	27	96	114	84	0	94	6	1
2	2	23	93	115	40	3	91	6	6
3	3	23	92	116	35	3	91	6	7
	Split-System Air Conditioners (Coil-Only)								
	Baseline	1	27	27	n/a	0	100	0	n/a
1, 2, 3	1	1	18	19	84	0	94	6	1
	Split-System Heat Pumps								
	Baseline	19	31	50	n/a	0	100	0	n/a
1, 2	1	23	21	44	9	0	67	33	4
3	2	26	21	47	(1)	19	57	24	5
	Single-Package Air Conditioners								
	Baseline	17	105	122	n/a	0	100	0	n/a
1	1	17	96	114	84	0	94	6	1
2	2	23	93	115	41	3	91	6	6
3	3	23	92	116	36	3	91	6	7
	Single-Package Heat Pumps								
	Baseline	20	31	51	n/a	0	100	0	n/a
1, 2	1	24	21	45	9	0	66	34	4
3	2	27	21	49	(1)	19	57	24	5
Small-Duct High-Velocity Air Conditioners									
	Baseline	18	107	124	n/a	0	100	0	n/a
1	1	18	98	116	84	0	94	6	1
2	2	24	94	117	37	3	91	6	7
3	3	24	94	118	32	3	91	6	7

Space-Constrained Air Conditioners									
	Baseline	17	107	123	n/a	0	100	0	n/a
1	1	17	98	115	84	0	94	6	1
2	2	23	94	117	42	3	91	6	6
3	3	23	94	117	37	3	91	6	7
Space-Constrained Heat Pumps									
	Baseline	19	31	50	n/a	0	100	0	n/a
1, 2	1	23	21	44	9	0	67	33	4
3	2	26	21	47	(1)	19	58	23	5

Parentheses indicate negative (-) values. For LCCs, a negative value means an increase in LCC by the amount indicated.

Table V.13. LCC and PBP Results for Furnace Standby Mode and Off Mode Power

Trial Standard Level	Efficiency Level	Life-Cycle Cost (*2009$*)			Life-Cycle Cost Savings (*2009$*)				Payback Period (years)
						% of Households that Experience			
		Installed Cost	Discounted Operating Cost	LCC	Average Savings	Net Cost	No Impact	Net Benefit	Median
	Non-weatherized Gas Furnaces								
	Baseline	0	133	133	n/a	0	100	0	n/a
1, 2	1	3	128	132	2	9.2	72.4	18.4	10.7
3	2	8	125	133	(0)	16.8	72.4	10.8	16.1
	Mobile Home Furnaces								
	Baseline	0	103	103	n/a	0	100	0	n/a
1, 2	1	1	102	103	(0)	5.7	90.6	3.8	11.9
3	2	4	101	104	(1)	7.7	90.6	1.8	17.9
	Oil-fired Furnaces								
	Baseline	0	180	180	n/a	0	100	0	n/a
1, 2	1	1	178	179	1	1.4	90.6	8.0	7.9
3	2	3	177	179	1	3.8	90.6	5.7	11.9
	Electric Furnaces								
	Baseline	0	111	111	n/a	0	100	0	n/a
1, 2	1	1	110	111	0	4.3	89.9	5.1	10.3
3	2	3	109	111	(1)	6.9	89.9	2.5	15.5

Parentheses indicate negative (-) values. For LCCs, a negative value means an increase in LCC by the amount indicated.

b. Consumer Subgroup Analysis[93]

(i) Central Air Conditioners and Heat Pumps

As described in section IV.H, for central air conditioners and heat pumps, DOE determined the impact of the considered energy efficiency TSLs on low-income households and senior-only households. For low-income and senior-only households, the sample sizes from 2005 RECS were very small (i.e., less than 1 percent of the entire sample) at the regional level for central air conditioners and even at the national level for heat pumps, so DOE only performed the subgroup analysis at the national level for air conditioners.

Table V.14 and Table V.15 present key results for split-system coil-only and blower-coil air conditioners, respectively. The analysis for low-income and senior-only households did not show substantially different impacts for these subgroups in comparison with the general population. See chapter 11 of the direct final rule TSD for further details.

Table V.14. Split-System Air Conditioners (Coil-Only): Comparison of Impacts for Consumer Subgroups and All Households, Nation

TSL	Efficiency Level SEER	LCC Savings (*2009$*)			Median Payback Period Years		
		Senior	Low Income	All	Senior	Low Income	All
1, 2	13.5	21	33	55	13	12	9
3, 4, 5	13	0	0	0	n/a	n/a	n/a
6	14	9	24	51	18	17	12
7	18*	(1,212)	(1,150)	(1,046)	100+	100+	100+

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[93] As described in section IV.H, DOE did not perform a subgroup analysis for the standby mode and off mode efficiency levels. The standby mode and off mode analysis relied on the test procedure to assess energy savings for the considered standby mode and off mode efficiency levels. Because the analysis used the same test procedure parameters for all sample households, the energy savings is the same among the consumer subgroups.

* Varies by size of equipment: 2-ton units are 18 SEER; 3-ton units are 17 SEER; and 5-ton units are 16 SEER.
Parentheses indicate negative (-) values. For LCCs, a negative value means an increase in LCC by the amount indicated.

Table V.15. Split-System Air Conditioners (Blower-Coil): Comparison of Impacts for Consumer Subgroups and All Households, Nation

TSL	Efficiency Level SEER	LCC Savings (*2009$*)			Median Payback Period Years		
		Senior	Low Income	All	Senior	Low Income	All
1, 2	13.5	11	25	46	15	15	11
3, 4, 5	13	0	0	0	n/a	n/a	n/a
6	14	7	22	49	17	16	13
7	24.5*	(696)	(630)	(421)	68	62	41

* Varies by size of equipment: 2-ton units are 24.5 SEER; 3-ton units are 22 SEER; and 5-ton units are 18 SEER.
Parentheses indicate negative (-) values. For LCCs, a negative value means an increase in LCC by the amount indicated.

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(ii) Furnaces

As described in section IV.H, for furnaces, DOE evaluated the impacts of the considered energy efficiency standard levels on low-income consumers and senior citizens (i.e., senior-only households). In addition, DOE analyzed the impacts for three other subgroups: (1) multi-family housing units; (2) new homes; and (3) replacement applications. DOE only presents the results for the Northern region in this section because, with the exception of TSL 7, there are no consumers impacted by national standards at the considered TSLs. At TSL 7, the impacts of national standards on the considered subgroups are approximately the same as the impacts of the standard for the Northern region.

Table V.16 compares the impacts of the TSLs for the Northern region for non-weatherized gas furnaces for low-income, senior-only, and multi-family households with those for all households. The senior and low-income households show somewhat higher LCC savings from more-efficient furnaces than the general population. In contrast, the multi-family households show lower LCC savings due to generally higher installation costs and lower heating energy use.

Table V.17 compares the impacts of the TSLs for the Northern region for non-weatherized gas furnaces for new home and replacement subgroups with those for all households. The households in new homes show significantly higher LCC savings because their average installation costs are lower, while the households in replacement applications show lower, but still positive, LCC savings compared to the general population. The latter result is primarily due to the high installation costs in some replacement applications. See chapter 11 of the direct final rule TSD for further details.

Table V.16. Non-Weatherized Gas Furnaces: Comparison of Impacts for Senior-Only, Low-Income, and Multi-Family Consumer Subgroups and All Households (North)

TSL	Efficiency Level AFUE	LCC Savings (2009$)				Median Payback Period Years			
		Senior	Low Income	Multi-Family	All	Senior	Low Income	Multi-Family	All
2, 4	90%	201	175	63	155	8.4	9.4	13.9	10.1
3	92%	273	242	104	215	6.6	7.2	9.8	7.7
5, 6	95%	410	367	176	323	8.3	8.5	11.3	9.4
7	98%	307	229	(26)	198	14.8	16.5	23.2	17.1

Parentheses indicate negative (-) values. For LCCs, a negative value means an increase in LCC by the amount indicated.

Table V.17. Non-Weatherized Gas Furnaces: Comparison of Impacts for Replacement and New Home Consumer Subgroups and All Households (North)

TSL	Efficiency Level AFUE	LCC Savings (2009$)			Median Payback Period Years		
		Replacement	New Home	All	Replacement	New Home	All

2, 4	90%	90	343	155	12.9	2.5	10.1
3	92%	151	404	215	9.0	5.1	7.7
5, 6	95%	262	502	323	9.7	8.8	9.4
7	98%	158	315	198	16.9	17.9	17.1

c. Rebuttable Presumption Payback

As discussed above, EPCA provides a rebuttable presumption that an energy conservation standard is economically justified if the increased purchase cost for a product that meets the standard is less than three times the value of the first-year energy (and, as applicable, water) savings resulting from the amended standard. (42 U.S.C. 6295(o)(2)(B)(iii)) In calculating a rebuttable presumption payback period for the considered standard levels, DOE used discrete values based on the applicable DOE test procedures rather than distributions for input values, and it based the energy use calculation on the DOE test procedures for furnaces and central air conditioners and heat pumps, as required by statute. Id. As a result, DOE calculated a single rebuttable presumption payback value, and not a distribution of payback periods, for each considered efficiency level.

For central air conditioner and heat pump energy efficiency, only single-package heat pumps at the 13.5 SEER level meet the less-than-three-year criteria. Rebuttable paybacks calculated for standby mode and off mode TSL 1 for the split system, single-package, small-duct high-velocity, and space-constrained air conditioners also meet the less-than-three-year criteria. None of the furnace energy efficiency levels meet the less-than-three-year criteria. The rebuttable presumption payback values for each considered efficiency level and product class are presented in chapter 8 of the direct final rule TSD.

While DOE examined the rebuttable presumption criterion, it considered whether the standard levels considered for today's direct final rule are economically justified through a more detailed analysis of the economic impacts of these levels, 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).

2. Economic Impacts on Manufacturers

DOE performed a manufacturer impact analysis (MIA) to estimate the impact of amended energy conservation standards on manufacturers of residential furnaces, central air conditioners, and heat pumps. The section below describes the expected impacts on manufacturers at each considered energy efficiency TSL (trial standard levels based on SEER, HSPF, and AFUE ratings) and each considered standby mode and off mode TSL (trial standard levels based on standby mode and off mode wattage). Chapter 12 of the TSD explains the analysis in further detail. A summary of the energy efficiency TSLs can be found in Table V.1, and a summary of standby mode and off mode TSLs can be found in Table V.2.

a. Industry Cash-Flow Analysis Results

Table V.18 through Table V.22 depict the financial impacts on manufacturers and the conversion costs DOE estimates manufacturers could incur at each TSL. The financial impacts on manufacturers are represented by changes in industry net present value (INPV). DOE presents the results by grouping product classes that are commonly produced by the same manufacturers.

Results for the energy efficiency standards for furnaces and central air conditioners and heat pumps are grouped as conventional products and niche products. These product groupings were analyzed under two markup scenarios: (1) the preservation of earnings before income and taxes (EBIT) scenario; and (2) the tiered markup scenario. As discussed in section IV.I.1 of the Methodology and Discussion section of this document, DOE considered the preservation of EBIT scenario to model manufacturer concerns about the inability to maintain their margins as manufacturing production costs increase to reach more-stringent efficiency levels. In this scenario, while manufacturers make the necessary investments required to convert their facilities to produce amended standards-compliant equipment, operating profit does not change in absolute dollars and decreases as a percentage of revenue.

DOE also considered the tiered markup scenario. The tiered markup scenario models the situation in which manufacturers maintain, when possible, three tiers of product markups. The tiers described by manufacturers in MIA interviews were defined as “good, better, best” or “value, standard, premium.” In the standards case, the tiered markups scenario considers the situation in which the breadth of a manufacturer’s portfolio of products shrinks and amended standards effectively “demote” higher-tier products to lower tiers. As a result, higher-efficiency products that previously commanded "standard" and "premium" mark-ups are assigned "value" and "standard" markups, respectively. Typically, a significant fraction of the market will seek the lowest-cost unit available for purchase, particularly in the new construction market. Manufacturers expect this phenomenon, in the standards case, to drive price competition at the new minimum efficiency and foster efforts to convert what was previously a "better" product into the new baseline "good" product. This scenario, therefore, reflects one of the industry's key concerns regarding this effect of product commoditization at higher efficiency levels.

Standby mode and off mode standards results are presented for the industry as a whole, without groupings. Due to the small incremental cost of standby mode and off mode components relative to the overall cost of furnaces, central air conditioners, and heat pumps, DOE has concluded that standby mode and off mode features would not have a differentiated impact on different manufacturers or different product classes. The impacts of standby mode and off mode features were analyzed for two markup scenarios: (1) a preservation of gross margin percentage scenario; and (2) a preservation of EBIT scenario. The preservation of gross margin percentage scenario assumes that manufacturers will maintain a constant gross margin percentage even as product costs increase in the standards case. This scenario represents an upper bound to manufacturer profitability after energy conservation standards are amended. In contrast, the preservation of EBIT scenario assumes manufacturers will not be able to maintain the base case gross margin level. Rather, as production costs go up, manufacturers will only be able to maintain the same operating profit—in absolute dollars—reducing gross margin as a percentage of revenue. In other words, as products get more expensive to produce, manufacturers are not able to make as much profit per unit on a percentage basis.

Each of the modeled scenarios results in a unique set of cash flows and corresponding industry value at each TSL. In the following discussion, the INPV results refer to the difference in industry value between the base case and each standards case that result from the sum of discounted cash flows from the base year 2010 through 2045, the end of the analysis period. To provide perspective on the short-run cash flow impact, DOE includes in the discussion of the results a comparison of free cash flow between the base case and the standards case at each TSL in the year before amended standards take effect.

(i) Cash-Flow Analysis Results for Conventional Products

Table V.18 and Table V.19 show the MIA results for each TSL using the markup scenarios described above for conventional residential furnace, central air conditioner, and heat pump products. This "conventional products" grouping includes the following product classes: (1) split-system air conditioning; (2) split-system heat pumps; (3) single-package air conditioning; (4) single-package heat pumps; and (5) non-weatherized gas furnaces.

Table V.18 Manufacturer Impact Analysis for Conventional Products Under the Preservation of EBIT Scenario

	Units	Base Case	Trial Standard Level						
			1	2	3	4	5	6	7
INPV	2009$ millions	8,347	8,354	7,847	7,936	7,893	7,857	7,685	6,855
Change in INPV	2009$ millions	*n/a*	8	(500)	(411)	(454)	(490)	(662)	(1,492)
	(%)	*n/a*	0.1	(6.0)	(4.9)	(5.4)	(5.9)	(7.9)	(17.9)
Product Conversion Costs	2009$ millions	*n/a*	0.0	5	12	12	25	127	279
Capital Conversion Costs	2009$ millions	*n/a*	0.0	15	16	16	52	158	532
Total Investment Required	2009$ millions	*n/a*	0.0	20	28	28	77	284	810

Parentheses indicate negative (-) values.

Table V.19. Manufacturer Impact Analysis for Conventional Products Under the Tiered Markups Scenario

	Units	Base Case	Trial Standard Level						
			1	2	3	4	5	6	7
INPV	2009$ millions	8,347	8,379	8,021	7,638	7,475	7,467	6,509	4,578
Change in INPV	2009$ millions	*n/a*	33	(326)	(709)	(871)	(879)	(1,837)	(3,768)
	(%)	*n/a*	0.4	(3.9)	(8.5)	(10.4)	(10.5)	(22.0)	(45.1)
Product Conversion Costs	2009$ millions	*n/a*	0.0	5	12	12	25	127	279
Capital Conversion Costs	2009$ millions	*n/a*	0.0	15	16	16	52	158	532
Total Investment Required	2009$ millions	*n/a*	0.0	20	28	28	77	284	810

Parentheses indicate negative (-) values.

Sales of split-system air conditioners make up more than 60 percent of residential central cooling shipments, and non-weatherized gas furnaces make up more than 80 percent of the residential furnace shipments, respectively. These two product classes are the largest drivers of INPV in the conventional product grouping. In the base case, the conventional products industry is estimated to have an INPV value of $8,347 million (2009$).

TSL 1 represents the efficiency levels for the conventional product classes that have the largest market share today. At TSL 1, DOE estimates impacts on INPV to be small, but positive. INPV impacts range from $33 million to $8 million, or a change in INPV of 0.4 percent to 0.1 percent. At this considered level, industry free cash flow[94] is estimated to remain steady at $511 million for both the base case and standards case in the year before the TSL 1 compliance date (2015).

At TSL 1, the impacts on the industry are minor because manufacturers already ship products at TSL 1 efficiencies in high volumes. Eighty-one percent of all conventional HVAC products shipped today meet or exceed the TSL 1 standards. Additionally, an increase in standards from 13 SEER to 13.5 SEER for split-system air conditioning and heat pumps is expected to require no significant conversion costs. As a result, INPV remains mostly stable at this considered standard level.

TSL 2 has a higher standard for non-weatherized gas furnaces than TSL 1. This results in a greater negative impact on INPV. TSL requires non-weatherized gas furnaces to meet a 92-percent AFUE minimum efficiency in the North. DOE estimates TSL 2 impacts on INPV to range from -$326 million to -$500 million, or a change in INPV of -3.9 percent to -6.0 percent. At this level, industry free cash flow is estimated to decrease

[94] Free cash flow (FCF) is a metric commonly used in financial valuation. DOE calculates FCF by adding back depreciation to net operating profit after tax and subtracting increases in working capital and capital expenditures. See TSD chapter 12 for more detail on FCF and its relevance to DOE's MIA results.

by approximately 5.3 percent to $484 million, compared to the base-case value of $511 million, in the year 2015.

At TSL 2, for the non-weatherized gas furnace standard, manufacturers may incur elevated conversion costs as they redesign a 92-percent AFUE furnace product to meet the requirements of the builder market and adjust their product families accordingly in the North. At 92-percent AFUE, these furnaces would require a secondary heat exchanger, and, when compared to a 90-percent AFUE design, the heat exchangers would need to be sized up. DOE estimates that at this level, non-weatherized gas furnace conversion costs total approximately $20 million for the industry. These conversion costs, along with changes in shipments due to standards, account for much of the drop in INPV from TSL 1 to TSL 2.

TSL 3 incorporates regional standards for split-system air conditioning and furnace products. Compared to the baseline, TSL 3 proposes a higher air conditioning and heat pump standard in the South (14 SEER minimum) and a higher furnace standard in the North (90-percent AFUE minimum). At TSL 3, DOE estimates impacts on INPV to range from -$411 million to -$709 million, or a change in INPV of -4.9 percent to -8.5 percent. At this considered level, industry free cash flow is estimated to decrease by approximately 5.8 percent to $481 million, compared to the base-case value of $511 million, in the year leading up to the year in which compliance with considered energy conservation standards would be required (2015).

Both markup scenarios in the GRIM for the energy efficiency standards at TSL 3 assume that a commoditization of 14 SEER air conditioning units in the South would put downward pressure on margins for 14 SEER units sold in all regions. Similarly, the 90-percent AFUE standard for non-weatherized gas furnaces in the North would negatively affect margins for non-weatherized gas furnace units sold in all regions. This impact on markups is more severe in the tiered scenario, because the change in the standard also compresses markups on higher-AFUE products, which are effectively demoted in the "good, better, best" sales model. As a result, INPV decreases by 8.5 percent in the tiered markup scenario, compared to 4.9 percent in the preservation of EBIT scenario.

TSL 4 represents the consensus agreement level and incorporates accelerated compliance dates. The standards are set at the same level as TSL 3, except that TSL 4 also includes EER standards for central air conditioners in the hot-dry region. In addition, the furnace standards are modeled to take effect in 2013, and the air conditioning and heat pump standards are modeled to take effect in 2015, instead of the 2016 compliance dates used in TSL 3. At TSL 4, DOE estimates impacts on INPV to range -$454 million to -$871 million, or a change in INPV of -5.4 percent to -10.4 percent. At this level, industry free cash flow is estimated to decrease by approximately 9.6 percent to $462 million, compared to the base-case value of $511 million, in the year 2015.

To comply with the earlier compliance dates, manufacturers must make earlier investments in product conversions, which negatively affect INPV because of discounting effects. Additionally, the accelerated schedule for amended standards leads to earlier commoditization of residential furnace, central air conditioner, and heat pump products. As a result, the INPV value is slightly more negative in TSL 4 than in TSL 3 for both the preservation of EBIT scenario and the tiered markups scenario.

TSL 5 includes higher furnace standards than TSL 4. Non-weatherized gas furnace standards would increase to 95-percent AFUE. Additionally, TSL 5 lacks the accelerated compliance dates associated with TSL 4. All HVAC standards in TSL 5 would require compliance in 2016. At TSL 5, DOE estimates impacts on INPV to range from -$490 million to -$879 million, or a change in INPV of -5.9 percent to -10.5 percent. At this considered level, industry free cash flow is estimated to decrease by approximately 9.7 percent to $461 million, compared to the base-case value of $511 million, in the year 2015.

At 95-percent AFUE, non-weatherized gas furnace efficiency would be one efficiency level below max-tech. To comply with such a standard, manufacturers would need to increase heat exchanger size up to the physical constraints of the furnace cabinets. Furnace manufacturers would need to upgrade their 95-percent AFUE production lines to meet demand. Additionally, manufacturers expect this efficiency level would require significant R&D costs to redesign and convert a premium, feature-loaded product into a basic value-line product, which would be demanded by the builder market. As a result, industry conversion costs could grow from $28 million at TSL 4 to $77 million at TSL 5. INPV becomes slightly more negative from TSL 4 to TSL 5.

TSL 6 elevates the standard for air conditioning and heat pumps over TSL 5 while maintaining the same standards for all furnace product classes. TSL 6 is the most aggressive regional standard considered in this rulemaking (although TSL 7 has more stringent standards, the standards in TSL 7 are national rather than regional). At TSL 6, DOE estimates impacts on INPV to range from -$662 million to -$1837 million, or a change in INPV of -7.9 percent to -22.0 percent. At this considered level, industry free cash flow is estimated to decrease by approximately 24.7 percent to $385 million, compared to the base-case value of $511 million, in the year 2015.

In the base case, 73 percent of split-system air conditioning shipments in the North are below 14 SEER, and 84 percent of split-system air conditioning shipments in the South are below 15 SEER. Increasing the minimum efficiency to 14 SEER in the North and 15 SEER in the South requires significantly more capital expenditure from manufacturers. At TSL 6, manufacturers would need to redesign their highest-volume product lines in both the South and the North. There are multiple design paths that manufacturer could take; however, the changes will likely involve the addition of two-stage compressors, the enlargement of heat exchangers, the application of more-sophisticated controls, the incorporation of microchannel technology, or some combination of these options. Some manufacturers indicated that new production facilities would be necessary at this potential standard level.

TSL 7 represents the max-tech efficiency level for all product classes. At TSL 7, DOE estimates impacts on INPV to range from -$1,492 million to -$3,768 million, or a change in INPV of -17.9 percent to -45.1 percent. At this considered level, industry free cash flow is estimated to decrease by approximately 65.9 percent to $174 million, compared to the base-case value of $511 million, in the year 2015.

At TSL 7, the industry incurs significant R&D costs and loses the ability to differentiate products based on efficiency. For central air conditioning systems, manufacturers would likely have to move to add a second compressor, incorporate inverter technology, or make their product significantly larger. For furnaces, manufacturers would likely have to incorporate burner modulation technology, which would include adding modulating gas valves, variable speed inducer fans, and more-sophisticated controls. These potential standard levels would require much higher R&D and product design expenditures by manufacturers. It could be difficult for all major manufacturers to justify the investments necessary to reach max-tech. A few manufacturers indicated that building a new facility would create less business disruption risk than attempting to completely redesign and upgrade existing facilities. Additionally, some manufacturers noted that lower labor rates in Mexico and other countries abroad may entice them to move their production facilities outside of the U.S. There was general agreement that the high conversion costs and more expensive components required in TSL 7 could also make foreign-based technologies, which have traditionally been more expensive, more attractive in the domestic market.

(ii) Cash-Flow Analysis Results for Niche Furnace Products

Table V.20 and Table V.21 show the MIA results for each TSL using the markup scenarios described above for niche furnace products. The niche furnace grouping includes the mobile home and oil furnace product classes. In the base case, annual mobile home furnace shipments total approximately 120,000 units/year, while annual oil furnace shipments total approximately 80,000 units/year for 2010.

Table V.20. Manufacturer Impact Analysis for Niche Furnace Products Under the Preservation of EBIT Scenario

	Units	Base Case	Trial Standard Level						
			1	**2**	**3**	**4**	**5**	**6**	**7**
INPV	2009$ millions	149	149	151	132	125	131	131	109
Change in INPV	2009$ millions	*n/a*	0	2	(17)	(24)	(18)	(18)	(40)
	(%)	*n/a*	0.0	1.2	(11.6)	(16.4)	(12.1)	(12.1)	(26.7)
Product Conversion Costs	2009$ millions	*n/a*	0.0	0	4	4	8	8	16
Capital Conversion Costs	2009$ millions	*n/a*	0.0	0	11	11	17	17	35
Total Investment Required	2009$ millions	*n/a*	0.0	0	15	15	24	24	51

Parentheses indicate negative (-) values.

Table V.21. Manufacturer Impact Analysis for Niche Furnace Products Under the Tiered Markup Scenario

	Units	Base Case	Trial Standard Level						
			1	**2**	**3**	**4**	**5**	**6**	**7**
INPV	2009$ millions	149	149	151	129	120	114	114	94
Change in INPV	2009$ millions	*n/a*	(0)	2	(20)	(29)	(36)	(36)	(55)
	(%)	*n/a*	(0.0)	1.4	(13.5)	(19.6)	(23.8)	(23.8)	(36.7)

Product Conversion Costs	2009$ millions	*n/a*	0.0	0	4	4	8	8	16
Capital Conversion Costs	2009$ millions	*n/a*	0.0	0	11	11	17	17	35
Total Investment Required	2009$ millions	*n/a*	0.0	0	15	15	24	24	51

Parentheses indicate negative (-) values.

At TSL 1 and TSL 2, the standards-case efficiency remains at the baseline level for both mobile home furnaces and oil furnaces. There are no conversion costs, and the INPV varies very little from the baseline value.

At TSL 3, the oil furnace standard increases to 83-percent AFUE, while the mobile home furnace standard increases to 90-percent AFUE in the North. At TSL 3, DOE estimates impacts on INPV to range from -$17 million to -$20 million, or a change in INPV of -11.6 percent to -13.5 percent. At this level, industry free cash flow is estimated to decrease by approximately 54.0 percent to $5.1 million, compared to the base-case value of $11.0 million, in the year 2015.

TSL 3 would require the addition of a secondary heat exchanger for mobile home furnace products sold in the North. As a result, mobile home furnace manufacturers could incur conversion costs for redesigns and tooling. Oil furnace manufacturers would likely need to increase the surface area of heat exchangers. DOE estimates conversion costs for the entire industry to meet the TSL 3 to be $15 million.

TSL 4 represents the consensus agreement level and incorporates accelerated compliance dates. The mobile home furnace standard and the oil furnace standard do not vary from TSL 3. DOE estimates impacts on INPV to range from -$24 million to -$29 million, or a change in INPV of -16.4 percent to -19.6 percent. At this level, industry free cash flow is estimated to decrease by approximately 11.5 percent to $9.8 million, compared to the base-case value of $11.0 million, in the year 2015.

The accelerated compliance dates of TSL 4 lead to earlier investments by manufacturers. The production line changes necessary to produce secondary heat exchangers for mobile home furnace products and larger heat exchanges for oil furnaces would need to occur before the standards year 2013. Manufacturers could incur conversion costs for redesigns and additional tooling totaling $15 million. There is a decrease in INPV in TSL 4, as compared to TSL 3, due to the earlier commoditization impacts of the accelerated compliance dates. In TSL 4, INPV decreases 4.8 percent to 6.1 percent lower than in TSL 3.

TSL 5 and TSL 6 represent an increase in standards for mobile home furnaces and oil furnaces above the level set in TSL 1 through TSL 4. The standard in the North for mobile home furnaces increases to 96-percent AFUE, and the national standard for oil furnaces increases to 85-percent AFUE. TSL 5 and TSL 6 require compliance in 2016. DOE estimates impacts on INPV to range from -$18 million to -$36 million, or a change in INPV of -12.1 percent to -23.8 percent. At this level, industry free cash flow is estimated to decrease by approximately 86.0 percent to $1.6 million, compared to the base-case value of $11 million, in the year 2015.

TSL 5 and TSL 6 would raise the standard in the North for mobile home furnaces to the max-tech level (i.e., 96-percent AFUE). At this level, all mobile home furnaces in the North would be required to be condensing. This change would drive the increase in conversion cost, as manufacturers work on condensing furnace designs that function within the physical dimension and price constraints of the mobile home market. Mobile home furnace manufacturers would no longer be able to differentiate products based on efficiency. In interviews, manufacturers noted that the loss of product differentiation would lead to increased focus on cost competitiveness. Given the size of the mobile home furnace market (approximately 120,000 units per year) and manufacturer feedback that the mobile home market is highly price sensitive, a number of manufacturers could choose to exit the market rather than compete at this efficiency level. Additionally, TSL 5 and TSL 6 would increase the standard for oil furnaces to 85-percent AFUE. To reach this level, manufacturers would continue to increase the surface area of heat exchangers, incurring additional production costs and higher raw material costs. Conversion costs for TSL 5 and TSL 6 are $24 million. At this cost, it is possible that some oil furnace manufacturers would exit the business.

TSL 7 raises the standard for oil furnaces and mobile home furnaces to max-tech. DOE estimates impacts on INPV to range -$40 million to -$55 million, or a change in INPV of -26.7 percent to -36.7 percent. At this considered level, industry free cash flow is estimated to decrease by approximately 193 percent to -$9.2 million, compared to the base-case value of $11 million, in the year 2015.

TSL 7 sets a national standard for oil furnaces at the max-tech level (i.e., 97-percent AFUE). This efficiency level would require the development of condensing oil furnaces as the baseline product. DOE was only able to identify one domestic manufacturer offering a condensing oil furnace. The development of cost-effective, reliable, and durable oil furnace products would require significant capital expenditures by a majority of the industry. It is unclear how many manufacturers would make the product conversion investment to compete in a market that supplies fewer than 80,000 units/year and, according to most manufacturers, is shrinking. However, given the limited size of the oil furnace market and the market's declining shipments, it could be expected that a number of manufacturers would choose to leave the market rather than compete at this efficiency level. DOE expects a similar effect in the mobile home furnace market.

(iii) Cash-Flow Analysis Results for Standby Mode and Off Mode Standards

Table V.22. Standby Mode and Off Mode Impacts for Furnace, Central Air Conditioning, and Heat Pump Products Under the Preservation of Gross Margin Percentage Scenario

	Units	**Base Case**	**Standby Mode and Off Mode TSL**		
			1	**2**	**3**
INPV	*2009$ millions*	8,711	8,715	8,716	8,734
Change in INPV	*2009$ millions*	*n/a*	4	5	23
	(%)	*n/a*	0.05	0.06	0.26
Product Conversion Costs	*2009$ millions*	*n/a*	2.77	2.77	2.77
Capital Conversion Costs	*2009$ millions*	*n/a*	0	0	0

Total Investment Required	*2009$ millions*	*n/a*	2.77	2.77	2.77

Table V.23. Standby Mode and Off Mode Impacts for Furnace, Central Air Conditioning, and Heat Pump Products Under the Preservation of EBIT scenario

	Units	**Base Case**	**Standby Mode and Off Mode TSL**		
			1	**2**	**3**
INPV	*2009$ millions*	8,711	8,458	8,457	8,456
Change in INPV	*2009$millions*	*n/a*	(253)	(253)	(255)
	(%)	*n/a*	(2.91)	(2.91)	(2.93)
Product Conversion Costs	*2009$ millions*	*n/a*	2.77	2.77	2.77
Capital Conversion Costs	*2009$ millions*	*n/a*	0	0	0
Total Investment Required	*2009$ millions*	*n/a*	2.77	2.77	2.77

Parentheses indicate negative (-) values.

The preservation of gross margin percentage and preservation of EBIT markup scenarios for the standby mode and off mode analysis provide similar results. DOE estimates impacts on INPV to range from $23 million to -$255 million, or a change in INPV of 0.26 percent to -2.93 percent. These results include the impacts of conversion costs, estimated at $2.8 million for the industry. DOE estimated total conversion costs to be similar at all three standby mode and off mode TSLs, because the levels of R&D, testing, and compliance expenditures do not vary dramatically. Furthermore, DOE did not identify significant changes to manufacturer production processes that would result from standby mode and off mode standards. In general, the range of potential impacts resulting from the standby mode and off mode standards is small when compared to the range of potential impacts resulting from the energy efficiency standards.

b. Impacts on Employment

DOE quantitatively assessed the impacts of amended energy conservation standards on domestic employment. DOE used the GRIM to estimate the domestic labor expenditures and number of domestic production workers in the base case and at each energy efficiency TSL from 2010 to 2045. DOE used statistical data from the U.S. Census Bureau's 2008 Economic Census,[95] the results of the engineering analysis, and interviews with manufacturers to determine the inputs necessary to calculate industry-wide labor expenditures and domestic employment levels. Labor expenditures resulting from the manufacture of products are a function of the labor intensity of the product, the sales volume, and an assumption that wages remain fixed in real terms over time.

In the GRIM, DOE used the labor content of each product and the manufacturing production costs from the engineering analysis to estimate the annual labor expenditures in the industry. DOE used Census data and interviews with manufacturers to estimate the portion of the total labor expenditures that is attributable to U.S. (i.e., domestic) labor.

The production worker estimates in this section only cover employment up to the line-supervisor level for functions involved in fabricating and assembling a product within a manufacturer facility. Workers performing services that are closely associated with production operations, such as material handing with a forklift, are also included as production labor. DOE's estimates only account for production workers who manufacture the specific products covered by this rulemaking. For example, even though a

[95] Annual Survey of Manufacturing: 2006. *American FactFinder*. 2008. Bureau of the Census (Available at: < http://factfinder.census.gov/servlet/IBQTable?_bm=y&-ds_name=AM0631GS101>).

manufacturer may also produce hearth products, a worker on a hearth product line would not be included with the estimate of the number of residential furnace workers.

Impact on employment results are based on analysis of energy efficiency standards. For standby mode and off mode, the technology options considered in the engineering analysis result in component swaps, which do not add significant product complexity. While some product development effort will be required, DOE does not expect the standby mode and off mode standard to meaningfully affect the amount of labor required in production. Therefore, the standby and off mode would not result in significant changes to employment calculations based on the energy efficiency TSLs.

The employment impacts shown in Table V.24 represent the potential production employment that could result following the adoption of amended energy conservation standards. The upper end of the results in the table estimates the maximum change in the number of production workers after amended energy conservation standards must be met. The upper end of the results assumes that manufacturers would continue to produce the same scope of covered products in the same production facilities, or in new or expanded facilities located in the United States. The upper end of the range, therefore, assumes that domestic production does not shift to lower-labor-cost countries. Because there is a real risk of manufacturers evaluating sourcing decisions in response to amended energy conservation standards, the lower end of the range of employment results in Table V.24 includes the estimated total number of U.S. production workers in the industry who could lose their jobs if all existing production were moved outside of the U.S. Finally, it is noted that the employment impacts shown are independent of the employment impacts to the broader U.S. economy, which are documented in chapter 13 of the direct final rule TSD.

Using the GRIM, DOE estimates that in the absence of amended energy conservation standards, there would be 16,902 domestic production workers involved in manufacturing residential furnaces, central air conditioners, and heat pumps in 2016. Using 2008 Census Bureau data and interviews with manufacturers, DOE estimates that approximately 89 percent of products sold in the United States are manufactured domestically. Table V.24 shows the range of the impacts of potential amended energy conservation standards on U.S. production workers in the residential furnace, central air conditioner, and heat pump market. The table accounts for both conventional products and niche furnace products.

Table V.24. Potential Changes in the Total Number of Residential Furnace, Central Air Conditioner, and Heat Pump Production Workers in 2016

	Trial Standard Level							
	Base Case	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Total Number of Domestic Production Workers in 2016 (without facilities moving offshore)	16,902	16,998	17,242	17,485	17,746	17,940	17,998	18,102
Potential Changes in Domestic	*n/a*	96 - (16,902)	340 - (16,902)	583 - (16,902)	844 - (16,902)	1038 - (16,902)	1096 - (16,902)	1200 - (16,902)

Production Workers in 2016*								

*DOE presents a range of potential employment impacts.
Parentheses indicate negative (-) values.

Based on the GRIM analysis, DOE estimates that there would be positive employment impacts among conventional residential furnace, central air conditioner, and heat pump manufacturers at the upper bound of the employment estimates. This effect occurs because the required labor content increases per product at higher efficiency levels, and the analysis assumes manufacturers do not alter the current mix of domestic and international production. DOE believes the assumption for the employment scenarios become less realistic at the most stringent TSLs when complete technology changes would likely require the development of new manufacturing plants.

c. Impacts on Manufacturing Capacity

(i) Conventional Furnaces, Central Air Conditioners, and Heat Pumps

Most manufacturers currently have excess production capacity, reflected in part by the substantial decline in shipments since the height of the housing boom in 2005. Manufacturers did not express major capacity-related concerns at the efficiency levels included at TSL 1, 2, and 3. Additionally, manufacturers did not express concerns about the production capacity at TSL 4, which includes accelerated compliance dates arising out of the consensus agreement. All major manufacturers that were interviewed agreed that the timelines in TSL 4 could be met and that no capacity shortages were likely to occur.

At TSL 5, the standard levels for all central air conditioners and heat pumps product classes would be the same as at TSL 4, so DOE does not anticipate capacity impacts for these products. For non-weatherized gas furnaces, TSL 5 would be more challenging for manufacturers because of the 95-percent AFUE standard in the North (as opposed to the 90-percent AFUE standard in the North in TSL 4). However, because the regional standard in the South is set at the baseline efficiency, manufacturers would not have to redesign all production lines. Additionally, TSL 5 allows for an additional 3 years beyond TSL 4's consensus timeline for manufacturers to ramp up production capabilities. Therefore, DOE does not believe there would be any impact on manufacturing capacity from TSL 1 to TSL 5.

At the efficiency levels included in TSL 6 and TSL 7, manufacturers were concerned that the changes in technology could impose production capacity constraints in the near to medium term. At TSL 6, the higher energy conservation standard would increase industry demand for some key components and tooling over current levels. All major manufacturers would seek to increase their purchasing volumes of high-efficiency compressors, ECM motors, and production tooling during the same timeframe. Given that the industry relies on a limited number of suppliers for these parts, some manufacturers expressed concern that a bottleneck in the supply chain could create production constraints.

At TSL 7, the major domestic manufacturers of split-system air conditioners and heat pumps would likely need to redesign all of their existing products to incorporate more-efficient technologies for residential applications. If manufacturers chose not to or could not afford to develop new technologies, they would likely need to significantly enlarge the products' exchangers, which in turn would require a redesign of their production lines to accommodate significantly larger units or to add a second compressor. This increased demand for components and production tooling could lead to short-term constraints on production. Manufacturers would face similar concerns with non-weatherized gas furnaces. Manufacturers would have to redesign all product lines to incorporate burner modulation technology, which would include adding modulating gas valves, variable-speed inducer fans, and more-sophisticated controls. The coinciding demand for modulating gas valves and variable-speed inducer fans from seven major manufacturers could potentially create supply chain constraints.

In summary, production capacity implications for the conventional product classes would be most severe at TSL 6 and TSL 7.

(ii) Niche Furnace Products

According to the manufacturers of oil furnace and mobile home furnace products, amended energy conservation standards should not significantly affect production capacity, except at the max-tech levels (where condensing operation would be required). According to manufacturers interviewed, these capacity-related concerns are focused on the technical feasibility of increasing oil furnace efficiency to condensing levels. Most manufacturers have not found a design that reliably delivers performance above 95-percent AFUE. Some manufacturers indicated that they would not be able to produce products at the condensing level until the sulfur content of heating oil was regulated and substantially lowered in key markets.

d. Impacts on Sub-Groups of Small Manufacturers

As discussed in section IV.I.1, using average cost assumptions to develop an industry cash-flow estimate is not adequate for assessing differential impacts among manufacturer subgroups. Small manufacturers, niche equipment manufacturers, and manufacturers exhibiting a cost structure substantially different from the industry average could be affected disproportionately. DOE used the results of the industry characterization to group manufacturers exhibiting similar characteristics. Consequently, DOE identified two sub-groups for analysis: (1) small manufacturers and (2) SDHV manufacturers.

(i) Small Manufacturers Sub-Group

DOE evaluated the impact of amended energy conservation standards on small manufacturers, specifically ones defined as "small businesses" by the U.S. Small Business Administration (SBA). The SBA defines a "small business" as having 750 employees or less for NAICS 333415, "Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing." Based on this definition, DOE identified four niche central air conditioner and heat pump manufacturers and five niche furnace manufacturers that are classified as small businesses. DOE describes the differential impacts on these small businesses in today's notice at section VI.B, Review Under the Regulatory Flexibility Act.

Section VI.B concludes that larger manufacturers could have a competitive advantage in multiple niche product markets due to their size and ability to access capital. Additionally, in some market segments, larger manufacturers have significantly higher production volumes over which to spread costs. The Department cannot certify today's rule would not have a significant economic impact on a substantial number of small manufacturers. However, DOE has carefully considered these potential impacts and has sought to mitigate any such impacts in today's rule. For a complete discussion of the impacts on small businesses, see chapter 12 of the direct final rule TSD.

(ii) Small-Duct, High-Velocity Manufacturers Sub-Group

Small-duct, high-velocity systems serve a niche within the residential air conditioning market. A SDHV system consists of a non-conventional indoor unit and air distribution system (produced by the SDHV manufacturer) mated to a conventional outdoor unit (produced by split-system manufacturers). These SDHV systems typically make use of flexible ducting and operate at a higher static pressure than conventional air conditioning systems. This product class makes up less than 0.5 percent of central air conditioning shipments. DOE estimates the total market size to be less than 30,000 units per year.

SDHV systems are primarily installed in existing structures that do not have air conditioning duct work. In this application, SDHV systems are often a more cost-effective solution for centralized cooling because conventional systems may require substantial installation and retrofit costs to install ducting. The SDHV system delivers conditioned air via small diameter flexible tubing, which requires less space than conventional ductwork. SDHV systems are often paired with hydronic heat, radiant heat, and ground temperature heat pump systems. Historically, approximately 80 percent of shipments have been for the retrofit market, and 20 percent of shipments have been for the new construction market.

DOE has identified three manufacturers of SDHV systems that serve the U.S. market. The two domestic manufacturers, Unico Systems and SpacePak, serve the majority of the market. SpacePak is a subsidiary of MesTek Inc., a U.S. holding company with over 30 specialty manufacturing brands. Unico is a small business, as defined by the SBA.

DOE's analysis of AHRI Directory product listings indicates that the primary difference between SDHV products rated at 11 SEER and SDHV products rated above 11 SEER is the paired condensing unit. The indoor unit, which is the component designed and manufactured by SpacePak and Unico, does not change as the AHRI-certified efficiency increases. SpacePak and Unico are reaching higher efficiencies by pairing their products with larger condensing units, which are produced by conventional air conditioning and heat pump manufacturers.

According to SDHV manufacturers, the small size of the SDHV industry limits influence on key suppliers. As a result, SDHV manufacturers must choose from stock fan motors, compressors, and products that are optimized for other applications and industries. The selection of available components limits the technology options available to SDHV manufacturers, thereby constraining the manufacturers' ability to achieve efficiencies above 11 SEER through improved product design. Interviewed SDHV manufacturers indicated that they are near max-tech for the SDHV indoor unit with today's standards and available components.

In 2004, both Unico and SpacePak petitioned DOE's Office of Hearings and Appeals (OHA) for exception relief from the 13 SEER energy efficiency standard found at 10 CFR 430.32(c)(2), with which compliance was required for products manufactured on or after January 23, 2006. OHA granted both petitions on October 14, 2004.[96] Accordingly, the manufacturers were authorized to produce equipment that performed at 11 SEER / 6.8 HSPF and above. In their 2004 application for exception relief, SpacePak and Unico both indicated that a 13 SEER standard would create significant hardships for the SDHV industry. SpacePak wrote in its application for exception relief that an absence of relief would lead to "the loss of all sales within the Unites States." As part of the 2004 OHA Decision and Order (case #TEE-0010), Lennox International filed comments stating that "it agrees these [SDHV] products would be unfairly burdened by…the 13 SEER/7.7 HSPF minimum level."

Since 2004, SDHV manufacturers have been able to reach efficiencies of 13 SEER, but the vast majority of products listed in the AHRI Directory are below 13 SEER

[96] Department of Energy: Office of Hearings and Appeals, Decision and Order, Case #TEE 0010 (2004) (Available at: http://www.oha.doe.gov/cases/ee/tee0010.pdf) (last accessed September 2010).

(see chapter 3 of the direct final rule TSD for a distribution of SDHV systems by efficiency level). This improved efficiency is primarily the result of pairing their products with higher-efficiency outdoor units produced by other manufacturers. One manufacturer has incorporated variable-speed technology to improve product efficiency. However, overall, SDHV manufacturer still face many of the same challenges they faced in 2004 and have limited options for further improving the efficiency of the air handling unit, which is the only component designed and produced by SDHV manufacturers. As a result, higher standards would force SDHV manufactures to pair their products with more expensive, higher-efficiency outdoor units to provide performance that meets energy conservation standards. TSL 1 through TSL 5 would require only the baseline efficiency level (13 SEER), while TSL 6 and TSL 7 would increase the level to 14 SEER and 14.5 SEER, respectively. DOE believes the increases represented by TSL 6 and TSL 7 would significantly adversely impact the financial standing of SDHV manufacturers. As discussed in their 2004 application for exception relief, such an increase would likely significantly depress shipments because it would require additional controls and a much more expensive outdoor unit. As a result manufacturers would be forced to spread fixed costs over a lower volume and would be less able to pass on the higher incremental costs. Manufacturers would face increasingly difficult decisions regarding the investment of resources toward what would likely be a much smaller market.

e. Cumulative Regulatory Burden

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

During previous stages of this rulemaking, DOE identified a number of requirements, in addition to amended energy conservation standards for furnaces, central air conditioners, and heat pumps, that manufacturers of these products will face for products they manufacture within three years prior to and three years after the anticipated compliance date of the amended standards. These requirements included DOE's amended energy conservation standards for other products produced by the manufacturers covered under this rulemaking. Amended energy conservation standards coming into effect during the analysis period that are expected to affect at least a subset of the manufacturers include the rulemakings for residential boilers, packaged terminal air conditioners/packaged terminal heat pumps, furnace fans, room air conditioners, and residential water heaters. DOE discusses these requirements in greater detail in chapter 12 of the direct final rule TSD.

The most common regulatory burden concern raised by manufacturers during interviews was the potential phase-down of HFCs. While no phase-down is currently required, air conditioning and heat pump manufacturers raised these concerns because of HFC phase-down language in proposed legislation, such as H.R. 2454, the American Clean Energy and Security Act of 2009. Manufacturers cited concerns that a phase-down of HFC refrigerants could negatively impact product efficiency, product functionality, and manufacturing processes for central air conditioners and heat pumps. Additionally, there is the potential for significant conversion costs as well as higher on-going costs for production.

Furnace manufacturers also cited concerns about the cumulative burden associated with low NO_X and ultra-low NO_X standards adopted in the South Coast Air Quality Management District (SCAQMD) and other air quality districts of California for mobile home furnaces, weatherized gas furnaces, and non-weatherized gas furnaces.[97] Manufacturers stated that these standards will require R&D resources, which may be limited due to conversion costs associated with Federal standards.

Several manufacturers indicated that Canada has programs in place that regulate products covered in this rulemaking. DOE research indicates that Natural Resources Canada (NRCan) regulates residential furnaces, central air conditioners and heat pumps, and furnace fans.[98]

[97] California Air Resources Board, South Coast AQMD List of Current Rules (2010) (Available at: http://www.arb.ca.gov/drdb/sc/cur.htm) (last accessed September 2010).
[98] Natural Resources Canada, Canada's Energy Efficiency Regulations (2009) (Available at: http://oee.nrcan.gc.ca/regulations/guide.cfm) (last accessed October 2010).

DOE discusses these and other requirements, and includes the full details of the cumulative regulatory burden, in chapter 12 of the direct final rule TSD.

3. National Impact Analysis

This section presents DOE's estimates of the national energy savings and the NPV of consumer benefits that would result from each of the TSLs considered as potential amended furnace, central air conditioner, and heat pump energy efficiency standards, as well as from each of the TSLs considered as potential standards for standby mode and off mode.

In estimating national energy savings and the NPV of consumer benefits, for TSLs 2, 3, and 4, DOE calculated a range of results that reflect alternative assumptions with respect to how the market for non-weatherized and mobile home furnaces will respond to a standard at 90-percent or 92-percent AFUE. DOE believes that the response of the market to a standard at either of these efficiency levels is sufficiently uncertain that it is reasonable to use a range to represent the expected impacts. The low end of the range reflects the approach to forecasting standards-case efficiency distributions described in section IV.G.2. With this approach, the part of the market that was below the amended standard level rolls up to the amended standard level in the year of compliance, and some fraction of shipments remains above the minimum. The high end of the range reflects the possibility that, under an amended standard that requires a minimum AFUE of 90 percent or 92 percent, the entire market will shift to 95 percent because the additional installed cost, relative to 90-percent or 92-percent AFUE, is minimal. In both cases, the approach to forecasting the change in efficiency in the years after the year of compliance is the same.

a. Significance of Energy Savings

To estimate the energy savings attributable to potential standards for furnaces, central air conditioners, and heat pumps, DOE compared the energy consumption of these products under the base case to their anticipated energy consumption under each TSL. As discussed in section IV.E, the results account for a rebound effect of 20 percent for furnaces, central air conditioners, and heat pumps (i.e., 20 percent of the total savings from higher product efficiency are "taken back" by consumers through more intensive use of the product).

Table V.25 presents DOE's forecasts of the national energy savings for each TSL considered for energy efficiency, and Table V.26 presents DOE's forecasts of the national energy savings for each TSL considered for standby mode and off mode power. The savings were calculated using the approach described in section IV.G. Chapter 10 of the direct final rule TSD presents tables that also show the magnitude of the energy savings if the savings are discounted at rates of 7 percent and 3 percent. Discounted energy savings represent a policy perspective in which energy savings realized farther in the future are less significant than energy savings realized in the nearer term.

Table V.25 Furnaces, Central Air Conditioners, and Heat Pumps: Cumulative National Energy Savings for Energy Efficiency TSLs for 2016-2045

Trial Standard Level	Quads
1	0.18
2	2.32 to 2.91
3	2.97 to 3.84
4*	3.20 to 4.22
5	3.89
6	5.91
7	19.18

* For TSL 4, which matches the recommendations in the consensus agreement, DOE forecasted the energy savings from 2015 through 2045 for central air conditioners and heat pumps, and from 2013 through 2045 for furnaces.

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Table V.26 Furnaces, Central Air Conditioners, and Heat Pumps: Cumulative National Energy Savings for Standby Mode and Off Mode Power TSLs for 2016-2045

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Trial Standard Level	Quads
1	0.153
2	0.16
3	0.186

DOE also conducted a sensitivity analysis that reflects alternate assumptions regarding the market demand for split-system coil-only air conditioner replacement units at 15 SEER and above in the standards cases (see section IV.G.2 for details). Table V.27 shows the NES results for this sensitivity analysis.

Table V.27 Furnaces, Central Air Conditioners, and Heat Pumps: Cumulative National Energy Savings for Energy Efficiency TSLs for 2016-2045 (Alternate Assumptions for Split-system Coil-only Air Conditioner Replacement Market)

Trial Standard Level	Quads
1	0.20
2	2.34 to 2.93
3	2.91 to 3.78
4*	3.14 to 4.16
5	3.83
6	5.69
7	19.01

* For TSL 4, which matches the recommendations in the consensus agreement, DOE forecasted the energy savings from 2015 through 2045 for central air conditioners and heat pumps, and from 2013 through 2045 for furnaces.

Comment [A11]: Changes recommended by OIRA.

b. Net Present Value of Consumer Costs and Benefits

DOE estimated the cumulative NPV to the Nation of the total costs and savings for consumers that would result from particular standard levels for furnaces, central air conditioners, and heat pumps. In accordance with the OMB's guidelines on regulatory analysis,[99] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. The 7-percent rate is an estimate of the average before-tax rate of return to private capital in the U.S. economy, and reflects the returns to real estate and small business capital as well as corporate capital. DOE used this discount rate to approximate the opportunity cost of capital in the private sector, since recent OMB analysis has found the average rate of return to capital to be near this rate. In addition, DOE used the 3-percent rate to capture the potential effects of standards on private consumption (e.g., through higher prices for products and the purchase of reduced amounts of energy). This rate represents the rate at which society discounts future consumption flows to their present value. This rate can be approximated by the real rate of return on long-term government debt, which has averaged about 3 percent on a pre-tax basis for the last 30 years.

Table V.28 shows the consumer NPV for each considered energy efficiency TSL for furnaces, central air conditioners, and heat pumps, using both a 7-percent and a 3-percent discount rate, and Table V.29 shows the consumer NPV results for each TSL

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

DOE considered for standby mode and off mode power. For all TSLs except TSL 4 (the level corresponding to the consensus agreement), the impacts cover the lifetime of products purchased in 2016-2045; for TSL 4, the impacts cover the lifetime of products purchased in 2013–2045 for furnaces and in 2015-2045 for central air conditioners and heat pumps. See chapter 10 of the direct final rule TSD for more detailed NPV results.

Table V.28 Furnaces, Central Air Conditioners, and Heat Pumps: Cumulative Net Present Value of Consumer Benefits for Energy Efficiency TSLs for Products Shipped in 2016-2045

Trial Standard Level	3-percent Discount Rate	7-percent Discount Rate
	Billion 2009$	
1	0.76	0.23
2	10.61 to 11.56	2.60 to 2.41
3	13.35 to 15.29	3.36 to 3.36
4*	14.73 to 17.55	3.93 to 4.21
5	15.69	3.47
6	8.18	(2.56)
7	(45.12)	(44.98)

* For TSL 4, which matches the recommendations in the consensus agreement, DOE forecasted the consumer benefits for products sold in 2015-2045 for central air conditioners and heat pumps, and in 2013-2045 for furnaces.
Parentheses indicate negative (-) values.

Table V.29 Furnaces, Central Air Conditioners, and Heat Pumps: Cumulative Net Present Value of Consumer Benefits for Standby Mode and Off Mode Power TSLs for Products Shipped in 2016-2045

Trial Standard Level	3-percent Discount Rate	7-percent Discount Rate
	Billion 2009$	
1	1.14	0.371
2	1.18	0.373
3	1.01	0.235

Parentheses indicate negative (-) values.

DOE also conducted a sensitivity analysis that reflects alternate assumptions regarding the market demand for split-system coil-only air conditioner replacement units

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at 15 SEER and above in the standards cases (see section IV.G.2 for details). Table V.30 shows the consumer NPV results for this sensitivity analysis.

Table V.30 Furnaces, Central Air Conditioners, and Heat Pumps: Cumulative Net Present Value of Consumer Benefits for Energy Efficiency TSLs for Products Shipped in 2016-2045 (Alternate Assumptions for Split-system Coil-only Air Conditioner Replacement Market)

Trial Standard Level	3-percent Discount Rate	7-percent Discount Rate
	Billion 2009$	
1	0.87	0.26
2	10.71 to 11.65	2.63 to 2.45
3	14.32 to 16.27	3.74 to 3.75
4*	15.71 to 18.53	4.31 to 4.59
5	16.66	3.85
6	10.36	(1.68)
7	(38.87)	(42.47)

* For TSL 4, which matches the recommendations in the consensus agreement, DOE forecasted the consumer benefits for products sold in 2015-2045 for central air conditioners and heat pumps, and in 2013-2045 for furnaces.
Parentheses indicate negative (-) values.

DOE also investigated the impact of different learning rates on the NPV for the seven energy efficiency TSLs. The NPV results presented in Table V.28 are based on learning rates of 18.1 percent for central air conditioners and heat pumps, and 30.6 percent for furnaces, both of which are referred to as the "default" learning rates. DOE considered three learning rate sensitivities: (1) a "high learning" rate; (2) a "low learning" rate; and (3) a "no learning" rate. The "high learning"' rates are 20.5 percent for central air conditioners and heat pumps and 33.3 percent for furnaces. The "low learning" rates are 11.5 percent for central air conditioners and heat pumps and 19.2 percent for furnaces. The "no learning" rate sensitivity assumes constant real prices over the entire forecast period. Refer to appendix 8-J of the TSD for details on the development of the above learning rates.

Table V.31 provides the annualized NPV of consumer benefits at a 7-percent discount rate, combined with the annualized present value of monetized benefits from CO_2 and NO_X emissions reductions, for each of the energy efficiency TSLs for the "default" learning rate and the three sensitivity cases. (DOE's method for annualization is described in section V.C.3 of this notice.) Table V.32 provides the same combined annualized NPVs using a 3-percent discount rate. (Section V.B.6 below provides a complete description and summary of the monetized benefits from CO_2 and NO_X emissions reductions.) For details on these results, see appendix 10-C of the direct final rule TSD.

Table V.31 Furnaces, Central Air Conditioners, and Heat Pumps: Annualized Net Present Value of Consumer Benefits (7-percent Discount Rate) and Annualized Present Value of Monetized Benefits from CO_2 and NO_X Emissions Reductions for Energy Efficiency TSLs for Products Shipped in 2016-2045**

	Learning Rate (LR)			
Trial Standard Level	**Default:** LR_{CAC-HP} = 18.1% LR_{FURN} = 30.6%	**High Sensitivity:** LR_{CAC-HP} = 20.5% LR_{FURN} = 33.3%	**Low Sensitivity:** LR_{CAC-HP} = 11.5% LR_{FURN} = 19.2%	**No Learning:** LR = 0% (constant real prices)
	Billion 2009$			
1	0.036	0.037	0.034	0.028
2	0.304 to 0.287	0.309 to 0.294	0.285 to 0.258	0.242 to 0.195
3	0.414 to 0.437	0.421 to 0.448	0.389 to 0.400	0.328 to 0.312
4*	0.456 to 0.517	0.464 to 0.528	0.430 to 0.479	0.366 to 0.387
5	0.451	0.462	0.414	0.326
6	0.075	0.106	(0.016)	(0.266)
7	(2.497)	(2.360)	(2.890)	(3.998)

* For TSL 4, which matches the recommendations in the consensus agreement, DOE forecasted the consumer benefits for products sold in 2015-2045 for central air conditioners and heat pumps, and in 2013-2045 for furnaces.
Parentheses indicate negative (-) values.
** The economic benefits from reduced CO_2 emissions were calculated using a SCC value of $22.1/metric ton in 2010 (in 2009$) for CO_2, increasing at 3% per year, and a discount rate of 3%. The economic benefits from reduced NO_X emissions were calculated using a value of $2,519/ton (in 2009$), which is the average of the low and high values used in DOE's analysis, and a 7-percent discount rate.

Table V.32 Furnaces, Central Air Conditioners, and Heat Pumps: Annualized Net Present Value of Consumer Benefits (3-percent Discount Rate) and Annualized Present Value of Monetized Benefits from CO_2 and NO_X Emissions Reductions for Energy Efficiency TSLs for Products Shipped in 2016-2045**

	Learning Rate (LR)			
Trial Standard Level	**Default:** LR_{CAC-HP} = 18.1% LR_{FURN} = 30.6%	**High Sensitivity:** LR_{CAC-HP} = 20.5% LR_{FURN} = 33.3%	**Low Sensitivity:** LR_{CAC-HP} = 11.5% LR_{FURN} = 19.2%	**No Learning:** LR = 0% (constant real prices)
	Billion 2009$			
1	0.057	0.058	0.055	0.048
2	0.639 to 0.685	0.646 to 0.694	0.611 to 0.644	0.553 to 0.559
3	0.827 to 0.950	0.837 to 0.964	0.793 to 0.898	0.711 to 0.782
4*	0.871 to 1.049	0.880 to 1.062	0.836 to 0.998	0.755 to 0.882
5	0.976	0.990	0.924	0.807
6	0.704	0.745	0.580	0.255
7	(1.152)	(0.972)	(1.673)	(3.094)

* For TSL 4, which matches the recommendations in the consensus agreement, DOE forecasted the consumer benefits for products sold in 2015-2045 for central air conditioners and heat pumps, and in 2013-2045 for furnaces.

Parentheses indicate negative (-) values.

** The economic benefits from reduced CO_2 emissions were calculated using a SCC value of $22.1/metric ton in 2010 (in 2009$) for CO_2, increasing at 3% per year, and a discount rate of 3%. The economic benefits from reduced NO_X emissions were calculated using a value of $2,519/ton (in 2009$), which is the average of the low and high values used in DOE's analysis, and a 3-percent discount rate.

Comment [A12]: Changes recommended by OIRA.

c. Indirect Impacts on Employment

DOE develops estimates of the indirect employment impacts of potential standards on the economy in general. As discussed above, DOE expects amended energy conservation standards for furnaces, central air conditioners, and heat pumps to reduce energy bills for consumers of these products, and the resulting net savings to be redirected to other forms of economic activity. These expected shifts in spending and economic activity could affect the demand for labor. As described in section IV.J, to estimate these effects, DOE used an input/output model of the U.S. economy. Table V.33 presents the estimated net indirect employment impacts in 2025 and 2045 for the energy efficiency TSLs that DOE considered in this rulemaking. Table V.34 shows the indirect employment impacts of the standby mode and off mode TSLs. Chapter 13 of the direct final rule TSD presents more detailed results.

Table V.33 Net Increase in Jobs from Indirect Employment Effects Under Furnace, Central Air Conditioner, and Heat Pump Energy Efficiency TSLs

Trial Standard Level	Jobs in 2025	Jobs in 2045
1	1,000	500
2	3,000	2,700
3	5,400	6,100
4	6,000	6,300
5	6,400	6,300
6	16,000	18,500
7	60,200	81,400

Table V.34 Net Increase in Jobs from Indirect Employment Effects Under Furnace, Central Air Conditioner, and Heat Pump Standby Mode and Off Mode Power TSLs

Trial Standard Level	Jobs in 2025	Jobs in 2045
1	320	800
2	350	860
3	420	1,020

The input/output model suggests that today's standards would be likely to increase the net demand for labor in the economy. However, the gains would most likely be very small relative to total national employment. Moreover, neither the BLS data nor the input/output model DOE uses includes the quality or wage level of the jobs. Therefore, DOE has concluded that today's standards are likely to produce employment benefits sufficient to fully offset any adverse impacts on employment in the manufacturing industry for the furnaces, central air conditioners, and heat pumps that are the subjects of this rulemaking.

4. Impact on Utility or Performance of Products

As presented in section III.D.1.d of this notice, DOE concluded that none of the TSLs considered in this notice would reduce the utility or performance of the products under consideration in this rulemaking. Furthermore, manufacturers of these products currently offer furnaces, central air conditioners, and heat pumps that meet or exceed today's standards. (42 U.S.C. 6295(o)(2)(B)(i)(IV))

5. Impact of Any Lessening of Competition

DOE has also considered any lessening of competition that is likely to result from amended standards. The Attorney General determines the impact, if any, of any lessening of competition likely to result from a proposed standard, and transmits such determination in writing to the Secretary, together with an analysis of the nature and extent of such impact. (42 U.S.C. 6295(o)(2)(B)(i)(V) and (ii))

DOE is publishing a NOPR containing energy conservation standards identical to those set forth in today's direct final rule and has transmitted a copy of today's direct final rule and the accompanying TSD to the Attorney General, requesting that the DOJ provide its determination on this issue. DOE will consider DOJ's comments on the rule in determining whether to proceed with the direct final rule. DOE will also publish and respond to DOJ's comments in the Federal Register in a separate notice.

6. Need of the Nation to Conserve Energy

An improvement in the energy efficiency of the products subject to today's direct final rule is likely to improve the security of the Nation's energy system by reducing overall demand for energy. Reduced electricity demand may also improve the reliability of the electricity system. (42 U.S.C. 6295(o)(2)(B)(i)(VI)) As a measure of this reduced demand, Table V.35 and Table V.36 present the estimated reduction in generating capacity in 2045 for the TSLs that DOE considered in this rulemaking for energy efficiency and standby mode and off mode power, respectively.

Table V.35 Reduction in Electric Generating Capacity in 2045 Under Considered Furnace, Central Air Conditioner, and Heat Pump Energy Efficiency TSLs

Trial Standard Level	Gigawatts
1	0.397
2	0.646 to 1.12
3	3.61 to 3.53
4	3.81 to 3.69
5	3.56
6	10.5
7	35.6

Table V.36 Reduction in Electric Generating Capacity in 2045 Under Considered Furnace, Central Air Conditioner, and Heat Pump Standby Mode and Off Mode Power TSLs

Trial Standard Level	Gigawatts
1	0.103
2	0.110
3	0.127

Energy savings from amended standards for furnaces, central air conditioners, and heat pumps could also produce environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases associated with electricity production, and also reduced site emissions. Table V.37 provides DOE's estimate of cumulative CO_2, NO_X, and Hg emissions reductions that would be expected to result from each of the TSLs considered in this rulemaking for energy efficiency standards, and Table V.38 provides the results for each of the TSLs considered for standby mode and off mode power standards. In the environmental assessment (chapter 15 in the direct final rule TSD), DOE reports annual CO_2, NO_X, and Hg emissions reductions for each considered TSL.

As discussed in section IV.L, DOE has not reported SO_2 emissions reductions from power plants, because there is uncertainty about the effect of energy conservation standards on the overall level of SO_2 emissions in the United States due to SO_2 emissions caps. DOE also did not include NO_X emissions reduction from power plants in States subject to CAIR because an amended energy conservation standard would not affect the overall level of NO_X emissions in those States due to the emissions caps mandated by CAIR.

Table V.37 Cumulative Emissions Reduction for 2016-2045 Under Furnace, Central Air Conditioner, and Heat Pump Energy Efficiency TSLs

Trial Standard Level	CO_2 million metric tons	NO_X thousand tons	Hg tons
1	15.2	12.3	0.022
2	62.8 to 61.2	55.5 to 56.7	0.011 to (0.012)
3	97.1 to 113	83.1 to 98.5	0.086 to 0.059
4*	105 to 134	90.1 to 117	0.097 to 0.071
5	116	102	0.059
6	200	168	0.270
7	772	640	1.160

* For TSL 4, which matches the recommendations in the consensus agreement, DOE forecasted the emissions reductions from 2015 through 2045 for central air conditioners and heat pumps, and from 2013 through 2045 for furnaces.
Parentheses indicate a negative value.

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Table V.38 Cumulative Emissions Reduction for 2016-2045 Under Furnace, Central Air Conditioner, and Heat Pump Standby Mode and Off Mode Power TSLs

Trial Standard Level	**CO_2** million metric tons	**NO_X** thousand tons	**Hg** tons
1	8.23	6.60	0.056
2	8.73	7.00	0.072
3	10.1	8.11	0.079

DOE also estimated monetary benefits likely to result from the reduced emissions of CO_2 and NO_X that DOE estimated for each of the TSLs considered for furnaces, central air conditioners, and heat pumps. In order to make this calculation similar to the calculation of the NPV of consumer benefit, DOE considered the reduced emissions expected to result over the lifetime of products shipped in the forecast period for each TSL.

As discussed in section IV.M, a Federal interagency group selected four SCC values for use in regulatory analyses, which DOE used in the direct final rule analysis. The four SCC values (expressed in 2009$) are $4.9/ton (the average value from a distribution that uses a 5-percent discount rate), $22.1/ton (the average value from a distribution that uses a 3-percent discount rate), $36.3/ton (the average value from a distribution that uses a 2.5-percent discount rate), and $67.1/ton (the 95th-percentile value from a distribution that uses a 3-percent discount rate). These values correspond to the value of CO_2 emission reductions in 2010; the values for later years are higher due to increasing damages as the magnitude of climate change increases. For each of the four cases, DOE calculated a present value of the stream of annual values using the same discount rate as was used in the studies upon which the dollar-per-ton values are based.

Table V.39 presents the global values of CO_2 emissions reductions at each TSL considered for energy efficiency. As explained in section IV.M.1, DOE calculated domestic values as a range from 7 percent to 23 percent of the global values, and these results are presented in Table V.40. Table V.41 and Table V.42 present similar results for the TSLs considered for standby mode and off mode power.

Table V.39 Estimates of Global Present Value of CO_2 Emissions Reductions Under Furnace, Central Air Conditioner, and Heat Pump Energy Efficiency TSLs

TSL	Million 2009$			
	5% discount rate, average*	3% discount rate, average*	2.5% discount rate, average*	3% discount rate, 95th percentile*
1	65	332	562	1013
2	328 to 320	1805 to 1757	3105 to 3021	5490 to 5344
3	496 to 577	2711 to 3149	4657 to 5409	8249 to 9581
4	530 to 672	2860 to 3622	4902 to 6204	8705 to 11025
5	596	3253	5586	9897
6	987	5326	9123	16209
7	3926	21391	36723	65087

* Columns are labeled by the discount rate used to calculate the SCC and whether it is an average value or drawn from a different part of the distribution. Values presented in the table incorporate the escalation of the SCC over time.

Table V.40 Estimates of Domestic Present Value of CO_2 Emissions Reductions Under Furnace, Central Air Conditioner, and Heat Pump Energy Efficiency TSLs

TSL	Million 2009$			
	5% discount rate, average*	3% discount rate, average*	2.5% discount rate, average*	3% discount rate, 95th percentile*
1	4.6 to 15.0	23.2 to 76.4	39.3 to 129	70.9 to 233
2	22.4 to 75.4	123 to 415	211 to 714	374 to 1263
3	34.7 to 133	190 to 724	326 to 1244	577 to 2204
4	37.1 to 155	200 to 833	343 to 1427	609 to 2536
5	41.7 to 137	228 to 748	391 to 1285	691 to 2269
6	69.1 to 227	373 to 1225	639 to 2098	1135 to 3728
7	275 to 903	1497 to 4920	2571 to 8446	4556 to 14970

* Columns are labeled by the discount rate used to calculate the SCC and whether it is an average value or drawn from a different part of the distribution. Values presented in the table incorporate the escalation of the SCC over time.

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Table V.41 Estimates of Global Present Value of CO_2 Emissions Reductions Under Furnace, Central Air Conditioner, and Heat Pump Standby Mode and Off Mode Power TSLs

	Million 2009$			
TSL	**5% discount rate, average***	**3% discount rate, average***	**2.5% discount rate, average***	**3% discount rate, 95th percentile***
1	41.7	228	392	694
2	44.3	242	417	738
3	51.7	283	487	862

***** Columns are labeled by the discount rate used to calculate the SCC and whether it is an average value or drawn from a different part of the distribution. Values presented in the table incorporate the escalation of the SCC over time.

Table V.42 Estimates of Domestic Present Value of CO_2 Emissions Reductions Under Furnace, Central Air Conditioner, and Heat Pump Standby Mode and Off Mode Power TSLs

	Million 2009$			
TSL	**5% discount rate, average***	**3% discount rate, average***	**2.5% discount rate, average***	**3% discount rate, 95th percentile***
1	2.92 to 9.59	16.0 to 52.4	27.4 to 90.2	48.6 to 159.6
2	3.10 to 10.2	16.9 to 55.7	29.2 to 95.9	51.7 to 169.7
3	3.62 to 11.9	19.8 to 65.1	34.1 to 112.0	60.3 to 198.3

***** Columns are labeled by the discount rate used to calculate the SCC and whether it is an average value or drawn from a different part of the distribution. Values presented in the table incorporate the escalation of the SCC over time.

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

DOE also estimated a range for the cumulative monetary value of the economic benefits associated with NO_X emissions reductions anticipated to result from amended standards for furnaces, central air conditioners, and heat pumps. The dollar-per-ton values that DOE used are discussed in section IV.M. Table V.43 presents the cumulative present values for each TSL considered for energy efficiency, calculated using 7-percent and 3-percent discount rates. Table V.44 presents similar results for the TSLs considered for standby mode and off mode power.

Table V.43 Estimates of Present Value of NO_X Emissions Reductions Under Furnace, Central Air Conditioner, and Heat Pump Energy Efficiency TSLs

TSL	**3% discount rate** million 2009$	**7% discount rate** million 2009$
1	3.4 to 35.3	1.7 to 17.0
2	17.9 to 188	6.8 to 72.3
3	26.4 to 322	10.3 to 126
4	28.5 to 380	11.9 to 160
5	32.3 to 332	12.7 to 131
6	52.2 to 536	21.2 to 218
7	203 to 2082	79.8 to 820

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Table V.44 Estimates of Present Value of NO_X Emissions Reductions Under Furnace, Central Air Conditioner, and Heat Pump Standby Mode and Off Mode Power TSLs

TSL	3% discount rate million 2009$	7% discount rate million 2009$
1	2.07 to 21.3	0.793 to 8.15
2	2.20 to 22.6	0.841 to 8.65
3	2.56 to 26.3	0.975 to 10.0

The NPV of the monetized benefits associated with emissions reductions can be viewed as a complement to the NPV of the consumer savings calculated for each TSL considered in this rulemaking. Table V.45 shows an example of the calculation of the combined NPV, including benefits from emissions reductions for the case of TSL 4 for furnaces, central air conditioners, and heat pumps. Table V.46 and Table V.47 present the NPV values that result from adding the estimates of the potential economic benefits resulting from reduced CO_2 and NO_X emissions in each of four valuation scenarios to the NPV of consumer savings calculated for each TSL considered for energy efficiency, at both a 7-percent and a 3-percent discount rate. The CO_2 values used in the columns of each table correspond to the four scenarios for the valuation of CO_2 emission reductions presented in section IV.M. Table V.48 and Table V.49 present similar results for the TSLs considered for standby mode and off mode power.

Table V.45 Adding Net Present Value of Consumer Savings to Present Value of Monetized Benefits from CO_2 and NO_X Emissions Reductions Under TSL 4 for Furnace, Central Air Conditioner, and Heat Pump Energy Efficiency

Category	Present Value billion 2009$	Discount Rate
Benefits		
Operating Cost Savings	10.6 to 14.0	7%
	26.3 to 34.4	3%
CO_2 Reduction Monetized Value (at $4.9/Metric Ton)*	0.530	5%
CO_2 Reduction Monetized Value (at $22.1/Metric Ton)*	2.860	3%
CO_2 Reduction Monetized Value (at $36.3/Metric Ton)*	4.902	2.5%
CO_2 Reduction Monetized Value (at $67.1/Metric Ton)*	8.705	3%
NO_X Reduction Monetized Value (at $2,519/Ton)*	0.067	7%
	0.161	3%
Total Monetary Benefits **	13.5 to 16.9	7%
	29.3 to 37.4	3%
Costs		
Incremental Installed Costs	6.7 to 9.8	7%
	11.5 to 16.8	3%
Net Benefits/Costs		
Including CO_2 and NO_X**	6.8 to 7.1	7%
	17.8 to 20.6	3%

* These values represent global values (in 2009$) of the social cost of CO_2 emissions in 2010 under several scenarios. The values of $4.9, $22.1, and $36.3 per ton are the averages of SCC distributions calculated using 5-percent, 3-percent, and 2.5-percent discount rates, respectively. The value of $67.1 per ton represents the 95th percentile of the SCC distribution calculated using a 3-percent discount rate. See section IV.M for details. The value for NO_X (in 2009$) is the average of the low and high values used in DOE's analysis.

** Total Monetary Benefits and Net Benefits/Costs for both the 3% and 7% cases utilize the central estimate of social cost of CO_2 emissions calculated at a 3% discount rate, which is equal to $22.1/ton in 2010 (in 2009$).

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Table V.46 Results of Adding Net Present Value of Consumer Savings (at 7% Discount Rate) to Present Value of Monetized Benefits from CO_2 and NO_X Emissions Reductions Under Furnace, Central Air Conditioner, and Heat Pump Energy Efficiency TSLs

TSL	Consumer NPV at 7% Discount Rate added to:			
	SCC Value of \$4.9/metric ton CO_2* and Low Value for NO_X** billion 2009\$	SCC Value of \$22.1/metric ton CO_2* and Medium Value for NO_X** billion 2009\$	SCC Value of \$36.3/metric ton CO_2* and Medium Value for NO_X** billion 2009\$	SCC Value of \$67.1/metric ton CO_2* and High Value for NO_X** billion 2009\$
1	0.29	0.57	0.80	1.26
2	2.93 to 2.74	4.44 to 4.21	5.74 to 5.47	8.16 to 7.8379
3	3.87 to 3.95	6.13 to 6.58	8.08 to 8.84	11.7 to 13.1
4	4.47 to 4.90	6.85 to 7.92	8.89 to 10.5	12.8 to 15.4
5	4.08	6.80	9.13	13.5
6	(1.55)	2.89	6.69	13.9
7	(41.0)	(23.1)	(7.81)	20.9

* These label values represent the global SCC of CO_2 in 2010, in 2009\$. The values have been calculated with scenario-consistent discount rates. See section IV.M for a discussion of the derivation of these values.
** Low Value corresponds to \$447 per ton of NO_X emissions. Medium Value corresponds to \$2,519 per ton of NO_X emissions. High Value corresponds to \$4,591 per ton of NO_X emissions.
Parentheses indicate negative (-) values.

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Table V.47 Results of Adding Net Present Value of Consumer Savings (at 3% Discount Rate) to Present Value of Monetized Benefits from CO_2 and NO_X Emissions Reductions Under Furnace, Central Air Conditioner, and Heat Pump Energy Efficiency TSLs

TSL	Consumer NPV at 3% Discount Rate added to:			
	SCC Value of $4.9/metric ton CO_2* and Low Value for NO_X** billion 2009$	SCC Value of $22.1/metric ton CO_2* and Medium Value for NO_X** billion 2009$	SCC Value of $36.3/metric ton CO_2* and Medium Value for NO_X** billion 2009$	SCC Value of $67.1/metric ton CO_2* and High Value for NO_X** billion 2009$
1	0.83	1.12	1.33	1.79
2	11.0 to 11.9	12.5 to 13.4	13.8 to 14.6	16.2 to 17.0
3	13.9 to 15.9	16.2 to 18.6	18.1 to 20.8	21.7 to 25.0
4	15.3 to 18.2	17.8 to 21.4	19.7 to 22.8	23.6 to 28.7
5	16.3	19.1	21.4	25.7
6	9.2	13.8	17.4	24.6
7	(41.1)	(22.6)	(8.0)	20.8

* The label values represent the global SCC of CO_2 in 2010, in 2009$. The values have been calculated with scenario-consistent discount rates. See section IV.M for a discussion of the derivation of these values.
** Low Value corresponds to $447 per ton of NO_X emissions. Medium Value corresponds to $2,519 per ton of NO_X emissions. High Value corresponds to $4,591 per ton of NO_X emissions.
Parentheses indicate negative (-) values.

Table V.48 Results of Adding Net Present Value of Consumer Savings (at 7% Discount Rate) to Present Value of Monetized Benefits from CO_2 and NO_X Emissions Reductions Under Furnace, Central Air Conditioner, and Heat Pump Standby Mode and Off Mode Power TSLs

TSL	Consumer NPV at 7% Discount Rate added to:			
	SCC Value of $4.9/metric ton CO_2* and Low Value for NO_X** billion 2009$	SCC Value of $22.1/metric ton CO_2* and Medium Value for NO_X** billion 2009$	SCC Value of $36.3/metric ton CO_2* and Medium Value for NO_X** billion 2009$	SCC Value of $67.1/metric ton CO_2* and High Value for NO_X** billion 2009$
1	0.413	0.603	0.767	1.072
2	0.418	0.620	0.794	1.119
3	0.288	0.524	0.728	1.107

* The label values represent the global SCC of CO_2 in 2010, in 2009$. The values have been calculated with scenario-consistent discount rates. See section IV.M for a discussion of the derivation of these values.
** Low Value corresponds to $447 per ton of NO_X emissions. Medium Value corresponds to $2,519 per ton of NO_X emissions. High Value corresponds to $4,591 per ton of NO_X emissions.

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Table V.49 Results of Adding Net Present Value of Consumer Savings (at 3% Discount Rate) to Present Value of Monetized Benefits from CO_2 and NO_X Emissions Reductions Under Furnace, Central Air Conditioner, and Heat Pump Standby Mode and Off Mode Power TSLs

TSL	**Consumer NPV at 3% Discount Rate added to:**			
	SCC Value of \$4.9/metric ton CO_2* and Low Value for NO_X** billion 2009$	SCC Value of \$22.1/metric ton CO_2* and Medium Value for NO_X** billion 2009$	SCC Value of \$36.3/metric ton CO_2* and Medium Value for NO_X** billion 2009$	SCC Value of \$67.1/metric ton CO_2* and High Value for NO_X** billion 2009$
1	1.182	1.378	1.542	1.854
2	1.226	1.434	1.608	1.939
3	1.069	1.312	1.516	1.903

* The label values represent the global SCC of CO_2 in 2010, in 2009$. The values have been calculated with scenario-consistent discount rates. See section IV.M for a discussion of the derivation of these values.
** Low Value corresponds to $447 per ton of NO_X emissions. Medium Value corresponds to $2,519 per ton of NO_X emissions. High Value corresponds to $4,591 per ton of NO_X emissions.

Although adding the value of consumer savings to the values of emission reductions provides a valuable perspective, two issues should be considered. First, the national operating savings are domestic U.S. consumer monetary savings that occur as a result of market transactions, while the value of CO_2 reductions is based on a global value. Second, the assessments of operating cost savings and CO_2 savings are performed with different methods that use quite different time frames for analysis. The national operating cost savings is measured for the lifetime of products shipped in the 30-year period after the compliance date. The SCC values, on the other hand, reflect the present value of future climate-related impacts resulting from the emission of one ton of carbon dioxide in each year. These impacts go well beyond 2100.

7. Other Factors

The Secretary, in determining whether a proposed standard is economically justified, may consider any other factors that he deems to be relevant. (42 U.S.C.

6295(o)(2)(B)(i)(VI)) In developing the proposals set forth in this notice, DOE has also considered the comments submitted by interested parties, including the recommendations in the consensus agreement, which DOE believes provides a reasoned statement by interested persons that are fairly representative of relevant points of view (including representatives of manufacturers of covered products, States, and efficiency advocates) and contains recommendations with respect to an energy conservation standard that are in accordance with 42 U.S.C. 6295(o). Moreover, DOE has encouraged the submission of consensus agreements as a way to get diverse stakeholders together, to develop an independent and probative analysis useful in DOE standard setting, and to expedite the rulemaking process. In the present case, one outcome of the consensus agreement was a recommendation to accelerate the compliance dates for these products, which would have the effect of producing additional energy savings at an earlier date. DOE also believes that standard levels recommended in the consensus agreement may increase the likelihood for regulatory compliance, while decreasing the risk of litigation.

C. Conclusion

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

The new or amended standard must also “result in significant conservation of energy.” (42 U.S.C. 6295(o)(3)(B))

For today’s direct final rule, DOE considered the impacts of standards at each TSL, beginning with the maximum technologically feasible level, to determine whether that level was economically justified. Where the max-tech level was not justified, DOE then considered the next most efficient level and undertook the same evaluation until it reached the highest efficiency level that is both technologically feasible and economically justified and saves a significant amount of energy.

To aid the reader as DOE discusses the benefits and/or burdens of each TSL, tables present a summary of the results of DOE’s quantitative analysis for each TSL. In addition to the quantitative results presented in the tables, DOE also considers other burdens and benefits that affect economic justification. These include the impacts on identifiable subgroups of consumers, such as low-income households and seniors, who may be disproportionately affected by an amended national standard. Section V.B.1 presents the estimated impacts of each TSL for these subgroups.

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

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In its current regulatory analysis, potential changes in the benefits and costs of a regulation due to changes in consumer purchase decisions are included in two ways. First, if consumers forego a purchase of a product in the standards case, this decreases sales for product manufacturers and the cost to manufacturers is included in the MIA. Second, DOE accounts for energy savings attributable only to products actually used by consumers in the standards case; if a regulatory option decreases the number of products used by consumers, this decreases the potential energy savings from an energy conservation standard. DOE provides detailed estimates of shipments and changes in the volume of product purchases under standards in chapter 9 of the TSD. However, DOE's current analysis does not explicitly control for heterogeneity in consumer preferences,

preferences across subcategories of products or specific features, or consumer price sensitivity variation according to household income (Reiss and White 2004).

While DOE is not prepared at present to provide a fuller quantifiable framework for estimating the benefits and costs of changes in consumer purchase decisions due to an energy conservation standard, DOE seeks comments on how to more fully assess the potential impact of energy conservation standards on consumer choice and how to quantify this impact in its regulatory analysis in future rulemakings.

Comment [A15]: Changes recommended by OIRA.

1. Benefits and Burdens of TSLs Considered for Furnace, Central Air Conditioner, and Heat Pump Energy Efficiency

Table V.50 through Table V.54 present summaries of the quantitative impacts estimated for each TSL for furnace, central air conditioner, and heat pump energy efficiency. The efficiency levels contained in each TSL are described in section V.A.

Table V.50 Summary of Results for Furnace, Central Air Conditioner, and Heat Pump Energy Efficiency TSLs: National Impacts

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	T
National Energy Savings (quads)	0.18	2.32 to 2.91	2.97 to 3.84	3.20 to 4.22	3.89	5.91	19
NPV of Consumer Benefits (2009$ billion)							
3% discount rate	0.76	10.61 to 11.56	13.35 to 15.29	14.73 to 17.55	15.69	8.18	(45.12)
7% discount rate	0.23	2.60 to 2.41	3.36 to 3.36	3.93 to 4.21	3.47	(2.56)	(44.98)
Cumulative Emissions Reduction							
CO_2 (million metric tons)	15.2	62.8 to 61.2	971.1 to 113	105 to 134	116	200	77
NO_X (thousand tons)	12.3	55.5 to 56.7	83.1 to 98.5	90.1 to 117	102	168	640
Hg (tons)	0.022	0.011 to (0.012)	0.086 to 0.059	0.097 to 0.071	0.059	0.270	1.160
Value of Emissions Reductions							
CO_2 (2009$ billion)*	0.065 to 1.013	0.320 to 5.49	0.496 to 9.58	0.530 to 11.03	0.596 to 9.90	0.987 to 16.21	3.9 65
NO_X – 3% discount rate (2009$ million)	3.4 to 35.3	17.9 to 188	26.4 to 322	28.5 to 380	32.3 to 332	52.2 to 536	203
NO_X – 7% discount rate (2009$ million)	1.7 to 17.0	6.8 to 72.3	10.3 to 126	11.9 to 160	12.7 to 131	21.2 to 218	79.8 to 820
Generation Capacity Reduction (GW)**	0.397	0.646 to 1.12	3.61 to 3.53	3.81 to 3.69	3.56	10.5	33.6
Employment Impacts							
Changes in Domestic Production Workers in 2016 (thousands)	0.1 to (16.9)	0.3 to (16.9)	0.6 to (16.9)	0.8 to (16.9)	1 to (16.9)	1.1 to (16.9)	1.2 (16.9)
Indirect Domestic Jobs (thousands) **	0.5	2.7	6.1	6.3	6.3	18.5	8

Parentheses indicate negative (-) values.

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

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Table V.51. Summary of Results for Furnace, Central Air Conditioner, and Heat Pump Energy Efficiency TSLs: Manufacturer Impacts

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Manufacturer Impacts						
Change in Industry NPV (2009$ million)	8 to 33	(324) to (498)	(428) to (729)	(478) to (900)	(508) to (915)	(680) to (1873)
Industry NPV (% change)	0.4 to 0.1	(3.8) to (5.9)	(5.0) to (8.6)	(5.6) to (10.6)	(6.0) to (10.8)	(8.0) to (22.0)

Parentheses indicate negative (-) values.

Table V.52. Summary of Results for Furnace, Central Air Conditioner, and Heat Pump Energy Efficiency TSLs: Consumer LCC Savings and Payback Period

Category	TSL 1*	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Mean LCC Savings** (2009$)						
Non-Weatherized Gas Furnaces	n/a					
North		215	155	155	323	323
South		n/a	n/a	n/a	n/a	n/a
Mobile Home Gas Furnaces	n/a					
North		n/a	419	419	585	585
South		n/a	n/a	n/a	n/a	n/a
Oil-Fired Furnaces	n/a	n/a	15	15	(18)	(18)
Split-System Air Conditioners (coil-only)	55					
Rest of Country		(8)	n/a	n/a	n/a	(26)
Hot-Humid		86	93	93	93	(303)
Hot-Dry		104	107	107	107	(468)
Split-System Air Conditioners (blower-coil)	46					
Rest of Country		(18)	n/a	n/a	n/a	(30)
Hot-Humid		77	89	89	89	177
Hot-Dry		90	101	101	101	196
Split-System Heat Pumps	71					
Rest of Country		5	4	4	4	(89)
Hot-Humid		82	102	102	102	137
Hot-Dry		148	175	175	175	274
Single-Package Air Conditioners	n/a	n/a	37	37	37	(68)
Single-Package Heat Pumps	n/a	n/a	104	104	104	15
SDHV Air Conditioners	n/a					
Rest of Country		n/a	n/a	n/a	n/a	(202)
Hot-Humid		n/a	n/a	n/a	n/a	(14)
Hot-Dry		n/a	n/a	n/a	n/a	(65)
Median Payback Period (years)						
Non-Weatherized Gas Furnaces	n/a					
North		7.7	10.1	10.1	9.4	9.4
South		n/a	n/a	n/a	n/a	n/a
Mobile Home Gas Furnaces	n/a					
North		n/a	10.7	10.7	11.5	11.5

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Category	TSL 1*	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7
South		n/a	n/a	n/a	n/a	n/a	13
Oil-Fired Furnaces	n/a	n/a	1.0	1.0	19.8	19.8	18.2
Split-System Air Conditioners (coil-only)	9						
Rest of Country		23	n/a	n/a	n/a	33	
Hot-Humid		6	7	7	7	34	
Hot-Dry		8	10	10	10	49	71
Split-System Air Conditioners (blower-coil)	11						
Rest of Country		26	n/a	n/a	n/a	28	
Hot-Humid		7	8	8	8	8	
Hot-Dry		10	11	11	11	11	31
Split-System Heat Pumps	7						
Rest of Country		13	13	13	13	20	33
Hot-Humid		6	6	6	6	7	
Hot-Dry		5	5	5	5	5	
Single-Package Air Conditioners	n/a	n/a	15	15	15	24	
Single-Package Heat Pumps	n/a	n/a	8	8	8	14	
SDHV Air Conditioners	n/a						
Rest of Country		n/a	n/a	n/a	n/a	74	
Hot-Humid		n/a	n/a	n/a	n/a	18	17
Hot-Dry		n/a	n/a	n/a	n/a	26	23

* TSL 1 does not include regional standards.
** Calculation of LCC savings or payback period is not applicable (n/a) in some cases because no consumers are impacted at some of the TSLs. A negative value (indicated by parentheses) means an increase in LCC by the amount indicated.

Table V.53. Summary of Results for Furnace, Central Air Conditioner, and Heat Pump Energy Efficiency TSLs: Distribution of Consumer LCC Impacts (Central Air Conditioners and Heat Pumps)

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Distribution of Consumer LCC Impacts						
Split-System Air Conditioners (coil-only)						
Rest of Country						
Net Cost (%)	11*	17	0	0	0	57
No Impact (%)	75*	75	100	100	100	27
Net Benefit (%)	14*	8	0	0	0	16
Hot-Humid						
Net Cost (%)		7	26	26	26	72
No Impact (%)		75	27	27	27	16
Net Benefit (%)		18	47	47	47	12
Hot-Dry						
Net Cost (%)		11	37	37	37	75
No Impact (%)		75	27	27	27	16
Net Benefit (%)		14	36	36	36	10
Split-System Air Conditioners (blower-coil)						
Rest of Country						
Net Cost (%)	9*	14	0	0	0	43
No Impact (%)	82*	82	100	100	100	45
Net Benefit (%)	9*	4	0	0	0	12
Hot-Humid						
Net Cost (%)		6	21	21	21	24
No Impact (%)		82	45	45	45	37
Net Benefit (%)		12	34	34	34	39
Hot-Dry						
Net Cost (%)		9	28	28	28	33
No Impact (%)		82	45	45	45	37
Net Benefit (%)		9	27	27	27	30
Split-System Heat Pumps						
Rest of Country						
Net Cost (%)	5*	9	35	35	35	58
No Impact (%)	86*	86	45	45	45	23
Net Benefit (%)	9*	5	20	20	20	19
Hot-Humid						
Net Cost (%)		4	17	17	17	29
No Impact (%)		86	45	45	45	23
Net Benefit (%)		10	38	38	38	48
Hot-Dry						
Net Cost (%)		4	15	15	15	25
No Impact (%)		86	45	45	45	23
Net Benefit (%)		11	40	40	40	52
Single-Package Air Conditioners (Nation)						
Net Cost (%)	0*	0	50	50	50	72
No Impact (%)	100*	100	17	17	17	1
Net Benefit (%)	0*	0	33	33	33	27

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Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7
Single-Package Heat Pumps (Nation)							
Net Cost (%)	0*	0	29	29	29	63	
No Impact (%)	100*	100	36	36	36	2	
Net Benefit (%)	0*	0	35	35	35	35	
SDHV Air Conditioners							
Rest of Country							
Net Cost (%)	0*	0	0	0	0	95	
No Impact (%)	100*	100	100	100	100	0	
Net Benefit (%)	0*	0	0	0	0	5	
Hot-Humid							
Net Cost (%)		0	0	0	0	68	
No Impact (%)		100	100	100	100	0	
Net Benefit (%)		0	0	0	0	32	
Hot-Dry							
Net Cost (%)		0	0	0	0	74	
No Impact (%)		100	100	100	100	0	
Net Benefit (%)		0	0	0	0	26	

* Results refer to Nation for TSL 1.

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Table V.54 Summary of Results for Furnace, Central Air Conditioner, and Heat Pump Energy Efficiency TSLs: Distribution of Consumer LCC Impacts (Furnaces)

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7
Distribution of Consumer LCC Impacts							
Non-Weatherized Gas Furnaces							
North							
Net Cost (%)	0*	11	10	10	23	23	59
No Impact (%)	100*	56	71	71	23	23	1
Net Benefit (%)	0*	33	19	19	54	54	41
South							
Net Cost (%)		0	0	0	0	0	72
No Impact (%)		100	100	100	100	100	0
Net Benefit (%)		0	0	0	0	0	27
Mobile Home Gas Furnaces							
North							
Net Cost (%)	0*	0	44	44	46	46	46
No Impact (%)	100*	100	10	10	8	8	8
Net Benefit (%)	0*	0	47	47	46	46	46
South							
Net Cost (%)		0	0	0	0	0	51
No Impact (%)		100	100	100	100	100	4
Net Benefit (%)		0	0	0	0	0	45
Oil-Fired Furnaces (Nation)							
Net Cost (%)	0	0	10	10	35	35	51
No Impact (%)	100	100	58	58	33	33	1
Net Benefit (%)	0	0	32	32	33	33	48

* Results refer to Nation for TSL 1.

DOE first considered TSL 7, which represents the max-tech efficiency levels.

TSL 7 would save 19.18 quads of energy, an amount DOE considers significant. Under TSL 7, the NPV of consumer benefit would be -$44.98 billion, using a discount rate of 7 percent, and -$45.12 billion, using a discount rate of 3 percent.

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The cumulative emissions reductions at TSL 7 are 772 Mt of CO_2, 640 thousand tons of NO_X, and 1.160 ton of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 7 ranges from $3.93 billion to $65.1 billion. Total generating capacity in 2045 is estimated to decrease by 35.6 GW under TSL 7.

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At TSL 7, the average LCC impact is a savings (LCC decrease) of $198 for non-weatherized gas furnaces in the northern region and a cost (LCC increase) of $181 in the southern region; a savings of $585 for mobile home gas furnaces in the northern region and a savings of $391 in the southern region; and a savings of $272 for oil-fired furnaces.

For split-system air conditioners (coil-only), the average consumer LCC impact is a cost of $1,343 in the rest of country, a cost of $797 in the hot-humid region, and a cost of $1,182 in the hot-dry region. For split-system air conditioners (blower-coil), the average LCC impact is a cost of $903 in the rest of country, a cost of $130 in the hot-humid region, and a cost of $311 in the hot-dry region. For split-system heat pumps, the average LCC impact is a cost of $604 in the rest of country, a savings of $103 in the hot-humid region, and a savings of $477 in the hot-dry region. For single-package air conditioners, the average LCC impact is a cost of $492. For single-package heat pumps, the average LCC impact is a cost of $363. For SDHV air conditioners, the average LCC impact is a cost of $294 in the rest of country, a cost of $25 in the hot-humid region, and a cost of $106 in the hot-dry region.

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At TSL 7, the median payback period for non-weatherized gas furnaces is 17.1 years in the northern region and 28.9 years in the southern region; 11.5 years for mobile home gas furnaces in the northern region and 13 years in the southern region; and 18.2 years for oil-fired furnaces.

For split-system air conditioners (coil-only), the median payback period is 100 years in the rest of country, 47 years in the hot-humid region, and 71 years in the hot-dry region. For split-system air conditioners (blower-coil), the median payback period is 100 years in the rest of country, 21 years in the hot-humid region, and 31 years in the hot-dry region. For split-system heat pumps, the median payback period is 33 years in the rest of country, 13 years in the hot-humid region, and 9 years in the hot-dry region. For single-package air conditioners, the median payback period is 46 years. For single-package heat pumps, the median payback period is 21 years. For SDHV air conditioners, the median payback period is 75 years in the rest of country, 17 years in the hot-humid region, and 23 years in the hot-dry region.

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At TSL 7, the fraction of consumers experiencing an LCC benefit is 41 percent for non-weatherized gas furnaces in the northern region and 27 percent in the southern region; 46 percent for mobile home gas furnaces in the northern region and 45 percent in the southern region; and 48 percent for oil-fired furnaces.

For split-system air conditioners (coil-only), the fraction of consumers experiencing an LCC benefit at TSL 7 is 1 percent in the rest of country, 10 percent in the hot-humid region, and 9 percent in the hot-dry region. For split-system air conditioners (blower-coil), the fraction of consumers experiencing an LCC benefit is 3 percent in the rest of country, 29 percent in the hot-humid region, and 23 percent in the hot-dry region. For split-system heat pumps, the fraction of consumers experiencing an LCC benefit is 13 percent in the rest of country, 40 percent in the hot-humid region, and 49 percent in the

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hot-dry region. For single-package air conditioners, the fraction of consumers experiencing an LCC benefit is 16 percent. For single-package heat pumps, the fraction of consumers experiencing an LCC benefit is 21 percent. For SDHV air conditioners, the fraction of consumers experiencing an LCC benefit is 8 percent in the rest of country, 33 percent in the hot-humid region, and 26 percent in the hot-dry region.

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At TSL 7, the fraction of consumers experiencing an LCC cost is 59 percent for non-weatherized gas furnaces in the northern region and 72 percent in the southern region; 46 percent for mobile home gas furnaces in the northern region and 51 percent in the southern region; and 51 percent for oil-fired furnaces.

For split-system air conditioners (coil-only), the fraction of consumers experiencing an LCC cost is 99 percent in the rest of country, 90 percent in the hot-humid region, and 91 percent in the hot-dry region. For split-system air conditioners (blower-coil), the fraction of consumers experiencing an LCC cost is 96 percent in the rest of country, 70 percent in the hot-humid region, and 76 percent in the hot-dry region. For split-system heat pumps, the fraction of consumers experiencing an LCC cost is 87 percent in the rest of country, 60 percent in the hot-humid region, and 51 percent in the hot-dry region. For single-package air conditioners, the fraction of consumers experiencing an LCC cost is 84 percent. For single-package heat pumps, the fraction of consumers experiencing an LCC cost is 79 percent. For SDHV air conditioners, the fraction of consumers experiencing an LCC cost is 92 percent in the rest of country, 67 percent in the hot-humid region, and 74 percent in the hot-dry region.

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At TSL 7, the projected change in INPV ranges from a decrease of $1,530 million to a decrease of $3,820 million. At TSL 7, DOE recognizes the risk of large negative impacts if manufacturers' expectations concerning reduced profit margins are realized. If the high end of the range of impacts is reached as DOE expects, TSL 7 could result in a net loss of 45.0 percent in INPV to furnace, central air conditioner, and heat pump manufacturers.

The Secretary concludes that at TSL 7 for furnace, central air conditioner, and heat pump energy efficiency, the benefits of energy savings, generating capacity reductions, emission reductions, and the estimated monetary value of the CO_2 emissions reductions would be outweighed by the negative NPV of consumer benefits, the economic burden on a significant fraction of consumers due to the large increases in product cost, and the capital conversion costs and profit margin impacts that could result in a very large reduction in INPV for the manufacturers. Consequently, the Secretary has concluded that TSL 7 is not economically justified.

DOE then considered TSL 6. TSL 6 would save 5.91 quads of energy, an amount DOE considers significant. Under TSL 6, the NPV of consumer benefit would be -$2.56 billion, using a discount rate of 7 percent, and $8.18 billion, using a discount rate of 3 percent.

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The cumulative emissions reductions at TSL 6 are 200 Mt of CO_2, 168 thousand tons of NO_X, and 0.270 ton of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 6 ranges from $0.987 billion to $16.2 billion. Total generating capacity in 2045 is estimated to decrease by 10.5 GW under TSL 6.

At TSL 6, the average LCC impact is a savings (LCC decrease) of $323 for non-weatherized gas furnaces in the northern region and not applicable in the south, a savings of $585 for mobile home gas furnaces in the northern region and not applicable in the south, and a cost of $18 for oil-fired furnaces.

For split-system air conditioners (coil-only), the average LCC impact is a cost of $26 in the rest of country, a cost of $303 in the hot-humid region, and a cost of $468 in the hot-dry region. For split-system air conditioners (blower-coil), the average LCC impact is a cost of $30 in the rest of country, a savings of $177 in the hot-humid region, and a savings of $196 in the hot-dry region. For split-system heat pumps, the average LCC impact is a cost of $89 in the rest of country, a savings of $137 in the hot-humid region, and a savings of $274 in the hot-dry region. For single-package air conditioners, the average LCC impact is a cost of $68. For single-package heat pumps the average LCC impact is a savings of $15. For SDHV air conditioners, the average LCC impact is a cost of $202 in the rest of country, a cost of $14 in the hot-humid region, and a cost of $65 in the hot-dry region.

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At TSL 6, the median payback period is 9.4 years for non-weatherized gas furnaces in the northern region and not applicable in the south; 11.5 years for mobile home gas furnaces in the northern region and not applicable in the south; and 19.8 years for oil-fired furnaces.

For split-system air conditioners (coil-only), the median payback period is 33 years in the rest of country, 34 years in the hot-humid region, and 49 years in the hot-dry region. For split-system air conditioners (blower-coil), the median payback period is 28 years in the rest of country, 8 years in the hot-humid region, and 11 years in the hot-dry region. For split-system heat pumps, the median payback period is 20 years in the rest of country, 7 years in the hot-humid region, and 5 years in the hot-dry region. For single-package air conditioners, the median payback period is 24 years. For single-package heat pumps, the median payback period is 14 years. For SDHV air conditioners, the median payback period is 74 years in the rest of country, 18 years in the hot-humid region, and 26 years in the hot-dry region.

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At TSL 6, the fraction of consumers experiencing an LCC benefit is 54 percent for non-weatherized gas furnaces in the northern region and 0 percent in the south; 46 percent for mobile home gas furnaces in the northern region and 0 percent in the south; and 33 percent for oil-fired furnaces.

For split-system air conditioners (coil-only), the fraction of consumers experiencing an LCC benefit is 16 percent in the rest of country, 12 percent in the hot-humid region, and 9 percent in the hot-dry region. For split-system air conditioners (blower-coil), the fraction of consumers experiencing an LCC benefit is 12 percent in the rest of country, 39 percent in the hot-humid region, and 31 percent in the hot-dry region. For split-system heat pumps, the fraction of consumers experiencing an LCC benefit is 19 percent in the rest of country, 48 percent in the hot-humid region, and 52 percent in the hot-dry region. For single-package air conditioners, the fraction of consumers experiencing an LCC benefit is 27 percent. For single-package heat pumps, the fraction of consumers experiencing an LCC benefit is 35 percent. For SDHV air conditioners, the fraction of consumers experiencing an LCC benefit is 5 percent in the rest of country, 32 percent in the hot-humid region, and 26 percent in the hot-dry region.

At TSL 6, the fraction of consumers experiencing an LCC cost is 23 percent for non-weatherized gas furnaces in the northern region and 0 percent in the south; 46 percent for mobile home gas furnaces in the northern region and 0 percent in the south; and 35 percent for oil-fired furnaces.

For split-system air conditioners (coil-only), the fraction of consumers experiencing an LCC cost is 56 percent in the rest of country, 73 percent in the hot-humid region, and 75 percent in the hot-dry region. For split-system air conditioners (blower-coil), the fraction of consumers experiencing an LCC cost is 43 percent in the rest of country, 25 percent in the hot-humid region, and 33 percent in the hot-dry region. For split-system heat pumps, the fraction of consumers experiencing an LCC cost is 58 percent in the rest of country, 29 percent in the hot-humid region, and 25 percent in the

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hot-dry region. For single-package air conditioners, the fraction of consumers experiencing an LCC cost is 72 percent. For single-package heat pumps, the fraction of consumers experiencing an LCC cost is 63 percent. For SDHV air conditioners, the fraction of consumers experiencing an LCC cost is 95 percent in the rest of country, 68 percent in the hot-humid region, and 74 percent in the hot-dry region.

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At TSL 6, the projected change in INPV ranges from a decrease of $680 million to a decrease of $1,873 million. At TSL 6, DOE recognizes the risk of negative impacts if manufacturers' expectations concerning reduced profit margins are realized. If the high end of the range of impacts is reached as DOE expects, TSL 6 could result in a net loss of 22.0 percent in INPV to furnace, central air conditioner, and heat pump manufacturers.

The Secretary concludes that at TSL 6 for furnace and central air conditioner and heat pump energy efficiency, the benefits of energy savings, generating capacity reductions, emission reductions, and the estimated monetary value of the CO_2 emissions reductions would be outweighed by the negative NPV of consumer benefits, the economic burden on a significant fraction of consumers due to the increases in installed product cost, and the capital conversion costs and profit margin impacts that could result in a very large reduction in INPV for the manufacturers. Consequently, the Secretary has concluded that TSL 6 is not economically justified.

As discussed above, DOE calculated a range of results for national energy savings and NPV of consumer benefit under TSL 4. Because the range of results for TSL 4 overlaps with the results for TSL 5, and because TSLs 4 and 5 are similar in many aspects, DOE discusses the benefits and burdens of TSLs 4 and 5 together below.

TSL 5 would save 3.98 quads of energy, an amount DOE considers significant. TSL 4 would save 3.20 to 4.22 quads of energy, an amount DOE considers significant. Under TSL 5, the NPV of consumer benefit would be $3.47 billion, using a discount rate of 7 percent, and $15.69 billion, using a discount rate of 3 percent. Under TSL 4, the NPV of consumer benefit would be $3.93 billion to $4.21 billion, using a discount rate of 7 percent, and $14.73 billion to $17.55 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 5 are 116 Mt of CO_2, 102 thousand tons of NO_X, and 0.059 ton of Hg. The cumulative emissions reductions at TSL 4 are 105 to 134 Mt of CO_2, 90.1 to 117 thousand tons of NO_X, and 0.097 to 0.071 ton of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 5 ranges from $0.596 billion to $9.90 billion. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 4 ranges from $0.530 billion to $11.0 billion. Total generating capacity in 2045 is estimated to decrease by 3.56 GW under TSL 5, and by 3.81 to 3.69 GW under TSL 4.

At TSL 5, the average LCC impact is a savings (LCC decrease) of $323 for non-weatherized gas furnaces in the northern region and not applicable in the south; a savings of $585 for mobile home gas furnaces in the northern region and not applicable in the south; and a cost of $18 for oil-fired furnaces. At TSL 4, the average LCC impact is a

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savings of $155 for non-weatherized gas furnaces in the northern region and not applicable in the south, a savings of $419 for mobile home gas furnaces in the northern region and not applicable in the south, and a savings of $15 for oil-fired furnaces.

For central air conditioners and heat pumps, the average LCC impacts for TSL 5 and TSL 4 are the same. For split-system air conditioners (coil-only), the average LCC impact is not applicable in the rest of country, but is a savings of $93 in the hot-humid region, and a savings of $107 in the hot-dry region. For split-system air conditioners (blower-coil), the average LCC impact is not applicable in the rest of country, but is a savings of $89 in the hot-humid region, and a savings of $101 in the hot-dry region. For split-system heat pumps, the average LCC impact is a savings of $4 in the rest of country, a savings of $102 in the hot-humid region, and a savings of $175 in the hot-dry region. For single-package air conditioners, the average LCC impact is a cost of $37. For single-package heat pumps, the average LCC impact is a cost of $104. For SDHV air conditioners, the average LCC impact is not applicable for all regions.

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At TSL 5, the median payback period is 9.4 years for non-weatherized gas furnaces in the northern region and not applicable in the south, 11.5 years for mobile home gas furnaces in the northern region and not applicable in the south, and 19.8 years for oil-fired furnaces. At TSL 4, the median payback period is 10.1 years for non-weatherized gas furnaces in the northern region and not applicable in the south, 10.7 years for mobile home gas furnaces in the northern region and not applicable in the south, and 1.0 year for oil-fired furnaces.

For central air conditioners and heat pumps, the median payback periods for TSL 5 and TSL 4 are the same. For split-system air conditioners (coil-only), the median payback period is not applicable in the rest of country, 7 years in the hot-humid region, and 10 years in the hot-dry region. For split-system air conditioners (blower-coil), the median payback period is not applicable in the rest of country, 8 years in the hot-humid region, and 11 years in the hot-dry region. For split-system heat pumps, the median payback period is 13 years in the rest of country, 6 years in the hot-humid region, and 5 years in the hot-dry region. For single-package air conditioners, the median payback period is 15 years. For single-package heat pumps, the median payback period is 8 years. For SDHV air conditioners, the median payback period is not applicable in all regions.

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At TSL 5, the fraction of consumers experiencing an LCC benefit is 54 percent for non-weatherized gas furnaces in the northern region and 0 percent in the south, 46 percent for mobile home gas furnaces in the northern region and 0 percent in the south, and 33 percent for oil-fired furnaces. At TSL 4, the fraction of consumers experiencing an LCC benefit is 19 percent for non-weatherized gas furnaces in the northern region and 0 percent in the south, 47 percent for mobile home gas furnaces in the northern region and 0 percent in the south, and 32 percent for oil-fired furnaces.

For central air conditioners and heat pumps, at TSL 5 and at TSL 4, the fraction of consumers experiencing an LCC benefit is the same. For split-system air conditioners (coil-only), the fraction of consumers experiencing an LCC benefit is 0 percent in the rest of country, 46 percent in the hot-humid region, and 36 percent in the hot-dry region. For split-system air conditioners (blower-coil), the fraction of consumers experiencing an LCC benefit is 0 percent in the rest of country, 34 percent in the hot-humid region, and 27 percent in the hot-dry region. For split-system heat pumps, the fraction of consumers experiencing an LCC benefit is 20 percent in the rest of country, 38 percent in the hot-humid region, and 40 percent in the hot-dry region. For single-package air conditioners, the fraction of consumers experiencing an LCC benefit is 33 percent. For single-package heat pumps, the fraction of consumers experiencing an LCC benefit is 35 percent. For SDHV air conditioners, no consumers experience an LCC benefit in any of the regions.

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At TSL 5, the fraction of consumers experiencing an LCC cost is 23 percent for non-weatherized gas furnaces in the northern region and 0 percent in the south, 46 percent for mobile home gas furnaces in the northern region and 0 percent in the south, and 35 percent for oil-fired furnaces. At TSL 4, the fraction of consumers experiencing an LCC cost is 10 percent for non-weatherized gas furnaces in the northern region and 0 percent in the south, 44 percent for mobile home gas furnaces in the northern region and 0 percent in the south, and 10 percent for oil-fired furnaces.

For central air conditioners and heat pumps, at TSL 5 and at TSL 4, the fraction of consumers experiencing an LCC cost is the same. For split-system air conditioners (coil-only), the fraction of consumers experiencing an LCC cost is 0 percent in the rest of country, 26 percent in the hot-humid region, and 37 percent in the hot-dry region. For split-system air conditioners (blower-coil), the fraction of consumers experiencing an

LCC cost is 0 percent in the rest of country, 21 percent in the hot-humid region, and 28 percent in the hot-dry region. For split-system heat pumps, the fraction of consumers experiencing an LCC cost is 35 percent in the rest of country, 17 percent in the hot-humid region, and 15 percent in the hot-dry region. For single-package air conditioners, the fraction of consumers experiencing an LCC cost is 37 percent. For single-package heat pumps, the fraction of consumers experiencing an LCC cost is 29 percent. For SDHV air conditioners, no consumers experience an LCC cost in any of the regions.

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At TSL 5, the projected change in INPV ranges from a decrease of $508 million to a decrease of $915 million. At TSL 5, DOE recognizes the risk of negative impacts if manufacturers' expectations concerning reduced profit margins are realized. If the high end of the range of impacts is reached as DOE expects, TSL 5 could result in a net loss of 10.8 percent in INPV to furnace, central air conditioner, and heat pump manufacturers. At TSL 4, the projected change in INPV ranges from a net loss of $478 million to a net loss of $900 million. At TSL 4, DOE recognizes the risk of negative impacts if manufacturers' expectations concerning reduced profit margins are realized. If the high end of the range of impacts is reached as DOE expects, TSL 4 could result in a net loss of 10.6 percent in INPV to furnace, central air conditioner, and heat pump manufacturers.

The Secretary concludes that at TSL 5 for furnace and central air conditioner and heat pump energy efficiency, the benefits of energy savings, positive NPV of consumer benefits, generating capacity reductions, emission reductions, and the estimated monetary value of the CO_2 emissions reductions are outweighed by the economic burden on some consumers due to large increases in installed cost, and the capital conversion costs and profit margin impacts that could result in a large reduction in INPV for the manufacturers. Consequently, the Secretary has concluded that TSL 5 is not economically justified.

The Secretary concludes that at TSL 4 for furnace and central air conditioner and heat pump energy efficiency, the benefits of energy savings, positive NPV of consumer benefits, generating capacity reductions, emission reductions, and the estimated monetary value of the CO_2 emissions reductions would outweigh the economic burden on some consumers due to increases in installed cost, and the capital conversion costs and profit margin impacts that could result in a moderate reduction in INPV for the manufacturers. TSL 4 may yield greater cumulative energy savings than TSL 5, and also a higher NPV of consumer benefits at both 3-percent and 7-percent discount rates.

In addition, the efficiency levels in TSL 4 correspond to the recommended levels in the consensus agreement, which DOE believes sets forth a statement by interested persons that are fairly representative of relevant points of view (including representatives of manufacturers of covered products, States, and efficiency advocates) and contains recommendations with respect to an energy conservation standard that are in accordance with 42 U.S.C. 6295(o). Moreover, DOE has encouraged the submission of consensus agreements as a way to get diverse stakeholders together, to develop an independent and probative analysis useful in DOE standard setting, and to expedite the rulemaking process. In the present case, one outcome of the consensus agreement was a recommendation to accelerate the compliance dates for these products, which would have the effect of producing additional energy savings at an earlier date. DOE also believes that standard levels recommended in the consensus agreement may increase the likelihood for regulatory compliance, while decreasing the risk of litigation.

After considering the analysis, comments to the furnaces RAP and the preliminary TSD for central air conditioners and heat pumps, and the benefits and burdens of TSL 4, the Secretary has concluded that this trial standard level offers the maximum improvement in efficiency that is technologically feasible and economically justified, and will result in significant conservation of energy. Therefore, DOE today adopts TSL 4 for furnaces and central air conditioners and heat pumps. Today's amended energy conservation standards for furnaces, central air conditioners, and heat pumps, expressed in terms of minimum energy efficiency, are shown in Table V.55.

Table V.55 Amended Standards for Furnace, Central Air Conditioner, and Heat Pump Energy Efficiency

<table>
<tr><th colspan="4">Residential Furnaces*</th></tr>
<tr><th>Product Class</th><th colspan="2">National Standards</th><th>Northern Region** Standards</th></tr>
<tr><td>Non-weatherized gas</td><td colspan="2">AFUE = 80%</td><td>AFUE = 90%</td></tr>
<tr><td>Mobile home gas</td><td colspan="2">AFUE = 80%</td><td>AFUE = 90%</td></tr>
<tr><td>Non-weatherized oil-fired</td><td colspan="2">AFUE = 83%</td><td>AFUE = 83%</td></tr>
<tr><td>Weatherized gas</td><td colspan="2">AFUE = 81%</td><td>AFUE = 81%</td></tr>
<tr><td>Mobile home oil-fired[‡‡]</td><td colspan="2">AFUE = 75%</td><td>AFUE = 75%</td></tr>
<tr><td>Weatherized oil-fired[‡‡]</td><td colspan="2">AFUE = 78%</td><td>AFUE = 78%</td></tr>
<tr><td>Electric[‡‡]</td><td colspan="2">AFUE = 78%</td><td>AFUE = 78%</td></tr>
<tr><th colspan="4">Central Air Conditioners and Heat Pumps[†]</th></tr>
<tr><th>Product Class</th><th>National Standards</th><th>Southeastern Region[††] Standards</th><th>Southwestern Region[‡] Standards</th></tr>
<tr><td>Split-system air conditioners</td><td>SEER = 13</td><td>SEER = 14</td><td>SEER = 14
EER = 12.2 (for units with a rated cooling capacity less than 45,000 Btu/h)
EER = 11.7 (for units with a rated cooling capacity equal to or greater than 45,000 Btu/h)</td></tr>
<tr><td>Split-system heat pumps</td><td>SEER = 14
HSPF = 8.2</td><td>SEER = 14
HSPF = 8.2</td><td>SEER = 14
HSPF = 8.2</td></tr>
<tr><td>Single-package air conditioners[‡‡]</td><td>SEER = 14</td><td>SEER = 14</td><td>SEER = 14
EER = 11.0</td></tr>
<tr><td>Single-package heat pumps</td><td>SEER = 14
HSPF = 8.0</td><td>SEER = 14
HSPF = 8.0</td><td>SEER = 14
HSPF = 8.0</td></tr>
<tr><td>Small-duct, high-velocity systems</td><td>SEER = 13
HSPF = 7.7</td><td>SEER = 13
HSPF = 7.7</td><td>SEER = 13
HSPF = 7.7</td></tr>
<tr><td>Space-constrained products – air conditioners[‡‡]</td><td>SEER = 12</td><td>SEER = 12</td><td>SEER = 12</td></tr>
<tr><td>Space-constrained products – heat pumps[‡‡]</td><td>SEER = 12
HSPF = 7.4</td><td>SEER = 12
HSPF = 7.4</td><td>SEER = 12
HSPF = 7.4</td></tr>
</table>

* AFUE is Annual Fuel Utilization Efficiency.

** The Northern region for furnaces contains the following States: Alaska, Colorado, Connecticut, Idaho, Illinois, Indiana, Iowa, Kansas, Maine, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Dakota, Ohio, Oregon, Pennsylvania, Rhode Island, South Dakota, Utah, Vermont, Washington, West Virginia, Wisconsin, and Wyoming.

[†] SEER is Seasonal Energy Efficiency Ratio; EER is Energy Efficiency Ratio; HSPF is Heating Seasonal Performance Factor; and Btu/h is British Thermal Units per hour.

[††] The Southeastern region for central air conditioners and heat pumps contains the following States: Alabama, Arkansas, Delaware, Florida, Georgia, Hawaii, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia, and the District of Columbia.

[‡]The Southwestern region for central air conditioners and heat pumps contains the States of Arizona, California, Nevada, and New Mexico.

DOE is not amending energy conservation standards for these product classes in this direct final rule.

2. Benefits and Burdens of TSLs Considered for Furnace, Central Air Conditioner, and Heat Pump Standby Mode and Off Mode Power

Table V.56 through Table V.58 present a summary of the quantitative impacts estimated for each TSL considered for furnace, central air conditioner, and heat pump standby mode and off mode power. The efficiency levels contained in each TSL are described in section V.A.

Table V.56 Summary of Results for Furnace, Central Air Conditioner, and Heat Pump Standby Mode and Off Mode Power TSLs: National Impacts

Category	**TSL 1**	**TSL 2**	**TSL 3**
National Energy Savings (quads)	0.153	0.16	0.186
NPV of Consumer Benefits (2009$ billion)			
3% discount rate	1.14	1.18	1.01
7% discount rate	0.371	0.373	0.235
Cumulative Emissions Reduction			
CO_2 (million metric tons)	8.23	8.73	10.1
NO_X (thousand tons)	6.60	7.00	8.11
Hg (ton)	0.056	0.072	0.079
Value of Emissions Reductions			
CO_2 (2009$ million)*	41.7 to 694	44.3 to 738	51.7 to 862
NO_X – 3% discount rate (2009$ million)	2.07 to 21.3	2.20 to 22.6	2.56 to 26.3
NO_X – 7% discount rate (2009$ million)	0.793 to 8.15	0.841 to 8.65	0.975 to 10.0
Generation Capacity Reduction (GW**)** **	0.103	0.110	0.127
Employment Impacts			
Total Potential Change in Domestic Production Workers in 2016 (thousands)	negligible	negligible	negligible
Indirect Domestic Jobs (thousands)**	0.8	0.86	1.02

Parentheses indicate negative (-) values.
* Range of the value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions.
** Changes in 2045.

Table V.57 Summary of Results for Furnace, Central Air Conditioner, and Heat Pump Standby Mode and Off Mode Power TSLs: Manufacturer and Consumer Impacts

Category	TSL 1	TSL 2	TSL 3
Manufacturer Impacts			
Change in Industry NPV (2009$ million)	4 to (253)	5 to (253)	23 to (255)
Industry NPV (% change)	.05 to (2.91)	.06 to (2.91)	0.26 to (2.93)
Consumer Mean LCC Savings* (2009$)			
Non-Weatherized Gas Furnaces	2	2	0
Mobile Home Gas Furnaces	0	0	(1)
Oil-Fired Furnaces	1	1	1
Electric Furnaces	0	0	(1)
Split-System Air Conditioners (coil-only)	84	84	84
Split-System Air Conditioners (blower-coil)	84	40	35
Split-System Heat Pumps	9	9	(1)
Single-Package Air Conditioners	84	41	36
Single-Package Heat Pumps	9	9	(1)
SDHV Air Conditioners	84	37	32
Space-Constrained Air Conditioners	84	42	37
Space-Constrained Heat Pumps	9	9	(1)
Consumer Median PBP (years)			
Non-Weatherized Gas Furnaces	11	11	16
Mobile Home Gas Furnaces	12	12	18
Oil-Fired Furnaces	8	8	12
Electric Furnaces	10	10	16
Split-System Air Conditioners (coil-only)	1	1	1
Split-System Air Conditioners (blower-coil)	1	6	7
Split-System Heat Pumps	4	4	5
Single-Package Air Conditioners	1	6	7
Single-Package Heat Pumps	4	4	5
SDHV Air Conditioners	1	7	7
Space-Constrained Air Conditioners	1	6	7
Space-Constrained Heat Pumps	4	4	5

* Parentheses indicate negative (-) values. For LCCs, a negative value means an increase in LCC by the amount indicated.

Table V.58 Summary of Results for Furnace, Central Air Conditioner, and Heat Pump Standby Mode and Off Mode Power TSLs: Distribution of Consumer Impacts

Category	TSL 1	TSL 2	TSL 3
Distribution of Consumer LCC Impacts			
Non-Weatherized Gas Furnaces			
Net Cost (%)	9	9	17
No Impact (%)	72	72	72
Net Benefit (%)	18	18	11
Mobile Home Gas Furnaces			
Net Cost (%)	6	6	8
No Impact (%)	91	91	91
Net Benefit (%)	4	4	2
Oil-Fired Furnaces			
Net Cost (%)	1	1	4
No Impact (%)	91	91	91
Net Benefit (%)	8	8	6
Electric Furnaces			
Net Cost (%)	4	4	7
No Impact (%)	90	90	90
Net Benefit (%)	5	5	3
Split-System Air Conditioners (coil-only)			
Net Cost (%)	0	0	0
No Impact (%)	94	94	94
Net Benefit (%)	6	6	6
Split-System Air Conditioners (blower-coil)			
Net Cost (%)	0	3	3
No Impact (%)	94	91	91
Net Benefit (%)	6	6	6
Split-System Heat Pumps			
Net Cost (%)	0	0	19
No Impact (%)	67	67	57
Net Benefit (%)	33	33	24
Single-Package Air Conditioners			
Net Cost (%)	0	3	3
No Impact (%)	94	91	91
Net Benefit (%)	6	6	6
Single-Package Heat Pumps			
Net Cost (%)	0	0	19
No Impact (%)	66	66	57
Net Benefit (%)	34	34	24
SDHV Air Conditioners			
Net Cost (%)	0	3	3
No Impact (%)	94	91	91
Net Benefit (%)	6	6	6
Space-Constrained Air Conditioners			
Net Cost (%)	0	3	3
No Impact (%)	94	91	91
Net Benefit (%)	6	6	6

Space-Constrained Heat Pumps			
Net Cost (%)	0	0	19
No Impact (%)	67	67	58
Net Benefit (%)	33	33	23

Values in the table are rounded off, and, thus, sums may not equal 100 percent in all cases.

DOE first considered TSL 3, which represents the max-tech efficiency levels. TSL 3 would save 0.186 quads of energy, an amount DOE considers significant. Under TSL 3, the NPV of consumer benefit would be $0.235 billion, using a discount rate of 7 percent, and $1.01 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 3 are 10.1 Mt of CO_2, 8.11 thousand tons of NO_X, and 0.079 ton of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 3 ranges from $51.7 million to $862 million. Total generating capacity in 2045 is estimated to decrease by 0.127 GW under TSL 3.

At TSL 3, the average LCC impact is a cost (LCC increase) of $0 for non-weatherized gas furnaces, a cost of $1 for mobile home gas furnaces, a savings of $1 for oil-fired furnaces, and a cost of $1 for electric furnaces. For split-system air conditioners (coil-only), the average LCC impact is a savings (LCC decrease) of $84. For split-system air conditioners (blower-coil), the average LCC impact is a savings of $35. For split-system heat pumps, the average LCC impact is a cost of $1. For single-package air conditioners, the average LCC impact is a savings of $36. For single-package heat pumps, the average LCC impact is a cost of $1. For SDHV air conditioners, the average LCC impact is a savings of $32. For space-constrained air conditioners, the average LCC impact is a savings of $37. For space-constrained heat pumps, the average LCC impact is a cost of $1.

At TSL 3, the median payback period is 16 years for non-weatherized gas furnaces; 18 years for mobile home gas furnaces; 12 years for oil-fired furnaces; and 16 years for electric furnaces. For split-system air conditioners (coil-only), the median payback period is 1 year. For split-system air conditioners (blower-coil), the median payback period is 7 years. For split-system heat pumps, the median payback period is 5 years. For single-package air conditioners, the median payback period is 7 years. For single-package heat pumps, the median payback period is 5 years. For SDHV air conditioners, the median payback period is 7 years. For space-constrained air conditioners, the median payback period is 7 years. For space-constrained heat pumps, the median payback period is 5 years.

At TSL 3, the fraction of consumers experiencing an LCC benefit is 11 percent for non-weatherized gas furnaces, 2 percent for mobile home gas furnaces, 6 percent for oil-fired furnaces, and 3 percent for electric furnaces. For split-system air conditioners (coil-only), the fraction of consumers experiencing an LCC benefit is 6 percent. For split-system air conditioners (blower-coil), the fraction of consumers experiencing an LCC benefit is 6 percent. For split-system heat pumps, the fraction of consumers experiencing an LCC benefit is 24 percent. For single-package air conditioners, the fraction of consumers experiencing an LCC benefit is 6 percent. For single-package heat pumps, the fraction of consumers experiencing an LCC benefit is 24 percent. For SDHV air conditioners, the fraction of consumers experiencing an LCC benefit is 6 percent. For space-constrained air conditioners, the fraction of consumers experiencing an LCC benefit is 6 percent. For space-constrained heat pumps, the fraction of consumers experiencing an LCC benefit is 23 percent.

At TSL 3, the fraction of consumers experiencing an LCC cost is 17 percent for non-weatherized gas furnaces, 8 percent for mobile home gas furnaces, 4 percent for oil-fired furnaces, and 7 percent for electric furnaces. For split-system air conditioners (coil-only), the fraction of consumers experiencing an LCC cost is 0 percent. For split-system air conditioners (blower-coil), the fraction of consumers experiencing an LCC cost is 3 percent. For split-system heat pumps, the fraction of consumers experiencing an LCC cost is 19 percent. For single-package air conditioners, the fraction of consumers experiencing an LCC cost is 3 percent. For single-package heat pumps, the fraction of consumers experiencing an LCC cost is 19 percent. For SDHV air conditioners, the fraction of consumers experiencing an LCC cost is 3 percent. For space-constrained air conditioners, the fraction of consumers experiencing an LCC cost is 3 percent. For space-constrained heat pumps, the fraction of consumers experiencing an LCC cost is 19 percent.

At TSL 3, the projected change in INPV ranges from an increase of $23 million to a decrease of $255 million. The model anticipates impacts on INPV to range from 0.26 percent to -2.93 percent. In general, the cost of standby mode and off mode features is not expected to significantly affect manufacturer profit margins for furnace, central air conditioner, and heat pump products.

The Secretary concludes that at TSL 3 for furnace and central air conditioner and heat pump standby mode and off mode power, the benefits of energy savings, positive NPV of consumer benefits at 3-percent discount rate, generating capacity reductions, emission reductions, and the estimated monetary value of the CO_2 emissions reductions would be outweighed by the negative NPV of consumer benefits at 7 percent and the economic burden on some consumers due to the increases in product cost. Of the consumers of furnaces and heat pumps who would be impacted, many more would be burdened by standards at TSL 3 than would benefit. Consequently, the Secretary has concluded that TSL 3 is not economically justified.

DOE then considered TSL 2. TSL 2 would save 0.16 quads of energy, an amount DOE considers significant. Under TSL 2, the NPV of consumer benefit would be $0.373 billion, using a discount rate of 7 percent, and $1.18 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 2 are 8.73 Mt of CO_2, 7.00 thousand tons of NO_X, and 0.072 tons of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 2 ranges from $44.3 million to $738 million. Total generating capacity in 2045 is estimated to decrease by 0.11 GW under TSL 2.

At TSL 2, the average LCC impact is a savings (LCC decrease) of $2 for non-weatherized gas furnaces, a savings of $0 for mobile home gas furnaces, a savings of $1 for oil-fired furnaces, and a savings of $0 for electric furnaces. For split-system air conditioners (coil-only), the average LCC impact is a savings of $84. For split-system air conditioners (blower-coil), the average LCC impact is a savings of $40. For split-system heat pumps, the average LCC impact is a savings of $9. For single-package air conditioners, the average LCC impact is a savings of $41. For single-package heat pumps, the average LCC impact is a savings of $9. For SDHV air conditioners, the average LCC impact is a savings of $37. For space-constrained air conditioners, the average LCC impact is a savings of $42. For space-constrained heat pumps, the average LCC impact is a savings of $9.

At TSL 2, the median payback period is 11 years for non-weatherized gas furnaces; 12 years for mobile home gas furnaces; 8 years for oil-fired furnaces; and 10 years for electric furnaces. For split-system air conditioners (coil-only), the median payback period is 1 year. For split-system air conditioners (blower-coil), the median payback period is 6 years. For split-system heat pumps, the median payback period is 4 years. For single-package air conditioners, the median payback period is 6 years. For single-package heat pumps, the median payback period is 4 years. For SDHV air conditioners, the median payback period is 7 years. For space-constrained air conditioners, the median payback period is 6 years. For space-constrained heat pumps, the median payback period is 4 years.

At TSL 2, the fraction of consumers experiencing an LCC benefit is 18 percent for non-weatherized gas furnaces, 4 percent for mobile home gas furnaces, 8 percent for oil-fired furnaces, and 5 percent for electric furnaces. For split-system air conditioners (coil-only), the fraction of consumers experiencing an LCC benefit is 6 percent. For split-system air conditioners (blower-coil), the fraction of consumers experiencing an LCC benefit is 6 percent. For split-system heat pumps, the fraction of consumers experiencing an LCC benefit is 33 percent. For single-package air conditioners, the fraction of consumers experiencing an LCC benefit is 6 percent. For single-package heat pumps, the fraction of consumers experiencing an LCC benefit is 34 percent. For SDHV air conditioners, the fraction of consumers experiencing an LCC benefit is 6 percent. For space-constrained air conditioners, the fraction of consumers experiencing an LCC benefit is 6 percent. For space-constrained heat pumps, the fraction of consumers experiencing an LCC benefit is 33 percent.

At TSL 2, the fraction of consumers experiencing an LCC cost is 9 percent for non-weatherized gas furnaces, 6 percent for mobile home gas furnaces, 1 percent for oil-fired furnaces, and 4 percent for electric furnaces. For split system air conditioners (coil-only), the fraction of consumers experiencing an LCC cost is 0 percent. For split-system air conditioners (blower-coil), the fraction of consumers experiencing an LCC cost is 3 percent. For split-system heat pumps, the fraction of consumers experiencing an LCC cost is 0 percent. For single-package air conditioners, the fraction of consumers experiencing an LCC cost is 3 percent. For single-package heat pumps, the fraction of consumers experiencing an LCC cost is 0 percent. For SDHV air conditioners, the fraction of consumers experiencing an LCC cost is 3 percent. For space-constrained air conditioners, the fraction of consumers experiencing an LCC cost is 3 percent. For space-constrained heat pumps, the fraction of consumers experiencing an LCC cost is 0 percent.

At TSL 2, the projected change in INPV ranges from an increase of $5 million to a decrease of $253 million. The modeled impacts on INPV range from 0.06 percent to -2.91 percent. In general, the incremental cost of standby mode and off mode features are not expected to significantly affect INPV for the furnace, central air conditioner, and heat pump industry at this level.

The Secretary concludes that at TSL 2 for furnace, central air conditioner, and heat pump standby mode and off mode power, the benefits of energy savings, positive NPV of consumer benefits at both 7-percent and 3-percent discount rates, generating capacity reductions, emission reductions, and the estimated monetary value of the CO_2 emissions reductions would outweigh the economic burden on a small fraction of consumers due to the increases in product cost. With the exception of consumers of mobile home gas furnaces (whose mean LCC impact is zero), the majority of the consumers that would be affected by standards at TSL 2 would see an LCC benefit. Consequently, the Secretary has concluded that TSL 2 is economically justified.

After considering the analysis and the benefits and burdens of TSL 2, the Secretary has concluded that this trial standard level offers the maximum improvement in energy efficiency that is technologically feasible and economically justified, and will result in the significant conservation of energy. Therefore, DOE today adopts TSL 2 for furnace, central air conditioner, and heat pump standby mode and off mode. Today's amended energy conservation standards for standby mode and off mode, expressed as maximum power in watts, are shown in Table V.59.

Table V.59 Standards for Furnace, Central Air Conditioner, and Heat Pump Standby Mode and Off Mode*

Residential Furnaces**	
Product Class	**Standby Mode and Off Mode Standard Levels**
Non-Weatherized Gas	$P_{W,SB}$ = 10 watts $P_{W,OFF}$ = 10 watts
Mobile Home Gas	$P_{W,SB}$ = 10 watts $P_{W,OFF}$ = 10 watts
Non-Weatherized Oil-Fired	$P_{W,SB}$ = 11 watts $P_{W,OFF}$ = 11 watts
Mobile Home Oil-Fired	$P_{W,SB}$ = 11 watts $P_{W,OFF}$ = 11 watts
Electric	$P_{W,SB}$ = 10 watts $P_{W,OFF}$ = 10 watts
Central Air Conditioners and Heat Pumps[†]	
Product Class	**Off Mode Standard Levels**[††]
Split-system air conditioners	$P_{W,OFF}$ = 30 watts
Split-system heat pumps	$P_{W,OFF}$ = 33 watts
Single-package air conditioners	$P_{W,OFF}$ = 30 watts
Single-package heat pumps	$P_{W,OFF}$ = 33watts
Small-duct, high-velocity systems	$P_{W,OFF}$ = 30 watts
Space-constrained air conditioners	$P_{W,OFF}$ = 30 watts
Space-constrained heat pumps	$P_{W,OFF}$ = 33 watts

*$P_{W,SB}$ is standby mode electrical power consumption, and $P_{W,OFF}$ is off mode electrical power consumption for furnaces.
** Standby mode and off mode energy consumption for weatherized gas and oil-fired furnaces is regulated as a part of single-package air conditioners and heat pumps, as discussed in section III.E.1.
† $P_{W,OFF}$ is off mode electrical power consumption for central air conditioners and heat pumps.
†† DOE is not adopting a separate standby mode standard level for central air conditioners and heat pumps, because standby mode power consumption for these products is already regulated by SEER and HSPF.

3. Annualized Benefits and Costs of Standards for Furnace, Central Air Conditioner, and Heat Pump Energy Efficiency

The benefits and costs of today's standards can also be expressed in terms of annualized values over the analysis period. The annualized monetary values are the sum of: (1) the annualized national economic value (expressed in 2009$) of the benefits from operating products that meet the standards (consisting primarily of operating cost savings from using less energy, minus increases in equipment purchase costs, which is another way of representing consumer NPV); and (2) the monetary value of the benefits of emission reductions, including CO_2 emission reductions.[100] The value of the CO_2 reductions, otherwise known as the Social Cost of Carbon (SCC), is calculated using a range of values per metric ton of CO_2 developed by a recent Federal interagency process. The monetary costs and benefits of cumulative emissions reductions are reported in 2009$ to permit comparisons with the other costs and benefits in the same dollar units.

[100] DOE used a two-step calculation process to convert the time-series of costs and benefits into annualized values. First, DOE calculated a present value in 2011, the year used for discounting the NPV of total consumer costs and savings, for the time-series of costs and benefits using discount rates of three and seven percent for all costs and benefits except for the value of CO_2 reductions. For the latter, DOE used a range of discount rates, as shown in Table I.3. From the present value, DOE then calculated the fixed annual payment over a 32-year period, starting in 2011 that yields the same present value. The fixed annual payment is the annualized value. Although DOE calculated annualized values, this does not imply that the time-series of cost and benefits from which the annualized values were determined would be a steady stream of payments.

Although combining the values of operating savings and CO_2 reductions provides a useful perspective, two issues should be considered. First, the national operating savings are domestic U.S. consumer monetary savings that occur as a result of market transactions, while the value of CO_2 reductions is based on a global value. Second, the assessments of operating cost savings and CO_2 savings are performed with different methods that use quite different time frames for analysis. The national operating cost savings is measured for the lifetime of products shipped in 2013–2045 for furnaces and 2015-2045 for central air conditioners and heat pumps. The SCC values, on the other hand, reflect the present value of future climate-related impacts resulting from the emission of one metric ton of carbon dioxide in each year. These impacts continue well beyond 2100.

Estimates of annualized benefits and costs of today's standards for furnace, central air conditioner, and heat pump energy efficiency are shown in Table V.60. The results under the primary estimate are as follows. Using a 7-percent discount rate and the SCC value of $22.1/ton in 2010 (in 2009$), the cost of the energy efficiency standards in today's direct final rule is $527 million to $773 million per year in increased equipment installed costs, while the annualized benefits are $837 million to $1106 million per year in reduced equipment operating costs, $140 million to $178 million in CO_2 reductions, and $5.3 million to $6.9 million in reduced NO_X emissions. In this case, the net benefit amounts to $456 million to $517 million per year. DOE also calculated annualized net benefits using a range of potential electricity and equipment price trend forecasts. Given the range of modeled price trends, the range of net benefits using a 7-percent discount

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rate is from $295 million to $623 million per year. The low estimate corresponds to a scenario with a low electricity price trend and a constant real price trend for equipment.

Comment [A16]: Change recommended by OIRA.

Using a 3-percent discount rate and the SCC value of $22.1/metric ton in 2010 (in 2009$), the cost of the energy efficiency standards in today's direct final rule is $566 million to $825 million per year in increased equipment installed costs, while the benefits are $1289 million to $1686 million per year in reduced operating costs, $140 million to $178 million in CO_2 reductions, and $7.9 million to $10.2 million in reduced NO_X emissions. In this case, the net benefit amounts to $871 million to $1049 million per year. DOE also calculated annualized net benefits using a range of potential electricity and equipment price trend forecasts. Given the range of modeled price trends, the range of net benefits using a 3-percent discount rate is from $601 million to $1,260 million per year. The low estimate corresponds to a scenario with a low electricity price trend and a constant real price trend for equipment.

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Comment [A17]: Change recommended by OIRA.

Table V.60 Annualized Benefits and Costs of Standards for Furnace, Central Air Conditioner, and Heat Pump Energy Efficiency (TSL 4)

	Discount Rate	Primary Estimate*	Low Estimate*	High Estimate*
		Monetized (million 2009$/year)		
Benefits				
Operating Cost Savings	7%	837 to 1,106	723 to 959	955 to 1,258
	3%	1,289 to 1,686	1,083 to 1,422	1,493 to 1,948
CO_2 Reduction at $4.9/t**	5%	34 to 43	34 to 43	34 to 43
CO_2 Reduction at $22.1/t**	3%	140 to 178	141 to 178	140 to 178
CO_2 Reduction at $36.3/t**	2.5%	224 to 284	225 to 285	224 to 284
CO_2 Reduction at $67.1/t**	3%	427 to 541	428 to 543	427 to 541
NO_X Reduction at $2,519/ton**	7%	5.3 to 6.9	5.3 to 7.0	5.3 to 6.9
	3%	7.9 to 10.2	7.9 to 10.3	7.9 to 10.2
Total†	7% plus CO_2 range	876 to 1,653	762 to 1,509	994 to 1,805
	7%	983 to 1,290	869 to 1,144	1,100 to 1,442
	3%	1,437 to 1,874	1,232 to 1,611	1,641 to 2,136
	3% plus CO_2 range	1,330 to 2,237	1,125 to 1,975	1,535 to 2,499
Costs				
Incremental Product Costs	7%	527 to 773	574 to 840	555 to 819
	3%	566 to 825	630 to 916	599 to 876
Net Benefits/Costs				
Total†	7% plus CO_2 range	349 to 880	188 to 669	438 to 986
	7%	456 to 517	295 to 305	545 to 623
	3%	871 to 1,049	601 to 695	1,042 to 1,260
	3% plus CO_2 range	764 to 1,412	494 to 1,059	935 to 1,623

* The benefits and costs are calculated for products shipped in 2013-2045 for the furnace standards and in 2015-2045 for the central air conditioner and heat pump standards.

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**The Primary, Low, and High Estimates utilize forecasts of energy prices and housing starts from the AEO2010 Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, the low estimate uses incremental product costs that reflects constant prices (no learning rate) for product prices, and the high estimate uses incremental product costs that reflects a declining trend (high learning rate) for product prices. The derivation and application of learning rates for product prices is explained in section IV.F.1.

Comment [A19]: Change recommended by OIRA.

† The CO_2 values represent global monetized values (in 2009$) of the social cost of CO_2 emissions in 2010 under several scenarios. The values of $4.9, $22.1, and $36.3 per metric ton are the averages of SCC distributions calculated using 5-percent, 3-percent, and 2.5-percent discount rates, respectively. The value of $67.1 per ton represents the 95th percentile of the SCC distribution calculated using a 3-percent discount rate. The value for NO_X (in 2009$) is the average of the low and high values used in DOE's analysis.

†† Total Benefits for both the 3-percent and 7-percent cases are derived using the SCC value calculated at a 3-percent discount rate, which is $22.1/ton in 2010 (in 2009$). In the rows labeled as "7% plus CO_2 range" and "3% plus CO_2 range," the operating cost and NO_X benefits are calculated using the labeled discount rate, and those values are added to the full range of CO_2 values.

4. Annualized Benefits and Costs of Standards for Furnace, Central Air Conditioner, and Heat Pump Standby Mode and Off Mode Power

As explained in detail above, the benefits and costs of today's standards for standby mode and off mode power can also be expressed in terms of annualized values. The annualized monetary values are the sum of: (1) the annualized national economic value (expressed in 2009$) of the benefits from operating products that meet the standards (consisting primarily of operating cost savings from using less energy, minus increases in equipment purchase costs, which is another way of representing consumer NPV); and (2) the monetary value of the benefits of emission reductions, including CO_2 emission reductions.

Estimates of annualized benefits and costs of today's standards for furnace, central air conditioner, and heat pump standby mode and off mode power are shown in

Table V.61. The results under the primary estimate are as follows. Using a 7-percent discount rate and the SCC value of $22.1/ton in 2010 (in 2009$), the cost of the standby mode and off mode standards in today's direct final rule is $16.4 million per year in increased equipment costs, while the annualized benefits are $46.5 million per year in reduced equipment operating costs, $12.4 million in CO_2 reductions, and $0.4 million in reduced NO_X emissions. In this case, the net benefit amounts to $42.8 million per year. Using a 3-percent discount rate and the SCC value of $22.1/ton in 2010 (in 2009$), the cost of the standby mode and off mode standards in today's direct final rule is $19.1 million per year in increased equipment costs, while the benefits are $79.3 million per year in reduced operating costs, $12.4 million in CO_2 reductions, and $0.6 million in reduced NO_X emissions. In this case, the net benefit amounts to $73.2 million per year.

Table V.61 Annualized Benefits and Costs of Standards for Furnace, Central Air Conditioner, and Heat Pump Standby Mode and Off Mode Power (TSL 2)

	Discount Rate	Primary Estimate*	Low Estimate*	High Estimate*
		Monetized (million 2009$/year)		
Benefits				
Operating Cost Savings	7%	46.5	40.4	52.8
	3%	79.3	67.9	90.8
CO_2 Reduction at $4.9/t**	5%	2.9	2.9	2.9
CO_2 Reduction at $22.1/t**	3%	12.4	12.4	12.4
CO_2 Reduction at $36.3/t**	2.5%	19.9	19.9	19.9
CO_2 Reduction at $67.1/t**	3%	37.6	37.6	37.6
NO_X Reduction at $2,519/ton**	7%	0.4	0.4	0.4
	3%	0.6	0.6	0.6
Total†	7% plus CO_2 range	49.7 to 84.5	43.6 to 78.4	56.1 to 90.8
	7%	59.2	53.1	65.5
	3%	92.3	80.9	103.8
	3% plus CO_2 range	82.8 to 117.5	71.4 to 106.2	94.3 to 129.1
Costs				
Incremental Product Costs	7%	16.4	15.2	17.7
	3%	19.1	17.6	20.6
Net Benefits/Costs				
Total†	7% plus CO_2 range	33.3 to 68.1	28.5 to 63.2	38.4 to 73.1
	7%	42.8	38.0	47.9
	3%	73.2	63.3	83.2
	3% plus CO_2 range	63.7 to 98.4	53.8 to 88.5	73.7 to 108.5

* The benefits and costs are calculated for products shipped in 2013-2045 for the furnace standards and in 2015-2045 for the central air conditioner and heat pump standards.

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**The Primary, Low, and High Estimates utilize forecasts of energy prices and housing starts from the AEO2010 Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, the low estimate uses incremental product costs that reflects constant prices (no learning rate) for product prices, and the high estimate uses incremental product costs that reflects a declining trend (high learning rate) for product prices. The derivation and application of learning rates for product prices is explained in section IV.F.1.

Comment [A20]: Change recommended by OIRA.

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‡ The CO_2 values represent global monetized values (in 2009$) of the social cost of CO_2 emissions in 2010 under several scenarios. The values of $4.9, $22.1, and $36.3 per metric ton are the averages of SCC distributions calculated using 5-percent, 3-percent, and 2.5-percent discount rates, respectively. The value of $67.1 per ton represents the 95th percentile of the SCC distribution calculated using a 3-percent discount rate. The value for NO_X (in 2009$) is the average of the low and high values used in DOE's analysis.

†† Total Benefits for both the 3-percent and 7-percent cases are derived using the SCC value calculated at a 3-percent discount rate, which is $22.1/ton in 2010 (in 2009$). In the rows labeled as "7% plus CO_2 range" and "3% plus CO_2 range," the operating cost and NO_X benefits are calculated using the labeled discount rate, and those values are added to the full range of CO_2 values.

5. Certification Requirements

In today's direct final rule, in addition to proposing amended energy conservation standards for the existing AFUE levels (for furnaces) and SEER and HSPF levels (for central air conditioners and heat pumps), DOE is setting new requirements for standby mode and off mode energy consumption for residential furnaces and off mode energy consumption for central air conditioners and heat pumps. Additionally, DOE is adopting new requirements for EER for States in the hot-dry, southwestern region for central air conditioners. Because standby mode and off mode for furnaces, off mode for central air conditioners and heat pumps, and EER for central air conditioners have not previously been regulated, DOE does not currently require certification for these metrics. DOE notes, however, that determining compliance with the standards in today's direct final rule will likely require manufacturers to certify these ratings (i.e., $P_{W,OFF}$ and $P_{W,SB}$ for furnaces, $P_{W,OFF}$ for central air conditioners and heat pumps, and EER for central air conditioners sold in the southwestern region (Arizona, California, Nevada, and New Mexico)). DOE has decided that it will address these certification requirements in a separate certification and enforcement rulemaking, or in a rulemaking to determine the enforcement mechanism for regional standards.

VI. Procedural Issues and Regulatory Review

A. Review Under Executive Order 12866 and 13563

Comment [A21]: Change recommended by OIRA.

Section 1(b)(1) of Executive Order 12866, "Regulatory Planning and Review," 58 FR 51735 (Oct. 4, 1993), requires each agency to identify the problem that it intends to address, including, where applicable, the failures of private markets or public institutions that warrant new agency action, as well as to assess the significance of that problem. The problems that today's standards address are as follows:

(1) There is a lack of consumer information and/or information processing capability about energy efficiency opportunities in the furnace, central air conditioner, and heat pump market.

(2) There is asymmetric information (one party to a transaction has more and better information than the other) and/or high transactions costs (costs of gathering information and effecting exchanges of goods and services).

(3) There are external benefits resulting from improved energy efficiency of furnaces, central air conditioners, and heat pumps that are not captured by the users of such equipment. These benefits include externalities related to environmental protection and energy security that are not reflected in energy prices, such as reduced emissions of greenhouse gases.

In addition, DOE has determined that today's regulatory action is an "economically significant regulatory action" under section 3(f)(1) of Executive Order 12866. Accordingly, section 6(a)(3) of the Executive Order requires that DOE prepare a regulatory impact analysis (RIA) on today's rule and that the Office of Information and Regulatory Affairs (OIRA) in the Office of Management and Budget (OMB) review this rule. DOE presented to OIRA for review the draft rule and other documents prepared for this rulemaking, including the RIA, and has included these documents in the rulemaking record. The assessments prepared pursuant to Executive Order 12866 can be found in the technical support document for this rulemaking. They are available for public review in the Resource Room of DOE's Building Technologies Program, 950 L'Enfant Plaza, SW., Suite 600, Washington, DC 20024, (202) 586-2945, between 9:00 a.m. and 4:00 p.m., Monday through Friday, except Federal holidays.

DOE has also reviewed this regulation pursuant to Executive Order 13563, issued on January 18, 2011 (76 FR 3281, Jan. 21, 2011). EO 13563 is supplemental to and explicitly reaffirms the principles, structures, and definitions governing regulatory review established in Executive Order 12866. To the extent permitted by law, agencies are required by Executive Order 13563 to: (1) propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify); (2) tailor regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations; (3) select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity); (4) to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt; and (5) identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public.

We emphasize as well that Executive Order 13563 requires agencies "to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible." In its guidance, the Office of Information and Regulatory Affairs has emphasized that such techniques may include "identifying changing future compliance costs that might result from technological innovation or anticipated behavioral changes." For the reasons stated in the preamble, DOE believes that today's direct final rule is consistent with these principles, including that, to the extent permitted by law, agencies adopt a regulation only upon a reasoned determination that its benefits justify its costs and select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits.

Comment [A22]: Change recommended by OIRA.

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 et seq.) requires preparation of a final regulatory flexibility analysis (FRFA) for any rule that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by Executive Order 13272, "Proper Consideration of Small Entities in Agency Rulemaking" 67 FR 53461 (August 16, 2002), DOE published procedures and policies on February 19, 2003, to ensure that the potential impacts of its rules on small entities are properly considered during the rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of the General Counsel's website (www.gc.doe.gov).

DOE reviewed the standard levels considered in today's direct final rule under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. 68 FR 7990. As a result of this review, DOE prepared a FRFA in support of today's standards, which DOE will transmit to the Chief Counsel for Advocacy of the SBA for review under 5 U.S.C 605(b). As presented and discussed below, the FRFA describes potential impacts on small residential furnace, central air conditioner, and heat pump manufacturers associated with today's direct final rule and discusses alternatives that could minimize these impacts. A description of the reasons why DOE is adopting the standards in today's rule and the objectives of and legal basis for the rule are set forth elsewhere in the preamble and not repeated here.

1. Description and Estimated Number of Small Entities Regulated

For the manufacturers of residential furnaces, central air conditioners, and heat pumps, the Small Business Administration (SBA) has set a size threshold, which defines those entities classified as "small businesses" for the purposes of the statute. DOE used the SBA's small business size standards to determine whether any small entities would be subject to the requirements of the rule. 65 FR 30836, 30848 (May 15, 2000), as amended at 65 FR 53533, 53544 (Sept. 5, 2000) and codified at 13 CFR part 121. The size standards are listed by North American Industry Classification System (NAICS) code and industry description and are available at: http://www.sba.gov/idc/groups/public/documents/sba_homepage/serv_sstd_tablepdf.pdf. Residential furnace and central air conditioning (including heat pumps) manufacturing is classified under NAICS 333415, "Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing." The SBA sets a threshold of 750 employees or less for an entity to be considered as a small business for this category.

During its market survey, DOE used all available public information to identify potential small manufacturers. DOE's research involved industry trade association membership directories (including AHRI), public databases (e.g., AHRI Directory[101], the SBA Database[102]), individual company websites, and market research tools (e.g., Dunn and Bradstreet reports[103] and Hoovers reports[104]) to create a list of companies that manufacture or sell products covered by this rulemaking. DOE also asked stakeholders and industry representatives if they were aware of any other small manufacturers during manufacturer interviews and at DOE public

[101] See http://www.ahridirectory.org/ahriDirectory/pages/home.aspx.
[102] See http://dsbs.sba.gov/dsbs/search/dsp_dsbs.cfm.
[103] See http://www.dnb.com/
[104] See http://www.hoovers.com/.

meetings. DOE reviewed publicly-available data and contacted select companies on its list, as necessary, to determine whether they met the SBA's definition of a small business manufacturer of covered residential furnaces, central air conditioners, and heat pumps. DOE screened out companies that do not offer products covered by this rulemaking, do not meet the definition of a "small business," or are foreign owned and operated.

For central air conditioners, DOE initially identified 89 distinct brands sold in the U.S. Out of these 89 brands, DOE determined that 18 brands are managed by small businesses. While identifying the parent companies of the 18 brands, DOE determined that only four companies are domestic small business manufacturers of central air conditioning products. Three of these small businesses produce space-constrained products and one produces small-duct, high-velocity products. None of the small businesses produced split-system air conditioning, split-system heat pumps, single-package air conditioning, or single-package heat pump products, which together make up 99 percent of industry air conditioner and heat pump shipments.

For residential furnaces, DOE initially identified at least 90 distinct brands sold in the U.S. Out of these 90 brands, DOE determined that 14 were managed by small businesses. When identifying the parent companies of the 14 brands, DOE determined that only five companies are domestic small business manufacturers of furnace products. All five small businesses manufacture oil furnaces as their primary product line. One of the small businesses also produces mobile home furnaces as a secondary product offering. DOE did not identify any small manufacturers producing non-weatherized gas furnaces or weatherized gas furnaces, which together make up over 95 percent of residential furnace shipments. DOE also did not identify any small manufacturers of electric furnaces affected by this rulemaking.

Next, DOE contacted all of the identified small business manufacturers listed in the AHRI directory to request an interview about the possible impacts of amended energy conservation standards on small manufacturers. Not all manufacturers responded to interview requests; however, DOE did interview three small furnace manufacturers and two small central air conditioning and heat pump manufacturers. From these discussions, DOE determined the expected impacts of the rule on affected small entities.

2. Description and Estimate of Compliance Requirements

After examining structure of the central air conditioner and heat pump and furnace market, DOE determined it necessary to examine impacts on small manufacturers in two broad categories: (1) manufacturers of central air conditioners and heat pumps and (2) manufacturers of furnaces.

a. Central Air Conditioning and Heat Pumps

As discussed above, no small manufacturers for split-system air conditioning, split-system heat pump, single-package air conditioning, or single-package heat pump products were identified. DOE identified four domestic small business manufacturers of central air conditioner and heat pump products. All four small businesses manufacture niche products; three produce space-constrained products, and one produces SDHV products.

With regard to the space-constrained market, the three small business manufacturers identified by DOE make up the vast majority of shipments of these products in the United States. DOE did not identify any competing large manufacturers in this niche market. Supporting this finding, no large manufacturers listed through-the-wall, or space-constrained, products in the AHRI directory. According to manufacturer interviews, no manufacturers have entered or exited the space-constrained market in the past decade. Furthermore, based on the screening analysis, teardown analysis, and market research, DOE has determined that the current energy conservation standard applicable to these products is equal to the max-tech efficiency level. In other words, DOE has determined it is unable to raise the energy conservation standards applicable to space-constrained products due to the state of technology and the design constraints inherent to these products. Therefore, because the efficiency level to which these three small manufacturers are subject will not change, DOE does not anticipate that the rule would adversely affect the small businesses manufacturing space-constrained air conditioning products.

With respect to SDHV products, DOE identified one company as a small domestic manufacturer. The company's primary competitors are a small manufacturer based in Canada and a domestic manufacturer that does not qualify as a small business due to its parent company's size. These three manufacturers account for the vast majority of the SDHV market in the U.S., which makes up less than 1 percent of the overall domestic central air conditioning and heat pumps market.

The current energy conservation standard for SDHV is 13 SEER. In today's notice, DOE is not amending that level. Therefore, because the efficiency level to which the manufacturers are subject will not change, DOE does not anticipate that the standard level would adversely affect the manufacturers of SDHV products.

It should be noted that this rulemaking adopts a separate standard for the SDHV product class. As a result, exception relief granted in 2004 under the condition that "exception relief will remain in effect until such time as the agency modifies the general energy efficiency standard for central air conditioners and establishes a different standard for SDHV systems that comports with the EPCA[105]" will expire. Large and small SDHV manufacturers operating under exception relief

[105] Department of Energy: Office of Hearings and Appeals, Decision and Order, Case #TEE 0010 (2004) (Available at: http://www.oha.doe.gov/cases/ee/tee0010.pdf) (last accessed September 2010).

will be required to either comply with the standard or re-apply for exception relief ahead of the compliance date.

b. Residential Furnaces

DOE identified five domestic small business manufacturers of residential furnace products. All five produce oil furnaces as their primary product line. Oil furnaces make up less than 3 percent of residential furnace shipments. One of the small businesses also produces mobile home furnaces as a secondary product line. No additional small manufacturers of mobile home furnaces were identified.

The five small business manufacturers of residential furnace products account for 22 percent of the 1,207 active oil furnace product listings in the AHRI Directory (data based on information available from the AHRI Directory in September 2010). Ninety-nine percent of the small oil furnace manufacturer product listings were above the base standard of 78-percent AFUE. Seventy-seven percent of the small oil furnace manufacturer product listings had efficiencies equal to or above 83-percent AFUE, the efficiency level for oil furnaces adopted in today's notice. All small business manufacturers of residential furnace products have product lines that meet the efficiency level adopted in today's notice.

In interviews, several small manufacturers noted that the majority of their businesses' sales are above 83-percent AFUE today. According to interviews, the small manufacturers focus on marketing their brands as premium products in the replacement market, while the major manufacturers tend to sell their products at lower cost and lower efficiency. For this reason, a higher standard is unlikely to require investments in research and development by small manufacturers to catch up to larger manufacturers in terms of technology development. However, in interviews, small oil furnace manufacturers did indicate some concern if the energy conservation standard were to be raised to 85 percent, which is the efficiency level just below max-tech, or above. At these efficiency levels, according to manufacturers, the installation costs for oil furnaces could significantly increase due to the need for chimney liners, which are necessary to manage the acidic condensate that results from the high sulfur content of domestic heating oil. Small oil furnace manufacturers expressed concern that the additional installation costs of a chimney liner would deter home owners from purchasing new oil furnaces and accelerate the contraction of an already-shrinking oil furnace market. Additionally, small manufacturers were concerned that a high standard would leave little opportunity to differentiate their oil furnaces as premium products through higher efficiencies. If the amended standards were sufficiently stringent as to leave little room for small manufacturers to offer higher-efficiency products, it would become more difficult to for them to justify their premium positioning in the marketplace. However, manufacturers indicated that the change in the efficiency level corresponding to that adopted by today's notice would not significantly alter that premium pricing dynamic.

For oil furnaces, the majority of both small business product lines and sales are at efficiencies equal to or above 83-percent AFUE. Oil furnace manufacturers do not expect to face significant conversion costs to reach the adopted level. Based on manufacturer feedback, DOE estimated that a typical small oil furnace manufacturer would need to invest $250,000 to cover conversion costs, including both capital and product conversion costs such as investments in production lines, R&D and engineering resources, and product testing, to meet the standard. However, any relatively fixed costs associated with R&D, marketing, and testing necessitated by today's direct final rule would have to be spread over lower volumes, on average, as compared to larger manufacturers. DOE believes this disproportionate adverse impact on small manufacturers is somewhat mitigated by an industry trend toward large manufacturers outsourcing their oil furnace production to small manufacturers, which has increased the sales of both domestic and Canadian small manufacturers. Interviewed small manufacturers indicated that larger manufacturers are becoming less willing to allocate resources to the shrinking oil furnace market, yet still want to maintain a presence in this portion of the market in order to offer a full product line. In turn, market share in oil furnace production is shifting to small manufacturers. For all of the foregoing reasons, DOE does not believe today's direct final rule jeopardizes the viability of the small oil furnace manufacturers.

As noted above, DOE identified one small manufacturer of mobile home furnaces. This manufacturer primarily produces and sells oil furnaces, but it also produces mobile home furnaces as a secondary product offering. The standard promulgated in today's notice would require 90-percent AFUE in the North and 80-percent AFUE in the South. DOE believes the adopted standard level would be unlikely to cause the small manufacturer to incur significant conversion costs because their current product offering already meets it, as illustrated by the listings in the AHRI directory.

In multiple niche product classes, larger manufacturers could have a competitive advantage due to their size and ability to access capital that may not be available to small businesses. Additionally, in some market segments, larger businesses have larger production volumes over which to spread costs.

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

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

4. Significant Alternatives to the Rule

The discussion above analyzes impacts on small businesses that would result from DOE's rule. In addition to the other TSLs being considered, the direct final rule TSD includes a regulatory impact analysis (RIA). For residential furnaces, central air conditioners, and heat pumps, the RIA discusses the following policy alternatives: (1) no change in standard; (2) consumer rebates; (3) consumer tax credits; (4) manufacturer tax credits; and (5) early replacement. While these alternatives may mitigate to some varying extent the economic impacts on small entities compared to the amended standards, DOE determined that the energy savings of these regulatory alternatives are at least 10 times smaller than those that would be expected to result from adoption of the amended standard levels. Thus, DOE rejected these alternatives and is adopting the amended standards set forth in this rulemaking. (See chapter 16 of the direct final rule TSD for further detail on the policy alternatives DOE considered.)

C. Review Under the Paperwork Reduction Act of 1995

Manufacturers of residential furnaces, central air conditioners, and heat pumps must certify to DOE that their products comply with any applicable energy conservation standard. In certifying compliance, manufacturers must test their products according to the DOE test procedures for furnaces, central air conditioners, and heat pumps, as applicable, including any amendments adopted for those particular test procedures. DOE has proposed regulations for the certification and recordkeeping requirements for all covered consumer products and commercial equipment, including residential furnaces, central air conditioners, and heat pumps. 75 FR 56796 (Sept. 16, 2010). The collection-of-information requirement for the certification and recordkeeping is subject to review and approval by OMB under the Paperwork Reduction Act (PRA). (44 U.S.C. 3501 et seq.) This requirement has been submitted to OMB for approval. Public reporting burden for the certification is estimated to average 20 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the PRA, unless that collection of information displays a currently valid OMB Control Number.

D. Review Under the National Environmental Policy Act of 1969

DOE has prepared an environmental assessment (EA) of the impacts of the direct final rule pursuant to the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.), the regulations of the Council on Environmental Quality (40 CFR parts 1500–1508), and DOE's regulations for compliance with the National Environmental Policy Act of 1969 (10 CFR part 1021). This assessment includes an examination of the potential effects of emission reductions likely to result from the rule in the context of global climate change, as well as other types of environmental impacts. The EA has been incorporated into the direct final rule TSD as chapter 15.

E. Review under Executive Order 13132

Executive Order 13132, "Federalism," 64 FR 43255 (Aug. 10, 1999) imposes certain requirements on Federal agencies formulating and implementing policies or regulations that preempt State law or that have Federalism implications. The Executive Order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and to carefully assess the necessity for such actions. The Executive Order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have Federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of today's direct final rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297) No further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of Executive Order 12988, "Civil Justice Reform," imposes on Federal agencies the general duty to adhere to the following requirements: (1) eliminate drafting errors and ambiguity; (2) write regulations to minimize litigation; and (3) provide a clear legal standard for affected conduct rather than a general standard and promote simplification and burden reduction. 61 FR 4729 (Feb. 7, 1996). Section 3(b) of Executive Order 12988 specifically requires that Executive agencies make every reasonable effort to ensure that the regulation: (1) clearly specifies the preemptive effect, if any; (2) clearly specifies any effect on existing Federal law or regulation; (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction; (4) specifies the retroactive effect, if any; (5) adequately defines key terms; and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of Executive Order 12988 requires Executive agencies to review regulations in light of applicable standards in section 3(a) and section 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, this direct final rule meets the relevant standards of Executive Order 12988.

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA) requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Pub. L. 104-4, sec. 201 (codified at 2 U.S.C. 1531). For a regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a "significant intergovernmental mandate," and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect small governments. On

March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820. DOE's policy statement is also available at http://www.gc.doe.gov.

Although today's rule does not contain a Federal intergovernmental mandate, it may impose expenditures of $100 million or more on the private sector. Specifically, the final rule could impose expenditures of $100 million or more. Such expenditures may include: (1) investment in research and development and in capital expenditures by furnace, central air conditioner, and heat pump manufacturers in the years between the final rule and the compliance date for the new standards, and (2) incremental additional expenditures by consumers to purchase higher-efficiency furnace, central air conditioner, and heat pump products, starting at the compliance date for the applicable standard.

Section 202 of UMRA authorizes a Federal agency to respond to the content requirements of UMRA in any other statement or analysis that accompanies the rule. 2 U.S.C. 1532(c). The content requirements of section 202(b) of UMRA relevant to a private sector mandate substantially overlap the economic analysis requirements that apply under section 325(o) of EPCA and Executive Order 12866. The **SUPPLEMENTARY INFORMATION** section of the direct final rule and the "Regulatory Impact Analysis" section of the TSD for this direct final rule respond to those requirements.

Under section 205 of UMRA, the Department is obligated to identify and consider a reasonable number of regulatory alternatives before promulgating a rule for which a written statement under section 202 is required. 2 U.S.C. 1535(a). DOE is required to select from those alternatives the most cost-effective and least burdensome alternative that achieves the objectives of the rule unless DOE publishes an explanation for doing otherwise, or the selection of such an alternative is inconsistent with law. As required by 42 U.S.C. 6295(d), (f) and (o), today's rule would establish amended energy conservation standards for residential furnaces, central air conditioners, and heat pumps that are designed to achieve the maximum improvement in energy efficiency that DOE has determined to be both technologically feasible and economically justified. A full discussion of the alternatives considered by DOE is presented in the "Regulatory Impact Analysis" chapter of the TSD for today's direct final rule.

H. Review Under the Treasury and General Government Appropriations Act, 1999

Section 654 of the Treasury and General Government Appropriations Act, 1999 (Pub. L. 105-277) requires Federal agencies to issue a Family Policymaking Assessment for any rule that may affect family well-being. This rule would not have any impact on the autonomy or integrity of the family as an institution. Accordingly, DOE has concluded that it is not necessary to prepare a Family Policymaking Assessment.

I. Review Under Executive Order 12630

DOE has determined, under Executive Order 12630, "Governmental Actions and Interference with Constitutionally Protected Property Rights," 53 FR 8859 (Mar. 18, 1988), that this regulation would not result in any takings which might require compensation under the Fifth Amendment to the U.S. Constitution.

J. Review Under the Treasury and General Government Appropriations Act, 2001

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516, note) provides for Federal agencies to review most disseminations of information to the public under guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (Feb. 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). DOE has reviewed today's notice under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

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

DOE has concluded that today's regulatory action, which sets forth energy conservation standards for furnaces, central air conditioners, and heat pumps, is not a significant energy action because the amended standards are not likely to have a significant adverse effect on the supply, distribution, or use of energy, nor has it been designated as such by the Administrator at OIRA. Accordingly, DOE has not prepared a Statement of Energy Effects on the direct final rule.

L. Review Under the Information Quality Bulletin for Peer Review

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

In response to OMB's Bulletin, DOE conducted formal in-progress peer reviews of the energy conservation standards development process and analyses and has prepared a Peer Review Report pertaining to the energy conservation standards rulemaking analyses. Generation of this report involved a rigorous, formal, and documented evaluation using objective criteria and qualified and independent reviewers to make a judgment as to the technical/scientific/business merit, the actual or anticipated results, and the productivity and management effectiveness of programs and/or projects. The "Energy Conservation Standards Rulemaking Peer Review Report" dated February 2007 has been disseminated and is available at the following Web site: http://www1.eere.energy.gov/buildings/appliance_standards/peer_review.html.

M. Congressional Notification

As required by 5 U.S.C. 801, DOE will report to Congress on the promulgation of this rule prior to its effective date. The report will state that it has been determined that the rule is a "major rule" as defined by 5 U.S.C. 804(2). DOE also will submit the supporting analyses to the Comptroller General in the U.S. Government Accountability Office (GAO) and make them available to each House of Congress.

VII. Public Participation

A. Submission of Comments

DOE will accept comments, data, and information regarding this direct final rule no later than the date provided in the **DATES** section at the beginning of this direct final rule. Interested parties may submit comments, data, and other information using any of the methods described in the **ADDRESSES** section at the beginning of this notice.

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

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

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

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

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

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

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

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

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

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

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

VIII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of today’s direct final rule.

List of Subjects in 10 CFR Part 430

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

Issued in Washington, DC, on

Henry Kelly
Acting Assistant Secretary
Energy Efficiency and Renewable Energy

For the reasons set forth in the preamble, DOE amends part 430 of chapter II, subchapter D, of title 10 of the Code of Federal Regulations, to read as set forth below:

PART 430 - ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

1. The authority for part 430 continues to read as follows:

Authority: 42 U.S.C. 6291-6309; 28 U.S.C. 2461 note.

2. Section 430.23 is amended by:

a. Redesignating paragraphs (m)(4), (m)(5), and (n)(5) as paragraphs (m)(5), (m)(6), and (n)(6), respectively;

b. Adding new paragraphs (m)(4) and (n)(5); and

c. Revising paragraph (n)(2).

The additions and revision read as follows:

§430.23 Test procedures for the measurement of energy and water consumption.

* * * * *

(m) Central air conditioners and heat pumps. * * *

* * * * *

(4) The average off mode power consumption for central air conditioners and central air conditioning heat pumps shall be determined according to appendix M of this subpart. Round the average off mode power consumption to the nearest watt.

* * * * *

(n) Furnaces. * * *

* * * * *

(2) The annual fuel utilization efficiency for furnaces, expressed in percent, is the ratio of the annual fuel output of useful energy delivered to the heated space to the annual fuel energy input to the furnace determined according to section 10.1 of appendix N of this subpart for gas and oil furnaces and determined in accordance with section 11.1 of the American National Standards Institute/American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ANSI/ASHRAE) Standard 103-1993 (incorporated by reference, see §430.3) for electric furnaces. Round the annual fuel utilization efficiency to the nearest whole percentage point.

* * * * *

(5) The average standby mode and off mode electrical power consumption for furnaces shall be determined according to section 8.6 of appendix N of this subpart. Round the average standby mode and off mode electrical power consumption to the nearest watt.

* * * * *

3. Appendix M to subpart B of part 430 is amended by adding a note after the heading that reads as follows:

Appendix M to Subpart B of Part 430— Uniform Test Method for Measuring the Energy Consumption of Central Air Conditioners and Heat Pumps

Note: The procedures and calculations that refer to off mode energy consumption (*i.e.*, sections 3.13 and 4.2.8 of this appendix M) need not be performed to determine compliance with energy conservation standards for central air conditioners and heat pumps at this time. However, any representation related to standby mode and off mode energy consumption of these products made after corresponding revisions to the central air conditioners and heat pumps test procedure must be based upon results generated under this test procedure, consistent with the requirements of 42 U.S.C. 6293(c)(2). For residential central air conditioners and heat pumps manufactured on or after January 1, 2015, compliance with the applicable provisions of this test procedure is required in order to determine compliance with energy conservation standards.

* * * * *

4. Appendix N to subpart B of part 430 is amended by:

a. Removing all references to "P_{OFF}" and adding in their place "$P_{W,OFF}$" in sections 8.6.2, 9.0, and 10.9;

b. Removing all references to "P_{SB}" and adding in their place "$P_{W,SB}$" in sections 8.6.1, 8.6.2, 9.0, and 10.9; and

c. Revising the note after the heading.

The revision reads as follows:

Appendix N to Subpart B of Part 430— Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers

Note: The procedures and calculations that refer to off mode energy consumption (*i.e.*, sections 8.6 and 10.9 of this appendix N) need not be performed to determine compliance with energy conservation standards for furnaces and boilers at this time. However, any representation related to standby mode and off mode energy consumption of these products made after April 18, 2011 must be based upon results generated under this test procedure, consistent with the requirements of 42 U.S.C. 6293(c)(2). For furnaces manufactured on or after May 1, 2013, compliance with the applicable provisions of this test procedure is required in order to determine compliance with energy conservation standards. For boilers, the statute requires that after July 1, 2010, any adopted energy conservation standard shall address standby mode and off mode energy consumption for these products, and upon the compliance date for such standards, compliance with the applicable provisions of this test procedure will be required.

* * * * *

5. Section 430.32 is amended by:

a. Adding in paragraph (c)(2) the words "and before January 1, 2015," after "2006,";

b. Revising the note to the table in paragraph (c)(2);

c. Adding new paragraphs (c)(3), (c)(4), (c)(5), (c)(6), (e)(1)(iii), and (e)(1)(iv); and

d. Revising paragraphs (e)(1)(i) and (e)(1)(ii).

The additions and revisions read as follows:

Deleted: Adding new paragraphs (c)(3), (c)(4), (c)(5), (c)(6), (e)(1)(iii), and (e)(1)(iv); and

Deleted: c.

§430.32 Energy and water conservation standards and their effective dates.

* * * * *

(c) Central air conditioners and heat pumps. * * *

* * * * *

(2) Central air conditioners and central air conditioning heat pumps manufactured on or after January 23, 2006, and before January 1, 2015, shall have Seasonal Energy Efficiency Ratio and Heating Seasonal Performance Factor no less than:

Product class	Seasonal energy efficiency ratio (SEER)	Heating seasonal performance factor (HSPF)
(i) Split-system air conditioners	13	
(ii)Split-system heat pumps	13	7.7
(iii) Single-package air conditioners	13	
(iv) Single-package heat pumps	13	7.7
(v)(A) Through-the-wall air conditioners and heat pumps-split system[1]	10.9	7.1
(v)(B) Through-the-wall air conditioners and heat pumps-single package[1]	10.6	7.0
(vi) Small-duct, high-velocity systems	13	7.7
(vii)(A) Space-constrained products – air conditioners	12	
(vii)(B) Space-constrained products – heat pumps	12	7.4

[1] The "through-the-wall air conditioners and heat pump – split system" and "through-the-wall air conditioner and heat pump – single package" product classes only applied to products manufactured prior to January 23, 2010. Products manufactured as of that date must be assigned to one of the remaining product classes listed in this table. The product class assignment depends on the product's characteristics. Product class definitions can be found in 10 CFR 430.2 and 10 CFR part 430, subpart B, appendix M. DOE believes that most, if not all, of the historically-characterized "through-the-wall" products will be assigned to one of the space-constrained product classes.

Moved (insertion) [3]

(3) Central air conditioners and central air conditioning heat pumps manufactured on or after January 1, 2015, shall have a Seasonal Energy Efficiency Ratio and Heating Seasonal Performance Factor not less than:

Product class[1]	Seasonal energy efficiency ratio (SEER)	Heating seasonal performance factor (HSPF)
(i) Split-system air conditioners	13	
(ii)Split-system heat pumps	14	8.2

(iii) Single-package air conditioners	14	
(iv) Single-package heat pumps	14	8.0
(v) Small-duct, high-velocity systems	13	7.7
(vi)(A) Space-constrained products – air conditioners	12	
(vi)(B) Space-constrained products – heat pumps	12	7.4

[1] The "through-the-wall air conditioners and heat pump – split system" and "through-the-wall air conditioner and heat pump – single package" product classes only applied to products manufactured prior to January 23, 2010. Products manufactured as of that date must be assigned to one of the remaining product classes listed in this table. The product class assignment depends on the product's characteristics. Product class definitions can be found in 10 CFR 430.2 and 10 CFR part 430, subpart B, appendix M. DOE believes that most, if not all, of the historically-characterized "through-the-wall" products will be assigned to one of the space-constrained product classes.

Moved up [3]: (vii)(B) Space-constrained products – heat pumps

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(4) In addition to meeting the applicable requirements in paragraph (c)(3) of this section, products in product class (i) of that paragraph (i.e., split-system air conditioners) that are manufactured on or after January 1, 2015, and installed in the States of Alabama, Arkansas, Delaware, Florida, Georgia, Hawaii, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, or Virginia, or in the District of Columbia, shall have a Seasonal Energy Efficiency Ratio not less than 14.

(5) In addition to meeting the applicable requirements in paragraphs (c)(3) of this section, products in product classes (i) and (iii) of paragraph (c)(3) (i.e., split-system air conditioners and single-package air conditioners) that are manufactured on or after January 1, 2015, and installed in the States of Arizona, California, Nevada, or New Mexico shall have a Seasonal Energy Efficiency Ratio not less than 14 and have an Energy Efficiency Ratio (at a standard rating of 95 °F dry bulb outdoor temperature) not less than the following:

Product class	Energy efficiency ratio (EER)
(i) Split-system rated cooling capacity less than 45,000 Btu/hr	12.2
(ii) Split-system rated cooling capacity equal to or greater than 45,000 Btu/hr	11.7
(iii) Single-package systems	11.0

(6) Central air conditioners and central air conditioning heat pumps manufactured on or after January 1, 2015, shall have an average off mode electrical power consumption not more than the following:

Product Class	Average off mode power consumption $P_{W,OFF}$ (watts)
(i) Split-system air conditioners	30
(ii) Split-system heat pumps	33
(iii) Single-package air conditioners	30
(iv) Single-package heat pumps	33
(v) Small-duct, high-velocity systems	30
(vi) Space-constrained air conditioners	30
(vii) Space-constrained heat pumps	33

*   *   *   *   *

(e) Furnaces and boilers.

(1) Furnaces.

(i) The Annual Fuel Utilization Efficiency (AFUE) of residential furnaces shall not be less than the following for non-weatherized furnaces manufactured before May 1, 2013, and weatherized furnaces manufactured before January 1, 2015:

Product class	AFUE (percent)[1]
(A) Furnaces (excluding classes noted below)	78
(B) Mobile Home furnaces	75
(C) Small furnaces (other than those designed solely for installation in mobile homes) having an input rate of less than 45,000 Btu/hr	
(1) Weatherized (outdoor)	78
(2) Non-weatherized (indoor)	78

[1] Annual Fuel Utilization Efficiency, as determined in §430.23(n)(2) of this part.

(ii) The AFUE of residential non-weatherized furnaces manufactured on or after May 1, 2013, and weatherized gas and oil-fired furnaces manufactured on or after January 1, 2015 shall be not less than the following:

Product class	AFUE (percent) [1]
(A) Non-weatherized gas furnaces (not including mobile home furnaces)	80
(B) Mobile Home gas furnaces	80
(C) Non-weatherized oil-fired furnaces (not including mobile home furnaces)	83
(D) Mobile Home oil-fired furnaces	75
(E) Weatherized gas furnaces	81
(F) Weatherized oil-fired furnaces	78
(G) Electric furnaces	78

[1] Annual Fuel Utilization Efficiency, as determined in §430.23(n)(2) of this part.

(iii) In addition to meeting the applicable requirements in paragraph (e)(1)(ii) of this section, products in product classes (A) and (B) of that paragraph (i.e., residential non-weatherized gas furnaces (including mobile home furnaces)) that are manufactured on or after May 1, 2013, and installed in the States of Alaska, Colorado, Connecticut, Idaho, Illinois, Indiana, Iowa, Kansas, Maine, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Dakota, Ohio, Oregon, Pennsylvania, Rhode Island, South Dakota, Utah, Vermont, Washington, West Virginia, Wisconsin, and Wyoming, shall have an AFUE not less than 90 percent.

(iv) Furnaces manufactured on or after May 1, 2013, shall have an electrical standby mode power consumption ($P_{W,SB}$) and electrical off mode power consumption ($P_{W,OFF}$) not more than the following:

Product class	Maximum standby mode electrical power consumption, $P_{W,SB}$ (watts)	Maximum off mode electrical power consumption, $P_{W,OFF}$ (watts)
(A) Non-weathered gas furnaces (including mobile home furnaces)	10	10
(B) Non-weatherized oil-fired furnaces (including mobile home furnaces)	11	11
(C) Electric furnaces	10	10

*   *   *   *   *