DEPARTMENT OF ENERGY

10 CFR Part 430

[Docket Number EE–2008–BT–STD–0012]

RIN 1904–AB79

Energy Conservation Program: Energy Conservation Standards for Residential Refrigerators, Refrigerator-Freezers, and Freezers

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

ACTION: Notice of proposed rulemaking (NOPR) and public meeting.

SUMMARY: The Energy Policy and Conservation Act (EPCA) prescribes energy conservation standards for various consumer products and commercial and industrial equipment, including residential refrigerators, refrigerator-freezers, and freezers. EPCA also requires the U.S. Department of Energy (DOE) to determine whether more stringent, amended standards for these products are technologically feasible and economically justified, and would save a significant amount of energy. In this NOPR, DOE proposes amended energy conservation standards for residential refrigerators, refrigerator-freezers, and freezers. The NOPR also announces a public meeting to receive comment on these proposed standards and associated analyses and results.

DATES: DOE will hold a public meeting on Thursday, October 14, 2010, from 9 a.m. to 4 p.m., in Washington, DC. DOE must receive requests to speak at the public meeting before 4 p.m., Thursday, September 30, 2010. Additionally, DOE plans to conduct the public meeting via webinar. To participate via webinar, DOE must be notified by no later than Thursday, October 7, 2010. Participants seeking to present statements in person during the meeting must submit to DOE a signed original and an electronic copy of statements to be given at the public meeting before 4 p.m., Thursday, October 7, 2010.

DOE will accept comments, data, and information regarding this notice of proposed rulemaking (NOPR) before and after the public meeting, but no later than November 26, 2010. *See* section VII, "Public Participation," for details.

ADDRESSES: The public meeting will be held at the U.S. Department of Energy, Forrestal Building, Room 1E–245, 1000 Independence Avenue, SW., Washington, DC 20585. To attend, please notify Ms. Brenda Edwards at (202) 586–2945. Please note that foreign nationals visiting DOE Headquarters are subject to advance security screening procedures, requiring a 30-day advance notice. Any foreign national wishing to participate in the meeting should advise DOE as soon as possible by contacting Ms. Brenda Edwards at (202) 586–2945 to initiate the necessary procedures.

Any comments submitted must identify the NOPR for Energy Conservation Standards for Refrigerators, Refrigerator-Freezers, and Freezers, and provide docket number EE–2008–BT–STD–0012 and/or regulatory information number (RIN) number 1904–AB79. 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: ResRefFreez-2008-STD-0012@hq.doe.gov.* Include the docket number and/or RIN in the subject line of the message.
3. *Mail:* Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, Mailstop EE–2J, 1000 Independence Avenue, SW., Washington, DC 20585–0121. Please submit one signed original paper copy.
4. *Hand Delivery/Courier:* Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, 950 L'Enfant Plaza, SW., Suite 600, Washington, DC 20024. *Telephone:* (202) 586–2945. Please submit one signed original paper copy.

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

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

FOR FURTHER INFORMATION CONTACT: Subid Wagley, 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, 202–287–1414, *e-mail: Subid.Wagley@ee.doe.gov* or Michael Kido, U.S. Department of Energy, Office of the General Counsel, GC–71, 1000 Independence Avenue, SW., Washington, DC 20585–0121, (202) 586–9507, e-mail: *Michael.Kido@hq.doe.gov.*

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

SUPPLEMENTARY INFORMATION:

Table of Contents

I. Summary of the Proposed Rule

The Energy Policy and Conservation Act (42 U.S.C. 6291 *et seq.;* EPCA or the Act), as amended, provides that any new or amended energy conservation standard DOE prescribes for certain consumer products, such as residential refrigerators, refrigerator-freezers, and freezers (collectively referred to in this document as "refrigeration products"), shall be designed to "achieve the maximum improvement in energy efficiency * * * which the Secretary determines is technologically feasible and economically justified." (42 U.S.C. 6295(o)(2)(A)) The new or amended standard must "result in significant conservation of energy." (42 U.S.C. 6295(o)(3)(B)) In accordance with these and other statutory provisions discussed in this notice, DOE proposes amended energy conservation standards for refrigeration products. The proposed standards, which are the maximum allowable energy use expressed as a function of the calculated adjusted volume of a given product, are shown in Table I.1. These proposed standards, if adopted, would apply to all products listed in Table I.1 and manufactured in, or imported into, the United States on or after January 1, 2014.

TABLE I.1—PROPOSED REFRIGERATION PRODUCT ENERGY CONSERVATION STANDARDS

[Effective starting 1/1/2014]

Product class	Equations for maximum energy use (kWh/yr)	
	based on AV (ft^3)	based on av (L)
1. Refrigerators and refrigerator-freezers with manual defrost	7.99AV + 225.0	0.282av + 225.0
1A. All-refrigerators—manual defrost	6.79AV + 193.6	0.240av + 193.6
2. Refrigerator-freezers—partial automatic defrost	7.99AV + 225.0	0.282av + 225.0
3. Refrigerator-freezers—automatic defrost with top-mounted freezer without an automatic icemaker	8.04AV + 232.7	0.284av + 232.7
3–BI. Built-in refrigerator-freezer—automatic defrost with top-mounted freezer without an automatic icemaker.	8.57AV + 248.2	0.303av + 248.2

TABLE I.1—PROPOSED REFRIGERATION PRODUCT ENERGY CONSERVATION STANDARDS—Continued

[Effective starting 1/1/2014]

Product class	Equations for maximum energy use (kWh/yr)	
	based on AV (ft^3)	based on av (L)
3I. Refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic icemaker without through-the-door ice service.	8.04AV + 316.7	0.284av + 316.7
3I–BI. Built-in refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic icemaker without through-the-door ice service.	8.57AV + 332.2	0.303av + 332.2
3A. All-refrigerators—automatic defrost	7.07AV + 201.6	0.250av + 201.6
3A–BI. Built-in All-refrigerators—automatic defrost	7.55AV + 215.1	0.266av + 215.1
4. Refrigerator-freezers—automatic defrost with side-mounted freezer without an automatic icemaker.	8.48AV + 296.5	0.299av + 296.5
4–BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer without an automatic icemaker.	9.04AV + 316.2	0.319av + 316.2
4I. Refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker without through-the-door ice service.	8.48AV + 380.5	0.299av + 380.5
4I–BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker without through-the-door ice service.	9.04AV + 400.2	0.319av + 400.2
5. Refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker.	8.80AV + 315.4	0.311av + 315.4
5–BI. Built-In Refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker.	9.35AV + 335.1	0.330av + 335.1
5I. Refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker without through-the-door ice service.	8.80AV + 399.4	0.311av + 399.4
5I–BI. Built-In Refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker without through-the-door ice service.	9.35AV + 419.1	0.330av + 419.1
5A. Refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service.	9.15AV + 471.3	0.323av + 471.3
5A–BI. Built-in refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service.	9.72AV + 4955.	0.343av + 495.5
6. Refrigerator-freezers—automatic defrost with top-mounted freezer with through-the-door ice service.	8.36AV + 384.1	0.295av + 384.1
7. Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service.	8.50AV + 431.1	0.300av + 431.1
7–BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service.	9.07AV + 454.3	0.320av + 454.3
8. Upright freezers with manual defrost	5.57AV + 193.7	0.197av + 193.7
9. Upright freezers with automatic defrost without an automatic icemaker	8.62AV + 228.3	0.305av + 228.3
9–BI. Built-In Upright freezers with automatic defrost without an automatic icemaker	9.24AV + 244.6	0.326av + 244.6
10. Chest freezers and all other freezers except compact freezers	7.29AV + 107.8	0.257av + 107.8
10A. Chest freezers with automatic defrost	10.24AV + 148.1	0.362av + 148.1
11. Compact refrigerators and refrigerator-freezers with manual defrost	9.03AV + 252.3	0.319av + 252.3
11A.Compact refrigerators and refrigerator-freezers with manual defrost	7.84AV + 219.1	0.277av + 219.1
12. Compact refrigerator-freezers—partial automatic defrost	5.91AV + 335.8	0.209av + 335.8
13. Compact refrigerator-freezers—automatic defrost with top-mounted freezer	11.80AV + 339.2	0.417av + 339.2
13A. Compact all-refrigerator—automatic defrost	9.17AV + 259.3	0.324av + 259.3
14. Compact refrigerator-freezers—automatic defrost with side-mounted freezer	6.82AV + 456.9	0.241av + 456.9
15. Compact refrigerator-freezers—automatic defrost with bottom-mounted freezer	12.88AV + 368.7	0.455av + 368.7
16. Compact upright freezers with manual defrost	8.65AV + 225.7	0.306av + 225.7
17. Compact upright freezers with automatic defrost	10.17AV + 351.9	0.359av + 351.9
18. Compact chest freezers	9.25AV + 136.8	0.327av + 136.8

AV = adjusted volume in cubic feet; av = adjusted volume in liters.

DOE's analyses indicate that the proposed standards would save a significant amount of energy—an estimated 4.48 quads of cumulative energy over 30 years (2014 through 2043). This amount is equivalent to three times the total energy used annually for refrigeration and freezers in U.S. homes.

The cumulative national net present value (NPV) of total consumer costs and savings of the proposed standards for products shipped in 2014–2043, in 2009$, ranges from $2.44 billion (at a 7-percent discount rate) to $18.57 billion (at a 3-percent discount rate).[1] The net present value (NPV) is the estimated total value of future operating-cost savings during the analysis period, minus the estimated increased product costs, discounted to 2010. 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 to 2043). Using a real discount rate of 7.2 percent, DOE estimates that INPV for manufacturers of all refrigeration products in the base case is $4.434 billion in 2009$. If DOE adopts the proposed standards, it expects that manufacturers may lose 11 to 22 percent of their INPV, or approximately $0.495 to $0.995 billion. Using a 7-percent discount rate, the NPV of consumer costs and savings from today's proposed standards would amount to 2.5 to 4.9 times the total estimated industry losses. Using a 3-percent discount rate, the NPV would

[1] DOE uses discount rates of 7 and 3 percent based on guidance from the Office of Management and Budget. See section IV.G for further information.

amount to 19 to 38 times the total estimated industry losses.

The projected economic impacts of the proposed standards on individual consumers are generally positive. For example, the estimated average life-cycle cost (LCC) savings are $22 for top-mount refrigerator-freezers, $19 for bottom-mount refrigerator-freezers, $37 for side-by-side refrigerator-freezers, $148 for upright freezers, $56 for chest freezers, $10 for compact refrigerators, $11 for compact freezers, and from $0 to $116 for built-in refrigeration products, depending on the product class.[2]

In addition, the proposed standards would have significant environmental benefits. The energy saved is in the form of electricity and DOE expects the energy savings from the proposed standards to eliminate the need for approximately 4.2 gigawatts (GW) of generating capacity by 2043. The savings would result in cumulative greenhouse gas emission reductions of 305 million metric tons (Mt[3]) of carbon dioxide (CO_2) in 2014–2043. During this period, the proposed standards would result in emissions reductions of 245 kilotons (kt) of nitrogen oxides (NO_X) and 1.55 tons (t) of mercury (Hg). DOE estimates the net present monetary value of the CO_2 emissions reduction is between $1.04 and $16.22 billion, expressed in 2009$ and discounted to 2010. DOE also estimates the net present monetary value of the NO_X emissions reduction, expressed in 2009$ and discounted to 2010, is between $22 and $229 million at a 7-percent discount rate, and between $53 and $546 million at a 3-percent discount rate.

DOE estimates emissions reduction benefits according to a multi-step approach. First, DOE analyzes monetized emissions benefits separately from the NPV of consumer benefits. Second, DOE calculates emissions relative to an "existing regulations" baseline determined by the most recent version of the Annual Energy Outlook forecast. The base case emissions scenario is described at *http://www.eia.doe.gov/oiaf/aeo/pdf/trend_6.pdf.* Finally, any emissions reductions are in addition to the regulatory emissions reductions modeled in AEO. DOE calculates this value by doing a perturbation of the base case AEO forecast as described in the TSD chapter 15 at section 15.2.4. As noted in section 15.2.4 of TSD chapter 15, the baseline accounts for regulatory emissions reductions through 2008, including CAIR but not CAMR. Subsequent regulations, including the currently proposed CAIR replacement rule, the Clean Air Transport Rule, do not appear in the baseline. DOE requests comment on its baseline treatment of regulatory emissions reductions. *See* Issue 1 under "Issues on Which DOE Seeks Comment" in section VII.E.

The benefits and costs of today's proposed standards can also be expressed in terms of annualized values over the 2014–2043 period. Estimates of annualized values are shown in Table I.2. The annualized monetary values are the sum of (1) the annualized national economic value, expressed in 2009$, of the benefits from operating products that meet the proposed standards (consisting primarily of operating cost savings from using less energy, minus increases in equipment purchase costs, which is another way of representing consumer NPV), and (2) the monetary value of the benefits of emission reductions, including CO_2 emission reductions.[4] The value of the CO_2 reductions, otherwise known as the Social Cost of Carbon (SCC), is calculated using a range of values per metric ton of CO_2 developed by a recent interagency process. The monetary costs and benefits of cumulative emissions reductions are reported in 2009$ to permit comparisons with the other costs and benefits in the same dollar units. The derivation of the SCC values is discussed in section IV.M.

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 refrigeration products shipped in 2014–2043. The SCC values, on the other hand, reflect the present value of all future climate-related impacts resulting from the emission of one ton of carbon dioxide in each year. These impacts go well beyond 2100.

Using a 7-percent discount rate and the SCC value of $21.40/ton in 2010 (in 2007$), which is discounted at 3 percent (*see* note below in Table I.2), the cost of the standards proposed in today's rule is $1,841 million per year in increased equipment costs, while the annualized benefits are $2,112 million per year in reduced equipment operating costs, $316 million in CO_2 reductions, and $7 million in reduced NO_X emissions. In this case, the net benefit amounts to $594 million per year. Using a 3-percent discount rate and the SCC value of $21.40/ton in 2010 (in 2007$), the cost of the standards proposed in today's rule is $1,849 million per year in increased equipment costs, while the benefits are $2,929 million per year in reduced operating costs, $316 million in CO_2 reductions, and $33 million in reduced NO_X emissions. At a 3-percent discount rate, the net benefit amounts to $1,429 million per year.

TABLE I.2—ANNUALIZED BENEFITS AND COSTS OF PROPOSED STANDARDS FOR REFRIGERATION PRODUCTS FOR 2014–2043 PERIOD

	Discount rate	Monetized (million 2009$/year)		
		Primary estimate*	Low estimate*	High estimate*
Benefits				
Operating Cost Savings	7%	2,112	1,852	2,377

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

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

[4] DOE used a two-step calculation process to convert the time-series of costs and benefits into annualized values. First, DOE calculated a present value for the time-series of costs and benefits using a discount rate of either three or seven percent. From the present value, DOE then calculated the fixed annual payment over the analysis time period (2014 through 2043) that yielded the same present value. The fixed annual payment is the annualized value. Although DOE calculated annualized values, this does not imply that the time-series of cost and benefits from which the annualized values were determined is a steady stream of payments.

TABLE I.2—ANNUALIZED BENEFITS AND COSTS OF PROPOSED STANDARDS FOR REFRIGERATION PRODUCTS FOR 2014–2043 PERIOD—Continued

	Discount rate	Monetized (million 2009$/year)		
		Primary estimate*	Low estimate*	High estimate*
	3%	2,929	2,520	3,335
CO_2 Reduction at $4.7/th **	5%	85	85	85
CO_2 Reduction at $21.4/th **	3%	316	316	316
CO_2 Reduction at $35.1/th **	2.5%	492	492	492
CO_2 Reduction at $64.9/th **	3%	963	963	963
NO_X Reduction at $2,519/th **	7%	7	7	7
	3%	33%	33	33
Total (Operating Cost Savings, CO_2 Reduction and NO_X Reduction) †.	7% plus CO_2 range	2,204–3,082	1,944–2,822	2,469–3,348
	7%	2,435	2,175	2,700
	3%	3,278	2,869	3,684
	3% plus CO_2 range	3,047–3,925	2,638–3,516	3,453–4,331
Costs				
Incremental Product Costs	7%	1,841	1,733	1,950
	3%	1,849	1,729	1,969
Net Benefits/Costs				
Total (Operating Cost Savings, CO_2 Reduction and NO_X Reduction, minus Incremental Product Costs) †.	7% plus CO_2 range	363–1,241	211–1,089	519–1,397
	7%	594	442	750
	3%	1,429	1,140	1,714
	3% plus CO_2 range	1,198–2,076	909–1,787	1,483–2,362

* The Primary, Low, and High Estimates utilize forecasts of energy prices and housing starts from the AEO2010 Reference case, Low Economic Growth case, and Low Economic Growth case, respectively.

** The CO_2 values represent global monetized values (in 2007$) of the social cost of CO_2 emissions in 2010 under several scenarios. The values of $4.70, $21.40, and $35.10 per ton are the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The value of $64.90 per ton represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The value for NO_X (in 2009$) is the average of the low and high values used in DOE's analysis. NO_X savings are in addition to the regulatory emissions reductions modeled in the Annual Energy Outlook forecast.

† Total Benefits for both the 3% and 7% cases are derived using the SCC value calculated at a 3% discount rate, which is $21.40/ton in 2010 (in 2007$). 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 with the $4.70/ton value at the low end, and the $64.90/ton value at the high end.

DOE has tentatively concluded that the proposed standards represent the maximum improvement in energy efficiency that is technologically feasible and economically justified, and would result in the significant conservation of energy. DOE further notes that products achieving these standard levels are already commercially available for at least some, if not most, product classes covered by today's proposal. Based on the analyses described above, DOE found the benefits of the proposed standards to the Nation (energy savings, positive NPV of consumer benefits, consumer LCC savings, and emission reductions) outweigh the burdens (loss of INPV for manufacturers and LCC increases for some consumers).

DOE also considered lower energy use levels as trial standard levels, and is still considering them in this rulemaking. However, DOE has tentatively concluded that the potential burdens of the lower energy use levels would outweigh the projected benefits. Based on consideration of the public comments DOE receives in response to this notice and related information collected and analyzed during the course of this rulemaking effort, DOE may adopt energy use levels presented in this notice that are either higher or lower than the proposed standards, or some combination of level(s) that incorporate the proposed standards in part.

II. Introduction

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

A. Authority

Title III of EPCA sets forth a variety of provisions designed to improve energy efficiency. Part A of title III (42 U.S.C. 6291–6309) provides for the Energy Conservation Program for Consumer Products Other than Automobiles.[5] EPCA covers consumer products and certain commercial equipment (referred to collectively hereafter as "covered products"), including the types of refrigeration products that are the subject of this rulemaking. (42 U.S.C. 6292(a)(1)) EPCA prescribed energy conservation standards for these products (42 U.S.C. 6295(b)(1)–(2)), and directed DOE to conduct three cycles of rulemakings to determine whether to amend these standards. (42 U.S.C. 6295(b)(3)(A)(i), (b)(3)(B)–(C), and (b)(4)) As explained in further detail in section II.B, this rulemaking represents the third round of amendments to the standards for refrigeration products under 42 U.S.C. 6295(b). (DOE 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

[5] This part was titled Part B in EPCA, but was subsequently codified as Part A in the U.S. Code for editorial reasons.

DOE would need to conduct would occur no later than six years from the issuance of a final rule establishing or amending a standard for a covered product.)

Under the Act, 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 responsible for labeling, and DOE implements the remainder of the program. Section 323 of the Act authorizes DOE, subject to certain criteria and conditions, to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating cost of each covered product. (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 of 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 under EPCA. *Id.* The test procedures for refrigeration products currently appear at title 10, Code of Federal Regulations (CFR), part 430, subpart B, appendices A1 and B1, respectively. (These procedures are undergoing possible amendments and may ultimately be recodified as part of new appendices A and B. See 75 FR 29824 (May 27, 2010) (discussing possible amendments to the test procedures for refrigeration products).

EPCA provides criteria for prescribing amended standards for covered products. As indicated above, any amended standard for a covered product must be designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) Furthermore, EPCA precludes DOE from adopting any standard that would not result in the significant conservation of energy. (42 U.S.C. 6295(o)(3)) Moreover, DOE may not prescribe a standard: (1) For certain products, including refrigeration products, 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)) The Act also provides that, in deciding whether a proposed standard is economically justified, DOE must determine whether the benefits of the standard exceed its burdens. (42 U.S.C. 6295(o)(2)(B)(i)) DOE must do so after receiving comments on the proposed standard, and by considering, to the greatest extent practicable, the following seven factors:

1. The economic impact of the standard on manufacturers and consumers of the products subject to the standard;
2. The savings in operating costs throughout the estimated average life of the covered products in the type (or class) compared to any increase in the price, initial charges, or maintenance expenses for the covered products that are likely to result from the imposition of the standard;
3. The total projected amount of energy 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 conservation; and
7. Other factors the Secretary of Energy (Secretary) considers relevant. (42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII))

EPCA 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 a 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) with performance characteristics, 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 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. *See* 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)).

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 can, however, grant waivers of Federal preemption for particular State laws or regulations, in accordance with the procedures and other provisions of section 327(d) of the Act. (42 U.S.C. 6297(d))

Finally, Section 310(3) of the Energy Independence and Security Act of 2007 (EISA 2007; Pub. L. 110–140 (codified at 42 U.S.C. 6295(gg))) amended EPCA to require that energy conservation standards address standby mode and off mode energy use. Specifically, when DOE adopts a standard for a covered product after July 1, 2010, it must, if justified by the criteria for adoption of standards in section 325(o) of EPCA (42 U.S.C. 6295(o)), incorporate standby mode and off mode energy use into the standard, if feasible, or adopt a separate standard for such energy use for that product. (42 U.S.C. 6295(gg)(3)(A)–(B)) DOE's current test procedures and standards for refrigeration products address standby and off mode energy use. In this rulemaking, DOE intends to incorporate such energy use into any amended standard it adopts in the final rule, which is scheduled to be issued by December 31, 2010.

B. Background

1. Current Standards

In a final rule published on April 28, 1997 (1997 Final Rule), DOE prescribed the current energy conservation standards for refrigeration products manufactured on or after July 1, 2001. 62 FR 23102. This final rule completed the second round of rulemaking to amend the standards for refrigeration products, required under 42 U.S.C. 6295(b)(3)(B)–(C). The standards consist of separate equations for each product class. Each equation provides a means to calculate the maximum levels of energy use permitted under the regulations. These levels vary based on the storage volume of the refrigeration product and on the particular characteristics and features included in a given product (*i.e.,* based on product class). 10 CFR 430.32(a). The current standards are set forth in Table II.1. DOE notes that the standard levels denoted in the proposed product classes listed as 5A and 10A were established by the Office of Hearings and Appeals through that Office's exception relief process.

TABLE II.1—FEDERAL ENERGY EFFICIENCY STANDARDS FOR REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS

Product class	Energy standard equations for maximum energy use (kWh/yr) — Made effective by the 1997 final rule
1. Refrigerators and refrigerator-freezers with manual defrost	8.82AV+248.4 0.31av+248.4
2. Refrigerator-freezers—partial automatic defrost	8.82AV+248.4 0.31av+248.4
3. Refrigerator-freezers—automatic defrost with top-mounted freezer without through-the-door ice service and all-refrigerator—automatic defrost.	9.80AV+276.0 0.35av+276.0
4. Refrigerator-freezers—automatic defrost with side-mounted freezer without through-the-door ice service	4.91AV+507.5 0.17av+507.5
5. Refrigerator-freezers—automatic defrost with bottom-mounted freezer without through-the-door ice service	4.60AV+459.0 0.16av+459.0
6. Refrigerator-freezers—automatic defrost with top-mounted freezer with through-the-door ice service	10.20AV+356.0 0.36av+356.0
7. Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service	10.10AV+406.0 0.36av+406.0
8. Upright freezers with manual defrost	7.55AV+258.3 0.27av+258.3
9. Upright freezers with automatic defrost	12.43AV+326.1 0.44av+326.1
10. Chest freezers and all other freezers except compact freezers	9.88AV+143.7 0.35av+143.7
11. Compact refrigerators and refrigerator-freezers with manual defrost	10.70AV+299.0 0.38av+299.0
12. Compact refrigerator-freezer—partial automatic defrost	7.00AV+398.0 0.25av+398.0
13. Compact refrigerator-freezers—automatic defrost with top-mounted freezer and compact all-refrigerator—automatic defrost.	12.70AV+355.0 0.45av+355.0
14. Compact refrigerator-freezers—automatic defrost with side-mounted freezer	7.60AV+501.0 0.27av+501.0
15. Compact refrigerator-freezers—automatic defrost with bottom-mounted freezer	13.10AV+367.0 0.46av+367.0
16. Compact upright freezers with manual defrost	9.78AV+250.8 0.35av+250.8
17. Compact upright freezers with automatic defrost	11.40AV+391.0 0.40av+391.0
18. Compact chest freezers	10.45AV+152.0 0.37av+152.0
Product class	**Made effective through OHA exception relief**
5A. Refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service	5.0AV+539.0 0.18av+539.0
10A. Chest freezers with automatic defrost	14.76AV+211.5 0.52av+211.5

AV: Adjusted Volume in ft^3; av: Adjusted Volume in liters (L).

2. History of Standards Rulemaking for Refrigerators, Refrigerator-Freezers, and Freezers

The amendments made to EPCA by the National Appliance Energy Conservation Act of 1987 (NAECA; Pub. L. 100–12) included mandatory energy conservation standards for refrigeration products and requirements that DOE conduct two cycles of rulemakings to determine whether to amend these standards. (42 U.S.C. 6295(b)(1), (2), (3)(A)(i), and (3)(B)–(C)) DOE completed the first of these rulemaking cycles in 1989 and 1990 by adopting amended performance standards for all refrigeration products manufactured on or after January 1, 1993. 54 FR 47916 (November 17, 1989); 55 FR 42845 (October 24, 1990). As indicated above, DOE completed a second rulemaking cycle to amend the standards for refrigeration products by issuing a final rule in 1997, which adopted the current standards for these products. 62 FR 23102 (April 28, 1997).

In 2005, DOE granted a petition, submitted by a coalition of state governments, utility companies, consumer and low-income advocacy groups, and environmental and energy efficiency organizations, requesting that it conduct a rulemaking to amend the standards for residential refrigerator-freezers.[6] DOE then conducted limited analyses to examine the technological and economic feasibility of amended standards at the ENERGY STAR levels that were in effect for 2005 for the two most popular product classes of refrigerator-freezers. These analyses identified potential energy savings and other potential benefits and burdens from such standards, and assessed other issues associated with such standards. Most recently, DOE has undertaken this rulemaking to satisfy the statutory requirement that DOE publish a final rule no later than December 31, 2010, to determine whether to amend the standards for refrigeration products manufactured on or after January 1, 2014. (42 U.S.C. 6295(b)(4))

DOE initiated this rulemaking on September 18, 2008, by publishing on its Web site its "Rulemaking Framework Document for Refrigerators, Refrigerator-Freezers, and Freezers." (A PDF of the framework document is available at *http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/refrigerator_freezer_framework.pdf*). DOE also published a notice announcing the availability of the framework document and a public meeting to discuss the document. It also requested public comment on the document. 73 FR 54089 (September 18, 2008). The framework document described the procedural and analytical approaches that DOE anticipated using to evaluate energy conservation standards for refrigeration products and identified various issues to be resolved in conducting the rulemaking.

On September 29, 2008, DOE held the framework document public meeting. At that meeting, DOE discussed the issues detailed in the framework document and described the analyses the agency planned to conduct during the rulemaking. Through the public meeting, DOE sought feedback from interested parties on these subjects and provided information regarding the rulemaking process that DOE would follow. Interested parties discussed the following major issues at the public meeting: Test procedure revisions; product classes; technology options; approaches to the engineering, life-cycle cost, and payback period analyses; efficiency levels analyzed in the engineering analysis; and the approach for estimating typical energy consumption. At the meeting, and during the related comment period, DOE received many comments that helped it identify and resolve issues involved in this rulemaking.

DOE then gathered additional information and performed preliminary analyses for the purpose of developing potential amended energy conservation standards for refrigeration products. This process culminated in DOE's announcement of the preliminary analysis public meeting, at which DOE would discuss and receive comments on the following matters: The product classes DOE analyzed; the analytical framework, models, and tools that DOE was using to evaluate standards; the results of the preliminary analyses performed by DOE; and potential standard levels that DOE could consider. 74 FR 58915 (November 16, 2009) (the November 2009 notice). DOE also invited written comments on these subjects and announced the availability on its Web site 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/pdfs/ref_frz_prenopr_prelim_tsd.pdf.*) Finally, DOE stated its interest in receiving views concerning other relevant issues that participants believed would affect energy conservation standards for refrigeration products, or that DOE should address in this NOPR. *Id.* at 58917–18.

The preliminary TSD provided an overview of the activities DOE undertook in developing standards for the refrigeration products, and discussed the comments DOE received in response to the framework document. It also described the analytical framework that DOE used (and continues to use) in this rulemaking, including a description of the methodology, the analytical tools, and the relationships among the various analyses that are part of the rulemaking. The preliminary TSD presented and described in detail each analysis DOE had performed up to that point, including descriptions of inputs, sources, methodologies, and results. These analyses were as follows:

- A *market and technology assessment* addressed the scope of this rulemaking, identified the potential classes for refrigeration products, 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 refrigeration products, and weighed these options against DOE's four prescribed screening criteria: (1) Technological feasibility, (2) practicability to manufacture, install, and service, (3) impacts on equipment utility or equipment availability, (4) adverse impacts on health or safety;
- An *engineering analysis* estimated the increases in manufacturer selling prices (MSPs) associated with more energy-efficient refrigeration products;
- An *energy use analysis* estimated the annual energy use in the field of refrigeration products as a function of efficiency levels;
- A *markups analysis* converted estimated manufacturer selling price (MSP) increases derived from the engineering analysis to consumer prices;
- A *life-cycle cost analysis* calculated, at the consumer level, the discounted savings in operating costs throughout the estimated average life of the product, compared to any increase in installed costs likely to result directly from the imposition of a given standard;
- A *payback period (PBP) analysis* estimated the amount of time it would take consumers to recover the higher expense of purchasing more energy efficient products through lower operating costs;
- A *shipments analysis* estimated shipments of the refrigeration products over the 30-year analysis period (2014–

[6] The petition, submitted June 1, 2004, can be viewed at *http://www.standardsasap.org/documents/rfdoe.pdf* (last accessed August 18, 2010).

2043), which were used in performing the national impact analysis (NIA);

• A *national impact analysis* assessed the national energy savings, and the national net present value of total consumer costs and savings, expected to result from specific, potential energy conservation standards for refrigeration products;

• A *preliminary manufacturer impact analysis* took the initial steps in evaluating the effects new efficiency standards may have on manufacturers.

In the November 2009 notice, DOE summarized the nature and function of the following analyses: (1) Engineering, (2) energy use characterization, (3) markups to determine installed prices, (4) LCC and PBP analyses, and (5) national impact analysis. *Id.* at 58917.

The preliminary analysis public meeting announced in the November 2009 notice took place on December 10, 2009. At this meeting, DOE presented the methodologies and results of the analyses set forth in the preliminary TSD. Major topics discussed at the meeting included test procedure revisions, product classes (including wine coolers, all-refrigerators,[7] and built-in refrigeration products), the use of alternative foam blowing agents and refrigerants, engineering analysis tools, the use of VIPs, mark-ups, field energy consumption, life-cycle cost inputs, efficiency distribution forecasts, and trial standard level selection criteria. DOE also discussed plans for conducting the NOPR analyses. The comments received since publication of the November 2009 notice, including those received at the preliminary analysis public meeting, have contributed to DOE's proposed resolution of the issues in this rulemaking. This NOPR quotes and summarizes many of these comments, and responds to the issues they raised. A parenthetical reference at the end of a quotation or paraphrase provides the location of the item in the public record.

In response to the preliminary analysis, DOE also received a comment submitted by groups representing manufacturers (Association of Home Appliance Manufacturers, Whirlpool, General Electric Company (GE), Electrolux, LG Electronics, BSH, Alliance Laundry, Viking Range, Sub-Zero Wolf, Friedrich A/C, U-Line, Samsung, Sharp Electronics, Miele, Heat Controller, AGA Marvel, Brown Stove, Haier, Fagor America, Airwell Group, Arcelik, Fisher & Paykel, Scotsman Ice, Indesit, Kuppersbusch, Kelon, DeLonghi); energy and environmental advocates (American Council for an Energy Efficient Economy, Appliance Standards Awareness Project, Natural Resources Defense Council, Alliance to Save Energy, Alliance for Water Efficiency, Northwest Power and Conservation Council, Northeast Energy Efficiency Partnerships); and consumer groups (Consumer Federation of America, National Consumer Law Center). This collective set of comments, which DOE refers to in this notice as the "Joint Comments"[8] recommends specific energy conservation standards for refrigeration products that, in the commenters' view, would satisfy the requirements under EPCA. DOE neither organized nor was a member of the group but sent staff to observe some meetings and made its contractors available to perform data processing. Consistent with its legal obligations when developing an energy conservation standard, DOE is providing the public with the opportunity to comment on the proposed levels that DOE is considering adopting for refrigeration products, which mirror those recommended in the Joint Comments. As DOE has not yet reached a final decision on the levels it should prescribe, DOE invites comment on these proposed levels, possible alternative levels, and all other aspects presented in today's NOPR.

III. General Discussion

The following section discusses various technical aspects related to this proposed rulemaking. In particular, it addresses aspects involving the test procedures for refrigeration products, the technological feasibility of potential standards to assign to these products, and the potential energy savings and economic justification for prescribing the proposed amended standards for refrigeration products.

A. Test Procedures

As noted above, DOE's current test procedures for refrigeration products appear at 10 CFR part 430, subpart B, appendices A1 (for refrigerators and refrigerator-freezers) and B1 (for freezers). DOE recently issued a NOPR in which it proposed to amend these appendices, and to create new Appendices A and B, applicable to refrigerators/refrigerator-freezers and freezers, respectively, for products covered by today's proposed standards, (*i.e.,* those manufactured on or after January 1, 2014). 75 FR 29824 (May 27, 2010). While the proposed test procedures would retain or revise many of the provisions currently in appendices A1 and B1, they would also add some new procedures. Most of the revisions and additions would apply to all refrigeration products, and would be reflected in both new appendices, as follows: Updating references to the Association of Home Appliance Manufacturers (AHAM) HRF–1 test standard; incorporating icemaking energy use into the energy use metric for products with automatic icemakers; clarifying the procedures for test sample preparation; modifying the test methods for convertible compartments and special-purpose compartments; modifying the anti-sweat heater definition to include those heaters that prevent sweat (*i.e.,* moisture condensation) on interior surfaces; establishing new compartment temperatures and volume calculation methods; modifying the test methods for advanced defrost systems; eliminating the optional third part of the test method for products with variable defrost systems; and adjusting and correcting the various energy use equations included in the test procedure regulatory text. *Id.*

DOE also proposed to adopt language in a new appendix A to incorporate test methods for products equipped with variable anti-sweat heater control systems that are currently addressed in waivers. These waivers apply only to refrigerators and refrigerator-freezers. *Id.* at 29835–37.

Finally, DOE proposed to amend certain other provisions to clarify that combination freezer-wine storage products are not subject to the standards for refrigerator-freezers and to require manufacturers and private labelers to include additional information when they certify to DOE the compliance of refrigeration products that use advanced controls. *Id.* at 29829 and 29841–42.

The test procedure NOPR public meeting was held June 22, 2010. DOE received numerous comments from stakeholders at this meeting, addressing all aspects of the proposed test procedure amendments. The comment period for the test procedure rulemaking ended on August 10, 2010. *Id.* at 29824.

1. Test Procedure Rulemaking Schedule

The preliminary analysis documents were published, and the preliminary analysis public meeting was held, prior to publication of the test procedure

[7] An "all-refrigerator" is defined as "an electric refrigerator which does not include a compartment for the freezing and long time storage of food at temperatures below 32 °F (0.0 °C). It may include a compartment of 0.50 cubic feet capacity (14.2 liters) or less for the freezing and storage of ice." (10 CFR part 430, subpart B, appendix A1, section 1.4).

[8] DOE Docket No. EERE–2008–BT–STD–0012, Comment 49. DOE considered the Joint Comments to supersede earlier comments by the listed parties regarding issues subsequently discussed in the Joint Comments.

NOPR describing the amended test procedure on which the preliminary analysis was based. Because of this situation, AHAM commented that it was difficult for it to comment fully on the preliminary analysis because the specific test procedure changes were not yet known. (AHAM, Public Meeting Transcript, No. 28 at p. 17)[9] Edison Electric Institute (EEI) expressed concern about completion of the energy standards rulemaking, since the test procedure NOPR had not yet been published. (EEI, Public Meeting Transcript, No. 28 at p. 25) The Appliance Standards Awareness Project (ASAP) commented that test procedure rulemakings have been completed by the time of the energy standards NOPR in the past, and that this is a reasonable approach. (ASAP, Public Meeting Transcript, No. 28 at p. 26)

While DOE acknowledges the advantages of publishing the test procedure rulemaking prior to discussing the preliminary analysis, the agency is working diligently to complete all of the rulemakings related to refrigeration products within the statutorily mandated schedule. DOE notes that under EPCA, an amended or new energy conservation standard may not be prescribed unless a test procedure for the regulated product has been prescribed. See 42 U.S.C. 6295(o)(3). DOE has every intention of complying with this requirement.

2. Icemaking

DOE received numerous comments regarding energy use attributable to icemaking during the preliminary analysis phase of this rulemaking.

Stakeholders generally agreed that icemaking energy use should be incorporated into the energy use metric for refrigeration products. American Council for an Energy Efficient Economy (ACEEE) and ASAP submitted a joint comment (hereafter referred to as ACEEE/ASAP) urging that icemaker energy use and losses associated with through-the-door ice and water service be incorporated into the test method and rulemaking. (ACEEE/ASAP, No. 43 at p. 1)[10] These commenters added that water service as well as ice service should be included in the refrigeration product energy use metric. (*Id.* at 1–2) A group of California utilities consisting of Pacific Gas and Electric, San Diego Gas and Electric, Southern California Gas Company, and Southern California Edison, collectively organized as the California Investor Owned Utilities (IOU), commented that the energy associated with operating automatic ice makers should be addressed, because operational automatic ice makers contribute significantly to the refrigerator energy consumption. (IOU, No. 36 at p. 2) IOU also commented that energy use associated with water dispensing should be considered in the test procedure. (IOU, No. 36 at p. 6) The Natural Resources Defense Council (NRDC) agreed with the guidance DOE developed on how to treat icemakers during testing (75 FR 2122 (January 14, 2010)), and commented that the guidance will be adequate for use in this rulemaking. NRDC added that it is imperative that DOE revise the test procedure to include ice maker energy usage in the next standard. (NRDC, No. 39 at p. 2) Support for incorporating icemaking energy use explicitly in the energy metric was also expressed by LG Electronics U.S.A. (LG), Northeast Energy Efficiency Partnerships (NEEP), Northwest Power and Conservation Council (NPCC), ASAP, and in unpaginated comments submitted by Sub Zero-Wolf, Inc. (Sub Zero). (LG, No. 41 at p. 1; NEEP, No. 38 at p. 1; NPCC, No. 33 at p. 1; ASAP, Public Meeting Transcript, No. 28 at p. 28; Sub Zero, No. 40 at p. 2)

Regarding the inclusion of a method in the test procedure for measuring the energy use attributable to water dispensing, DOE is unaware of any publicly available information about the daily water usage by consumers using water dispenser-equipped refrigeration products. DOE developed a preliminary estimate for this energy use as follows. Assuming an average consumption of 0.63 gallons per standard size refrigerator per day,[11] a water temperature of 70 °F when entering the system (typical household ambient temperature to which the water in the refrigerator supply tubing would equilibrate between icemaking cycles) and a dispensed temperature of 39 °F (the standardized temperature for the fresh food compartment in the HRF–1–2008 test procedure), and a refrigeration system EER[12] of 5 Btu/hr-W, this energy use is equal to 12 kWh per year, roughly 2.5 percent of the average energy use of a typical refrigerator-freezer. Based on these data, there appears to be limited potential for savings from increasing the efficiency of the cooling and processing of the dispensed water. Although solenoid valves are energized while water is dispersed, the duration of valve actuation is so short that the valves do not contribute significantly to energy use. The only significant energy use attributable to water dispensation by the refrigeration system is for cooling the water. Unlike with the case of automatic icemaking, in which electric heaters are typically used to free ice from an ice mold, there is no obvious portion of the energy use that can be reduced or eliminated by improving component efficiency. Based on the limited amount of available data, DOE currently lacks sufficient information regarding the level of water consumption associated with water dispenser-equipped refrigeration equipment to either develop a test procedure or set a standard within the context of the agency's current rulemaking activities. DOE may consider the adoption of such a method in a future rulemaking to amend its test procedures.

Several stakeholders highlighted the challenges involved in the development of a test procedure for icemaking energy use. AHAM commented that developing a procedure to determine automatic icemaking energy consumption would be complex, and that any such procedure must be robust and repeatable. (AHAM, No. 34 at p. 2) GE commented that it is critical that DOE insist on a robust, repeatable procedure that minimizes variability for calculating icemaker energy prior to inclusion in any standards. (GE, No. 37 at p. 1) LG commented on the complexity of such a procedure and also emphasized that any such procedure that DOE adopts be verifiable, repeatable, and reliable. (LG, No. 41 at p. 3) Other stakeholders commenting on the complexity of development of an icemaking test procedure include Sub Zero and AHAM. (Sub Zero, No. 40 at p. 3; Sub Zero, Public Meeting Transcript, No. 28 at p. 29; AHAM, Public Meeting Transcript, at pp. 30, 31)

AHAM's ongoing work to develop a test procedure to measure icemaking energy use was mentioned at the public

[9] Comments made during the public meeting are cited as (Commenter acronym, Public Meeting Transcript, No. 28 at [pages in the transcript at which the comment appears]).

[10] Written comments are cited as (Commenter acronym, No. [assigned comment number in the docket] at p. [page number at which the comment appears]).

[11] Based on 0.22 gallons of drinking water per person per day (Am J Physiol Regul Integr Comp Physiol 283: R993–R1004, 2002.) and 2.89 people per household with a standard sized refrigerator (2005 RECS data for standard-size refrigerators with TTD ice.).

[12] EER, the energy efficiency ratio, is a measure of the efficiency of a compressor or a refrigeration system, being equal to the delivered cooling in British Thermal Units per hour (Btu/hr) divided by the compressor or system power input in Watts (W). The value 5 Btu/hr-W is based on a typical EER of 5.5 Btu/hr-W for the compressor of a baseline standard-size refrigerator (See NOPR TSD Chapter 5, Engineering Analysis, section 5.8.4), with some reduction of this efficiency associated with the additional power input of the evaporator and condenser fans.

meeting. (Public Meeting Transcript, No. 28 at pp. 28–33) AHAM noted that there was significant variation in the initial measurements made by AHAM members to assess a preliminary icemaking energy use test procedure and that additional work is required to better understand the reasons for this variation. (See "AHAM Update to DOE on Status of Ice Maker Energy Test Procedure," 11/19/2009, No. 46) AHAM further commented that the next step is to complete round robin evaluation, which is expected to take 3 to 4 months. The initial measurements made by AHAM members did not explore the potential impact of volume or product type on automatic ice maker energy use and provided no indication of how icemaker energy might be incorporated into the baseline energy efficiency curves. Additional testing to provide this information is expected to take another 4 months. (AHAM, No. 34 at p. 2) The projected date of completion of this process, based on the January 15 date of the comments, was at best the middle of August 2010.

Given the complexity of this test procedure development work, many stakeholders suggested that finalizing a standard in 2010 based on a test procedure which includes a measurement of icemaking energy use is not critical for purposes of setting appropriate energy efficiency levels. Stakeholders who held this view included ACEEE/ASAP, GE, NRDC, and Sub Zero. (ACEEE/ASAP, No. 43 at p. 1–2; GE, No. 37 at p. 1; NRDC, No. 39 at p. 2; Sub Zero, No. 40 at p. 3) NEEP disagreed with this viewpoint and commented that DOE should consider imposing a deadline for the industry-led process to finalize an updated test procedure that incorporates icemaking energy use, after which DOE should quickly finalize a procedure to incorporate into its regulations. NEEP also suggested that a test procedure update prior to promulgation of standards was a more ideal solution. (NEEP, No. 38 at p. 1) Sub Zero and NEEP commented that a short delay in publication of the final rule for this rulemaking would be acceptable if necessary to allow sufficient time to develop the icemaking test procedure. (Sub Zero, No. 40 at p. 3; NEEP, No. 38 at p. 2)

Several stakeholder comments addressed details associated with an icemaking test procedure. AHAM commented that the energy use metric should be expressed in annual kWh per year. (AHAM, Public Meeting Transcript, No. 28 at p. 32) The AHAM draft proposal is based on converting a measurement of the energy required to produce one pound of ice by a production quantity of 1.8 pounds per day to determine annual icemaking energy use. (AHAM, No. 34 at p. 2) IOU recommended consideration of either a "kWh per pound of ice" metric or a "kWh per year" metric. (IOU, No. 36 at pp. 2–3) In light of these comments, DOE proposes to establish an annual energy use for ice that will be added to the energy use measured using the current test procedure (or an amended version of the current procedure) to provide a total annual energy use metric that includes the energy associated with icemaking.

Additionally, AHAM commented that "the test procedure may need to allow manufacturers to subtract the thermodynamic energy required to convert water to ice, so that this energy is not targeted for energy efficiency improvements." (AHAM, No. 34 at p. 2) However, AHAM acknowledged that the theoretical efficiency depends on the Coefficient of Performance (COP)[13] of the particular refrigerator-freezer, which can vary. (*Id.*) Consideration of the COP in this context is important, because the AHAM comment implication is that the thermodynamic energy required to convert water to ice is independent of refrigerator design. On the contrary, this energy use is indirectly proportional to the COP, which is a characteristic of the refrigerator's design. However, EPCA requires that test procedures "shall be reasonably designed to produce test results which measure energy efficiency, energy use * * * or estimated annual operating cost of a covered product during a representative average use cycle or period of use * * *" (42 U.S.C. 6293(b)(3)). This statutory provision calls for measuring energy use, and does not single out for incorporation into the test procedure only that portion of the energy use that could be eliminated or reduced through design modifications. DOE tentatively interpreted this requirement to mean that the test procedure must measure all of the energy use associated with a given product function.

LG commented that an icemaking test procedure should consider the potential overlap of icemaking and defrost periods. (LG, No. 41 at p. 3) DOE interprets this comment as addressing the fact that achieving steady state operation during icemaking may take a long time to achieve—possibly longer than the elapsed time between defrosts. Hence, the energy use increment associated with icemaking is difficult to distinguish from the energy use increment associated with defrost. DOE is not at this time considering this level of detail regarding a potential icemaking test.

Both AHAM and Sub Zero mentioned the need to consider manual as well as automatic icemaking. (AHAM, Public Meeting Transcript, No. 28 at p. 32; Sub Zero, No. 40 at p. 3) DOE notes that there is limited information available regarding the energy use of automatic icemakers, while there is no publicly available information regarding the energy use involved in manual icemaking. Hence, DOE is examining the possibility of incorporating the energy use of automatic icemakers into the energy use metric while leaving open for the time being the treatment of energy use related to manual icemaking.

DOE plans to incorporate icemaking energy use into the energy use metric for refrigeration products. However, DOE acknowledges the challenges in developing an accurate and repeatable test procedure and the need to avoid uncontrolled variability in energy test results associated with adopting a premature procedure. DOE also seeks to address this aspect of energy consumption and to improve the accuracy of representations of energy use (*i.e.,* on the EnergyGuide label used to inform consumers regarding product energy use) and has attempted to lay the initial foundations for an improved measurement by proposing a fixed placeholder representing icemaking energy use in kWh per year for all products equipped with an automatic icemaker. 75 FR 29846–47 (May 27, 2010). The proposed placeholder value is equal to the average reported by AHAM of measurements made using a draft icemaking energy use test procedure. ("AHAM Update to DOE on Status of Ice Maker Energy Test Procedure," No. 46 at p. 11) DOE intends to closely monitor industry efforts in developing a method of measuring icemaking energy use and may propose the incorporation of such a measurement into the test procedure and energy conservation standard at the appropriate time.

Stakeholders also commented regarding the approach used to set standards for icemaking energy use or to adjustment of energy standards to include icemaking energy use. DOE sought input regarding an appropriate method to establish maximum icemaking energy use as a function of product class and adjusted volume, as well as the available technology options to reduce icemaking energy use.

[13] Coefficient of Performance, equal to cooling energy delivered by the refrigeration product divided by energy input. This is related to EER, explained above, by the conversion of the units of energy input from British Thermal Units (Btu) to Watt-Hours (W-h).

(Preliminary Analysis Public Meeting Presentation, No. 26 at p. 19) EEI commented that maximum icemaking energy is more a function of the number and characteristics of occupants/users than it is a function of volume. (EEI, Public Meeting Transcript, No. 28 at p. 34) DOE agrees with this comment, but notes that energy conservation standards, defined by EPCA as "a performance standard which prescribes a minimum level of energy efficiency or a maximum quantity of energy use * * * for a covered product * * *" (42 U.S.C. 6291(6)(A)), do not address characteristics of the product purchasers or users. IOU commented that ice maker efficiency is directly affected by refrigeration system efficiency, ice maker component efficiency, allowable sub freezing temperature, and ice maker type. (IOU, No. 36 at p. 6) Stakeholders including AHAM, GE, and Whirlpool commented that it is premature to evaluate design options for reducing icemaking energy use and/or to set standards for icemaking at other than current baseline levels. (AHAM, No. 34 at p. 3; AHAM, Public Meeting Transcript, No. 28 at pp. 32, 33; GE, No. 37 at p. 1; Whirlpool, No. 31 at p. 5) AHAM further elaborated that a necessary first step before setting standards for icemaking would be to develop a robust test procedure and to establish that function's baseline energy use. In AHAM's view, the evaluation of design options and the potential for energy use reduction should be considered for a future rulemaking after fully demonstrating the validity of the test procedure (AHAM, No. 34 at p. 3)

DOE agrees that proposing a standard level for icemaking energy use is premature prior to the development of a test procedure that can be used to evaluate baseline icemaking energy use. EPCA prohibits the establishment of energy conservation standards for refrigeration products if no test procedure has been prescribed. See 42 U.S.C. 6295(o)(3)(A). DOE's proposed approach of assigning a fixed quantity of energy to icemaking in the test procedure in lieu of a test that measures each product's icemaking efficiency for comparison with a standard would provide information to consumers regarding the additional energy use associated with icemaking, since the energy use measurement reported on EnergyGuide labels will include this component. This proposed method would also give the industry additional time in which to perfect its test procedure to address this particular energy-consuming component.

The test procedure, which is the basis for the engineering analysis, does not consider variation of icemaking energy use as a function of product characteristics (other than the presence of an automatic icemaker). For that reason, DOE stated during the preliminary analysis public meeting that the engineering analysis does not consider icemaking. (Public Meeting Transcript, No. 28 at p. 27) NPCC pointed out that DOE's energy use analysis (see chapter 7 of the preliminary TSD) does address icemaking energy use through application in the calculations of the Usage Adjustment Factor (UAF) that converts energy test measurements to field energy use. (NPCC, Public Meeting Transcript, No. 28 at p. 27) DOE agrees that the usage adjustment factors (UAF) incorporate an adjustment to include icemaking energy use. (See Preliminary TSD, No. 22 at p. 7–6.) In the preliminary LCC analysis, DOE calculated energy savings by multiplying the energy use reduction under consideration (*e.g.,* 20-percent energy use reduction) by multiplying this percentage reduction by all of the calculated baseline field energy use, including icemaking energy use for products having automatic icemakers. In contrast, the NOPR analysis separated icemaking energy use from consideration of energy use reduction as much as possible, which is consistent with the proposal DOE is currently considering to incorporate icemaking energy use into the test procedure. This process is described more fully in the NOPR TSD.

3. Circumvention

Consumers Union submitted comments that specifically addressed circumvention. Key points made in its submittal included the following:

• Test procedures need to keep up with product development and must be continually updated and strengthened. Test procedures must be updated more frequently. (Consumers Union, No. 44 at pp. 5, 6)

• Regulations should explicitly provide a procedure for DOE to quickly close testing loopholes and to hold manufacturers accountable for any intentional manipulation of test procedures. (Consumers Union, No. 44 at pp. 5, 6)

• The test procedure should require compartment temperatures to be within a smaller range of acceptable values, such as within +/−2° F of ideal storage values. (Consumers Union, No. 44 at p. 5)

• The test procedure should reflect typical consumer conditions by explicitly forbidding any special energy savings at test temperatures, settings, or conditions that consumers are unlikely to experience. (Consumers Union, No. 44 at p. 5)

DOE acknowledges the need to update test procedures more frequently. DOE also acknowledges that enforcement and verification activities are needed to ensure that manufacturers cannot circumvent the test procedure. To this end, DOE is examining a variety of options to address these concerns and notes that its concurrent test procedure rulemaking would likely deal with these issues. Additionally, by statute, the agency is obligated to update its test procedure at least once every seven years, which DOE has every intention to fulfill. *See* 42 U.S.C. 6293(b).

4. Variable Anti-Sweat Heater Control

Anti-sweat heaters are used to prevent the condensation of moisture on refrigeration product surfaces. Such accumulation of moisture as liquid droplets is undesirable because (1) It is unsightly, (2) it encourages mold growth, and (3) the water drops can fall to the floor and create a slip hazard. These heaters are often electricity-consuming resistance heaters. However, many refrigeration products also use waste heat from the refrigeration system to provide anti-sweat heating functions. This is accomplished by routing hot gas or warm liquid refrigerant tubing in the regions of the cabinet that require anti-sweat heating.

GE and AHAM both supported DOE's proposal to amend the current test procedure to address the treatment of products equipped with a variable anti-sweat heater control system. These systems control anti-sweat heater operation by reducing or eliminating their energy use when ambient conditions, such as humidity, indicate that heater operation at full load is unnecessary. (GE, No. 37 at p. 2; AHAM, No. 34 at p. 10) DOE notes that, while it plans to modify the current test procedure to enable it to address variable anti-sweat heater control systems, the agency may choose not to directly incorporate the current waiver language covering these types of systems into the test procedure. *See, e.g.,* variable antisweat heater waivers published at 73 FR 10425 (February 27, 2008) and 74 FR 20695 (May 5, 2009). DOE proposed as part of its test procedure amendments to incorporate a modified version of that procedure (*see* 75 FR 29835–37 (May 27, 2010)), and is considering public comments in finalizing those amendments.

5. Standby and Off Mode Energy Use

DOE also notes that EPCA, as amended by EISA 2007, requires DOE to amend its test procedures for all covered products, including those for refrigeration products, to include measurement of standby mode and off mode energy consumption, except where current test procedures fully address such energy consumption. (42 U.S.C. 6295(gg)(2)) As indicated above, DOE's current test procedures for refrigeration products fully address standby and off mode energy use, and any amended test procedure that DOE adopts for these products will continue to do so.

B. Technological Feasibility

1. General

In each standards rulemaking, DOE conducts a screening analysis based on information gathered on all current technology options and prototype designs that have the potential to improve product or equipment efficiency. To conduct the 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 currently in use by the relevant industry, or if a working prototype exists. *See* 10 CFR part 430, subpart C, appendix A, section 4(a)(4)(i) (providing that "[t]echnologies incorporated in commercially available products or in working prototypes will be considered technologically feasible.")

Once DOE has determined that particular design options are technologically feasible, it evaluates each of these design options using 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)). Section IV.B of this notice discusses the results of the screening analysis for refrigeration products, particularly the designs DOE considered, those it screened out, and those that are the basis for the trial standard levels (TSLs) in this rulemaking. For further details on the screening analysis for this rulemaking, see chapter 4, Screening Analysis, of the NOPR TSD.

2. Maximum Technologically Feasible Levels

When DOE proposes to adopt (or not adopt) an amended standard for a type or class of covered product, it must "determine the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible" for such product. (42 U.S.C. 6295(p)(1)) Accordingly, DOE determined the maximum technologically feasible (hereafter max-tech) reductions in energy use for refrigeration products in the engineering analysis.

As described in the preliminary TSD, DOE conducted a full analysis of a set of product classes that comprise a large percentage of product shipments in the market today. DOE's approach for extending proposed standard levels established for these product classes to the non-analyzed product classes is described in chapter 2, Analytical Framework, of the preliminary TSD, in section 2.15. However, this section of this notice reports the max-tech efficiency levels only for the directly analyzed product classes.

DOE used the proposed test procedures that would apply once manufacturers must comply with the new standard to determine the max-tech efficiency levels of the directly analyzed product classes. The efficiency levels are defined as reductions in that portion of the energy use not associated with icemaking. As described in section III.A, above, the energy use associated with icemaking under the proposed test procedure is a fixed quantity not correlated with an efficiency level. Separating this fixed quantity of energy use from the definition of efficiency level allows a more direct comparison of products, irrespective of whether a given product is equipped with an automatic icemaker. This approach also allows DOE to compare the efficiency levels based on the proposed test procedure (*i.e.,* projections of possible energy use reductions) against the energy use based on the existing test procedure and current standard.[14]

DOE used the full set of design options considered applicable for these products classes to determine the max-tech efficiency levels for the analyzed product classes. (*See* chapter 5 of the NOPR TSD, section 5.4.4.) Table III.1 lists the max-tech levels that DOE determined for this rulemaking. The table also presents the max-tech levels that are commercially available. The max-tech levels differ from those presented in the preliminary TSD, and are generally lower (*i.e.,* the percent energy use reductions are lower for the NOPR analysis, thus the max-tech energy use is higher). The reduction in the max-tech efficiency levels is due to the revisions DOE implemented in the NOPR engineering analysis to address new information obtained during this phase of the work.

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

Product class	Description	Efficiency level (percent energy use reduction)	
		DOE analysis (in percent)	Max tech commercially available (in percent)
Standard-Size Refrigerator-Freezers			
3	Refrigerator-freezers—automatic defrost with top-mounted freezer without through-the-door ice service.	36	30
5	Refrigerator-freezers—automatic defrost with bottom-mounted freezer without through-the-door ice service.	36	33
7	Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service.	33	32

[14] In other words, a product with energy usage that is a certain percentage below the current energy standard should remain the same percentage below the baseline energy use under the proposed test procedure after subtracting icemaking energy use. Hence, the max-tech levels expressed as percentage of energy use reduction should be the same for both sets of test procedures.

TABLE III.1—MAX-TECH EFFICIENCY LEVELS FOR THE REFRIGERATION PRODUCTS RULEMAKING—Continued

Product class	Description	Efficiency level (percent energy use reduction)	
		DOE analysis (in percent)	Max tech commercially available (in percent)
Standard-Size Freezers			
9	Upright freezers with automatic defrost	44	27
10	Chest freezers and all other freezers except compact freezers	41	16
Compact Products			
11	Compact refrigerators and refrigerator-freezers with manual defrost	59	27
18	Compact chest freezers	42	23
Built-In Products			
3A–BI	Built-In All-refrigerators—automatic defrost	28	31
5–BI	Built-In Refrigerator-freezers—automatic defrost with bottom-mounted freezer without through-the-door ice service.	27	27
7–BI	Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service.	22	21
9–BI	Built-In Upright freezers with automatic defrost	27	27

The max-tech efficiency levels identified for commercially available products are in most cases different from the max-tech levels shown in Table III.1. These levels are significantly higher than the commercially available max-tech levels for product classes 9 (upright freezers with automatic defrost), 10 (chest freezers), 11 (compact refrigerators and refrigerator-freezers with manual defrost), and 18 (compact chest freezers). DOE determined that higher max-tech levels for these products were possible because the commercially available products generally do not use all of the energy efficient design options considered in the DOE max-tech analyses. Prototypes with the DOE max-tech levels have not been identified, but the design options are all used in commercially available products.

DOE determined the max-tech levels using the EPA Refrigerator Analysis (ERA) program to conduct energy modeling. DOE conducted this energy modeling for specific products examined during the engineering analysis. DOE created energy models for the existing products and adjusted these models to represent modified designs using the screened-in design options. The max-tech levels represent the most efficient design option combinations applicable for the analyzed products. This process is described in the NOPR TSD in chapter 5, Engineering Analysis in sections 5.4.4 and 5.7. DOE considered different sets of design options for each product class, as indicated in Table III.2,

TABLE III.2—DESIGN OPTIONS CONSIDERED FOR MAX TECH

Product class	Design option							
	BLDC* fan motors	Heat exchanger improvement	Thicker walls	Vacuum insulation panels (VIPs)	Variable speed compressor	Adaptive defrost	Variable anti-sweat heater control	Isobutane refrigerant
3	√	√		√	√	√		
5	√	√		√	√	√	√	
7	√	√		√	√	√	√	
9	√	√	√	√	√	√		
10		√	√	√	√			
11		√	√	√	√			√
18		√	√	√	√			
3A–BI	√	√		√	√	√		
5–BI	√	√		√	√	√	√	
7–BI	√	√		√	√	√	√	
9–BI	√	√		√	√	√		

* Brushless-Direct-Current.

Stakeholder comments and questions regarding the preliminary analysis max-tech levels primarily address (a) The validity of max tech that is calculated based on technology options that are used in commercialized products but which is not achieved in actual products or prototypes, (b) the validity of consideration of variable speed compressors for compact products, (c) whether some of the design options, particularly heat exchanger size increases, would fit physically in the products, and (d) the validation of the energy modeling predictions. Comments falling under categories (b) through (d) address engineering analysis issues and are discussed in section IV.C, below.

Some stakeholders questioned DOE's use of energy analysis based on design options used in commercial products to determine max-tech levels rather than the maximum efficiency levels of available products.

AHAM questioned DOE's use of the max-tech evaluation. AHAM supports DOE's historical approach of using the max-tech reference to identify those units in the market that have achieved the maximum efficiency. (AHAM, No. 34 at pp. 10, 15)

GE also pointed out the discrepancy between the commercially available max-tech level and the theoretical max-tech level. (GE, Public Meeting Transcript, No. 28 at p. 77) GE mentioned that DOE has not provided a detailed comparison of the maximum efficiency levels currently available in the market with the model-based max tech. (*Id.*) In written comments, GE also stated that DOE should not use theoretical max-tech levels not yet proven as viable alternatives in the marketplace and noted that there may be some instances where the inclusion of certain designs options may not yield additive improvements in efficiency. (GE, No. 37 at p. 2)

While DOE has often selected max-tech levels that are based on commercially available efficiency levels, max-tech selections are not required to be limited to commercially available products or prototypes. DOE follows a prescribed method for evaluating technologies, which is laid out in 10 CFR part 430, subpart C, appendix A. When DOE evaluates design options in ascertaining max-tech levels, these options are ones that have been incorporated into commercial products or in working prototypes. See, *e.g.,* 10 CFR part 430, subpart C, appendix A, section 4(a)(4)(i) and 5(b)(1). The range of candidate standard levels will typically include the most energy efficient combination of design options. 10 CFR part 430, subpart C, appendix A, section 5(c)(3)(i)(A). Because all of the design options represented by the max-tech levels examined by DOE are in use in the marketplace, DOE is considering max-tech levels that employ *combinations* of these design options, which, for some of the product classes, are not currently found in the marketplace. DOE considered in the analysis whether the chosen design options used for the max-tech analyses can be combined and concluded that the chosen combinations are valid. For example, when considering VIPs, DOE adjusted the analysis to remove some conventional insulation, and when considering variable-speed compressors, DOE removed high-efficiency single-speed compressor design options.

DOE requests comment on the max-tech levels identified and on the combinations of design options considered applicable to achieve max-tech designs. DOE requests that comments also address as appropriate the differences in applicable design options for different product classes. *See* Issue 2 under "Issues on Which DOE Seeks Comment" in section VII.E. Based on comments received in response to these issues, DOE may make adjustments to its proposed levels.

C. Energy Savings

1. Determination of Savings

DOE used its NIA spreadsheet model to estimate energy savings from amended standards for the refrigeration products that are the subject of this rulemaking.[15] For each TSL, DOE forecasted energy savings beginning in 2014, the year that manufacturers would be required to comply with amended standards, and ending in 2043. 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 amended mandatory efficiency standards, and considers market demand for more-efficient products.

The NIA spreadsheet model calculates the electricity savings in "site energy" expressed in kilowatt-hours (kWh). Site energy is the energy directly consumed by refrigeration products at the locations where they are used. DOE reports national energy savings on an annual basis in terms of the aggregated source (primary) energy savings, which is the savings in the energy that is used to generate and transmit the site energy. (See TSD chapter 10.) To convert site energy to source energy, DOE derived annual conversion factors from the model used to prepare the Energy Information Administration's (EIA) *Annual Energy Outlook 2010 (AEO2010).*

2. Significance of Savings

As noted above, 42 U.S.C. 6295(o)(3)(B) prevents 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, in *Natural Resources Defense Council* v. *Herrington,* 768 F.2d 1355, 1373 (DC Cir. 1985), indicated that Congress intended "significant" energy savings in this context to be savings that were not "genuinely trivial." The energy savings for all of the TSLs considered in this rulemaking are nontrivial, and, therefore, DOE considers them "significant" within the meaning of section 325 of EPCA.

[15] The NIA spreadsheet model is described in section IV.G of this notice.

D. Economic Justification

1. Specific Criteria

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

a. Economic Impact on Manufacturers and Consumers

In determining the impacts of an amended standard on manufacturers, DOE first determines the quantitative impacts using an annual cash-flow approach. This step includes both a short-term assessment—based on the cost and capital requirements during the period between the issuance of a regulation and when entities must comply with the regulation—and a long-term assessment over a 30-year analysis period. The industry-wide 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 separately specified in EPCA 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 national net present value 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 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 assumed in its analysis that consumers will purchase the considered products in 2014.

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 receive LCC savings or experience 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 a national standard.

c. Energy Savings

While significant conservation of energy is a separate statutory requirement for imposing an energy conservation standard, EPCA requires DOE, in determining the economic justification of a standard, to consider the total projected energy savings that are expected to result directly from the standard. (42 U.S.C. 6295(o)(2)(B)(i)(III)) DOE uses the NIA spreadsheet results in its consideration of total projected energy 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 sought to develop standards for refrigeration products that would not lessen the utility or performance of these products. None of the TSLs presented in today's NOPR would substantially reduce the utility or performance of the products under consideration in the rulemaking. However, manufacturers may reduce the availability of features that increase energy use, such as multiple drawers, in response to amended standards. (42 U.S.C. 6295(o)(2)(B)(i)(IV))

e. Impact of Any Lessening of Competition

EPCA directs DOE to consider any lessening of competition that is likely to result from standards. It also directs the Attorney General of the United States (Attorney General) to determine the impact, if any, of any lessening of competition likely to result from a proposed standard and to transmit such determination to the Secretary within 60 days of the publication of a proposed rule, together with an analysis of the nature and extent of the impact. (42 U.S.C. 6295(o)(2)(B)(i)(V) and (B)(ii)) DOE has transmitted a copy of today's proposed rule to the Attorney General and has requested that the Department of Justice (DOJ) provide its determination on this issue. DOE will address the Attorney General's determination in the final rule.

f. Need for National Energy Conservation

Certain benefits of the proposed standards are likely to be reflected in 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 standards may affect the Nation's needed power generation capacity.

Energy savings from the proposed 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. DOE reports the environmental effects from the proposed standards for refrigeration products, and from each TSL it considered, in the environmental assessment contained in chapter 15 in the NOPR TSD. DOE also reports estimates of the economic value of emissions reductions resulting from the considered TSLs.

g. Other Factors

EPCA allows the Secretary of Energy, in determining whether a standard is economically justified, to consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6295(o)(2)(B)(i)(VII)) In developing the proposals of this notice, DOE has also considered the comments of the stakeholders, including those raised in the Joint Comments.

2. Rebuttable Presumption

As set forth in 42 U.S.C. 6295(o)(2)(B)(iii), EPCA creates a rebuttable presumption that an energy conservation standard is economically justified if the additional cost to the consumer of a product that meets the standard is less than three times the value of the first-year of energy savings resulting from the standard, as calculated under the applicable DOE test procedure. DOE's LCC and PBP analyses generate values used to calculate the payback period for consumers of potential amended energy conservation standards. These analyses include, but are not limited to, the 3-year payback period contemplated under the rebuttable presumption test. However, DOE routinely conducts an 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 definitively evaluate the economic justification for a potential standard level (thereby supporting or rebutting the results of any preliminary determination of economic justification). The rebuttable presumption payback calculation is discussed in section IV.F.12 of this NOPR and chapter 8 of the NOPR TSD.

IV. Methodology and Discussion

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

Additionally, DOE estimated the impacts on utilities and the environment of energy efficiency standards for refrigeration products. DOE used a version of EIA's National Energy Modeling System (NEMS) for the utility and environmental analyses. The NEMS model simulates the energy sector of the U.S. economy. EIA uses NEMS to prepare its *Annual Energy Outlook,* a widely known energy forecast for the United States. The version of NEMS used for appliance standards analysis is called NEMS–BT,[16] and is based on the *AEO* version with minor modifications.[17] The

[16] BT stands for DOE's Building Technologies Program.

[17] The EIA allows 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

Continued

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

A. Market and Technology Assessment

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. The subjects addressed in the market and technology assessment for this rulemaking include product classes and manufacturers; quantities, and types of products sold and offered for sale; retail market trends; regulatory and non-regulatory programs; and technologies or design options that could improve the energy efficiency of the product(s) under examination. See chapter 3, Market and Technology Assessment, of the NOPR TSD for further discussion of the market and technology assessment.

Discussion presented in this section of today's NOPR primarily addresses the scope of coverage of refrigeration products and the product class structure. Both of these issues were discussed at length during the preliminary analysis public meeting. DOE is proposing several modifications of the product class structure, as discussed in section IV.A.2, Below.

1. Exclusion of Wine Coolers From This Rulemaking

During the preliminary analysis, DOE considered whether wine coolers are covered products under EPCA, and whether they would be considered in this rulemaking. DOE modified the definition of "Electric Refrigerator" on November 19, 2001, by limiting the definition to products designed for the refrigerated storage of food at temperatures above 32 °F and below 39 °F. 66 FR 57845, 57848 (November 19, 2001). The modification imposed an upper limit on the applicable storage temperature range, thus eliminating wine storage products, which operate with storage temperatures above 40 °F (and generally near 55 °F) from consideration as electric refrigerators. The industry generally urged DOE to consider wine coolers within the scope of its rulemaking. (AHAM, No. 34 at p. 9; Sub Zero, Public Meeting Transcript, No. 28 at p. 108; Sub Zero, No. 40 at p. 9; Whirlpool, No. 31 at p. 2) AHAM further argued that DOE does have the authority to regulate wine coolers, and stated that regulation of wine coolers under a DOE standard is important to prevent manufacturers from having to meet multiple State requirements. (AHAM, Public Meeting Transcript, No. 28 at p. 36) Sub Zero suggested that DOE establish a standard that is consistent with current standards set by the California Energy Commission (CEC) and Natural Resources Canada (NRCan), and also argued that no State or foreign requirement should set a de facto national standard for any appliance. (Sub Zero, No. 40 at p. 9) Other commenters, IOU and Energy Solutions, representing Pacific Gas and Electric (PG&E), supported DOE's proposal. (IOU, No. 36 at p. 12; PG&E, Public Meeting Transcript, No. 28 at p. 36)

DOE notes that residential wine coolers are appliances designed for the storage of wine at a temperature of approximately 55 °F. Because they are neither designed for food storage, nor maintain storage temperatures below 39 °F, they are not "electric refrigerators" as defined in 10 CFR 430.2. Since EPCA does not define the term "refrigerators" or "refrigeration products," a definition could be developed to account for those products that operate with warmer compartment temperature ranges, including wine storage products. DOE may consider such a change in a future rulemaking.

2. Product Classes

In evaluating and establishing energy conservation standards, DOE generally divides covered products into classes by the type of energy used, or by capacity or other performance-related feature that justifies a different standard for those products. (See 42 U.S.C. 6295(q)). In deciding whether a feature justifies a different standard, DOE must consider factors such as the utility of the feature to users. (*Id.*) DOE normally establishes different energy conservation standards for different product classes based on these criteria. The CFR sets forth 18 product classes for refrigerators, refrigerator-freezers, and freezers.[18] These classes are based on the following characteristics: type of unit (refrigerator, refrigerator-freezer, or freezer), size of the cabinet (standard or compact), type of defrost system (manual, partial, or automatic), presence or absence of through-the-door (TTD) ice service, and placement of the fresh food and freezer compartments for refrigerator-freezers (top, side, bottom).

DOE proposes to create 19 new product classes to account for the increasingly wider number of variants of products. Six new product classes were discussed and proposed in the preliminary analysis phase. Table IV.1 presents the product classes under consideration in this rulemaking, including both current and proposed classes. Note that the designation of some of the current product classes has changed in order to address the proposed division of these product classes. The subsections below provide additional details and discussion of comments relating to the product classes under consideration.

TABLE IV.1—PROPOSED PRODUCT CLASSES FOR REFRIGERATION PRODUCTS

Number	Product class
Classes listed in the CFR	
1	Refrigerators and refrigerator-freezers with manual defrost.
2	Refrigerator-freezers—partial automatic defrost.
3	Refrigerator-freezers—automatic defrost with top-mounted freezer without an automatic icemaker.
4	Refrigerator-freezers—automatic defrost with side-mounted freezer without an automatic icemaker.
5	Refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker.
6	Refrigerator-freezers—automatic defrost with top-mounted freezer with through-the-door ice service.
7	Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service.

modifications and runs the model under various policy scenarios that deviate from *AEO* assumptions, the name "NEMS–BT" refers to the model as used here. 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.*

[18] Title 10—Energy, Chapter II—Department of Energy, Part 430—Energy Conservation Program for Consumer Products, Subpart A—General Provisions, Section 430.32—Energy and Water Conservation Standards and Effective Dates.

TABLE IV.1—PROPOSED PRODUCT CLASSES FOR REFRIGERATION PRODUCTS—Continued

Number	Product class
8	Upright freezers with manual defrost.
9	Upright freezers with automatic defrost without an automatic icemaker.
10	Chest freezers with manual defrost and all other freezers except compact freezers.
11	Compact refrigerators and refrigerator-freezers with manual defrost.
12	Compact refrigerator-freezers—partial automatic defrost.
13	Compact refrigerator-freezers—automatic defrost with top-mounted freezer.
14	Compact refrigerator-freezers—automatic defrost with side-mounted freezer.
15	Compact refrigerator-freezers—automatic defrost with bottom-mounted freezer.
16	Compact upright freezers with manual defrost.
17	Compact upright freezers with automatic defrost.
18	Compact chest freezers.
Product classes proposed to be established in this rulemaking and introduced in the preliminary TSD	
1A	All-refrigerators—manual defrost.
3A	All-refrigerators—automatic defrost.
5A	Refrigerator-freezers—automatic defrost with bottom-mounted freezer with through-the-door ice service.
10A	Chest freezers with automatic defrost.
11A	Compact all-refrigerators—manual defrost.
13A	Compact all-refrigerators—automatic defrost.
Additional product classes proposed to be established in this rulemaking	
3–BI	Built-in refrigerator-freezer—automatic defrost with top-mounted freezer without an automatic icemaker.
3I	Refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic icemaker without through-the-door ice service.
3I–BI	Built-in refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic icemaker without through-the-door ice service.
3A–BI	Built-in all-refrigerators—automatic defrost.
4I	Refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker without through-the-door ice service.
4–BI	Built-in refrigerator-freezers—automatic defrost with side-mounted freezer without an automatic icemaker.
4I–BI	Built-in refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker without through-the-door ice service.
5I	Refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker without through-the-door ice service.
5–BI	Built-in refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker.
5I–BI	Built-in refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker without through-the-door ice service.
5A–BI	Built-in refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service.
7–BI	Built-in refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service.
9–BI	Built-in upright freezers with automatic defrost without an automatic icemaker.

DOE proposed six new product classes in the preliminary TSD. Two of these, product class 5A, "automatic defrost refrigerator-freezers with bottom-mounted freezer with through-the-door ice service," and product class 10A, "chest freezers with automatic defrost," were identified in the framework document as product classes 19 and 20. DOE modified the designation of these product classes in order to maintain consistency with the product class designations adopted by Canada. DOE received comments from AHAM and Whirlpool supporting this modification. (AHAM, Public Meeting Transcript, No. 28 at pp. 40; AHAM, No. 34 at p. 3; Whirlpool, No. 31 at p. 1)

Four additional product classes proposed in the preliminary TSD are all-refrigerators. As described below, the proposed new test procedure has led to DOE's proposal to establish separate product classes for these products.

As part of today's NOPR, DOE proposes 13 additional new product classes. These classes are based on incorporation of icemaking energy use into the test procedure, and the need to address the different consumer utility and energy use characteristics of built-in products.

EPCA requires that the establishment of separate product classes be based on either (A) consumption of a different kind of energy from that consumed by other covered products within such type (or class); or (B) a capacity or other performance-related feature which other products within such type (or class) do not have, where such feature justifies a higher or lower standard from that which applies to other products within such type (or class). (42 U.S.C. 6295(q)). The second of these criteria is applicable to all of the new product classes proposed in this rulemaking.

a. French Door Refrigerators With Through-the-Door Ice Service

DOE proposes to establish a new product class 5A (refrigerator-freezers—automatic defrost with bottom-mounted freezer with through-the-door ice service). Most, if not all, products of this class have a pair of French doors rather than a single door serving the upper fresh food compartment. Products of class 5A have TTD ice service features which are not present in current product class 5 (refrigerator-freezers—automatic defrost with bottom-mounted freezer without through-the-door ice service). These added features increase energy use because of the thermal load associated with the TTD dispenser penetration and the anti-sweat heater energy generally used in this area of the product. *See, e.g.,* Decision and Order (Maytag Corporation), Office of Hearings and Appeals, Case No. TEE–0022 (published August 11, 2005) (granting exception relief to Maytag and creating a revised energy equation to permit the sale of refrigerator-freezers equipped with a bottom-mounted freezer and through-the-door ice service). Hence, because of the presence of this capability, DOE has determined that these unique features merit a separate product class and justify a separate maximum energy use standard.

b. Chest Freezers With Automatic Defrost

Products of class 10A (chest freezers with automatic defrost) include an automatic defrost function, a feature not present in chest freezers with manual defrost. Automatic, as opposed to manual, defrost is recognized as a feature with distinct consumer utility that increases energy use, justifying a separate energy use standard. *See, e.g.,* Decision and Order (Electrolux Home Products, Inc.), Office of Hearings and Appeals, Case No. TEE–0012 (published September 13, 2004).

c. All-Refrigerators

DOE proposes establishing four new all-refrigerator product classes to separate these products from their current product classes. These current product classes—1 (refrigerators and refrigerator-freezers with manual defrost), 3 (refrigerator-freezers—automatic defrost with top-mounted freezer without through-the-door ice service and all-refrigerators—automatic defrost), 11 (compact refrigerators and refrigerator-freezers with manual defrost), and 13 (compact refrigerator-freezers—automatic defrost with top-mounted freezer and compact all-refrigerator—automatic defrost)—include refrigerators with freezer compartments ("basic refrigerators"), refrigerator-freezers, and all-refrigerators. The proposed test procedure changes described in section III.A will result in significantly higher measured energy use for basic refrigerators and refrigerator-freezers, and somewhat less energy use for all-refrigerators. At this time, DOE believes that these differences in energy use characteristics under the proposed new test procedures, combined with the distinct utility difference associated with presence of a freezer compartment (of 0.5 cubic foot size or greater) satisfy the criteria under EPCA to establish separate product classes. (See 42 U.S.C. 6295(q)(1)(B)). DOE received comments supporting this proposal from AHAM and Whirlpool (AHAM, Public Meeting Transcript, No. 28 at p. 40; AHAM, No. 34 at p. 4; Whirlpool, Public Meeting Transcript, No. 28 at pp. 41–42) Whirlpool clarified in written comments that separate product classes should not be added for multi-door refrigerators (Whirlpool, No. 31 at p. 1).

DOE's proposal to separate all-refrigerators from the product classes that currently include all-refrigerators, refrigerator-freezers, and basic refrigerators is based on the performance afforded by the freezer compartments of refrigerator-freezers and basic refrigerators. All-refrigerators were not explicitly mentioned when the 1990 energy standard was established. 54 FR 6062, 6077 (February 7, 1989). Product class 1 includes all-refrigerators with manual defrost, since "all-refrigerator" is a sub-category of "refrigerator." That final rule did not explicitly recognize the existence of all-refrigerators with automatic defrost. (*Id.*) These products were subsequently added to product class 3 starting with the 1993 standard. 54 FR 47916 (November 17, 1989). The NOPR for that final rule, made this change in response to comments received from Whirlpool and AHAM. 53 FR 48798, 48809 (December 2, 1988). When compact products were later separated from standard-size products with the 2001 standard, the compact all-refrigerators became part of product classes 11 (for manual defrost products) and 13 (for automatic defrost products). 62 FR 23102 (April 28, 1997).

Under the proposed test procedures that underpin today's proposed levels, the energy use characteristics of all-refrigerators will not be consistent with the refrigerator-freezers and basic refrigerators of the same current product classes. Specifically, the measured energy use of all-refrigerators is expected to decrease under the proposed new test procedures, while the measured energy use of refrigerator-freezers and basic refrigerators is expected to increase significantly (See the preliminary TSD chapter 5, Engineering Analysis, section 5.4.2.1). Since the freezer compartments of refrigerator-freezers and basic refrigerators provide a different level of consumer utility than all-refrigerators, and because the product differences also contribute to different efficiency characteristics, DOE tentatively believes that separating these product classes is justified under EPCA. *See* 42 U.S.C. 6295(q).

With respect to the treatment of those products equipped with off-cycle defrost, DOE sought comment on whether stakeholders agree with the agency's interpretation that this feature is a form of automatic defrost and whether the proposed product class 1A (all-refrigerators with manual defrost) is needed. In products with off-cycle defrost, the evaporator warms above freezing temperature when the compressor turns off, thus allowing the frost to melt. Such defrost systems are used only in all-refrigerators or fresh food compartments of refrigerator-freezers, because the compartment temperature must be above 32 °F for the evaporator to warm above freezing. The proposed product class 1A includes standard-size all-refrigerators with manual defrost. If off-cycle defrost is treated as automatic defrost rather than manual defrost, product class 1A would consist primarily of refrigerators with roll-bond evaporators enclosing freezer compartments with a size of less than 0.5 cubic foot. During the preliminary analysis discussion, DOE was unaware of whether standard-size products with such small freezer compartments exist and requested comment on these issues for this reason.

AHAM commented during the public meeting that it considers off-cycle defrost to be automatic defrost, but that it was not aware of any all-refrigerator products with manual defrost (AHAM, Public Meeting Transcript, No. 28 at p. 40) However, Sanyo E&E Corporation (Sanyo) indicated in written comments that it manufacturers such products (Sanyo, No. 32 at p. 3) Based on this information, DOE proposes that product class 1A be established in addition to the other all-refrigerator product classes.

ASAP urged DOE to avoid introducing too many product classes, and that streamlining product classes has been shown to reduce overall energy consumption. (ASAP, Public Meeting Transcript, No. 28 at p. 41) DOE believes that each of its proposed product classes is needed to ensure that meaningful efficiency levels will be established for each of these products. Because the measured energy use of products with freezer compartments larger than 0.5 cubic foot is expected to increase roughly 15 percent under the proposed new test procedure and the energy use of all-refrigerators is expected to decrease roughly 3 percent (see chapter 5, Engineering Analysis, of the preliminary TSD, section 5.4.2.1), the energy use characteristics of the former group of products will determine the new standards for these product classes. The proposed test procedure would be more representative of field energy use differences of these product classes and would show higher energy use for basic refrigerators and refrigerator-freezers than all-refrigerators. Accordingly, by DOE's estimates, the potential energy savings associated with all-refrigerators resulting from the new energy standard would be roughly 18 percent less if DOE retains the current product class structure than they would be if DOE establishes separate all-refrigerator product classes.

d. Products With Automatic Icemakers

The test procedure proposed to apply to refrigeration products covered under the proposed new energy conservation standards incorporates energy use associated with automatic icemaking. 75 FR 29846 (May 27, 2010). DOE considers an automatic icemaker to be a feature that provides unique consumer utility. Products equipped with an automatic icemaker would have energy characteristics that are distinct from those without one because the energy use measured under the proposed test procedure depends on the presence of an automatic icemaker. Therefore, DOE tentatively concludes that establishing product class distinctions based on the presence of an automatic icemaker is justified. (*See* 42 U.S.C. 6295(q).)

Some of the existing product classes denote products that inherently have automatic icemakers. These include product classes 6 (refrigerator-freezers—automatic defrost with top-mounted freezer with through-the-door ice service) and 7 (refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service). However, some of the other product classes denote products that may or may not include automatic icemakers. For these products, DOE proposes to establish new product classes, as indicated in Table IV.1, above. These proposed new product classes include conventional (free-standing) and built-in classes of refrigerator-freezers with automatic defrost. Built-in product classes are discussed further in section IV.A.2.e below.

DOE requests comments on its proposal to establish product classes for products with automatic icemakers, including DOE's proposed approach to account for icemakers in the product class structure. See Issue 3 under "Issues on Which DOE Seeks Comment" in section VII.E of this NOPR. The classes and levels that DOE ultimately adopts may be adjusted from the proposal based on the comments an information DOE receives and gathers.

e. Built-In Products

DOE received several comments on the possible establishment of separate product classes for built-in refrigeration products. Sub Zero supported establishing separate product classes, citing (i) inherent design differences between built-in and free-standing products that make attaining higher efficiency levels more difficult for built-ins (the efficiency level difference was quantified as about 15 percent), (ii) limited design options for improving built-in unit efficiency, (iii) the unique utility of these products, not offered by conventional units, which, in Sub Zero's view, satisfies the criteria under EPCA to justify creating a new product class, and (iv) the precedent set in the previous refrigeration product rulemaking, where separate product classes were established for compact refrigerators. (Sub Zero, Public Meeting Transcript, No. 28 at pp. 101–04; Sub Zero, No. 40 at pp. 5–7) In Sub Zero's view, the unique consumer utility offered by built-ins is their ability to fit seamlessly into the surrounding kitchen cabinetry. (Sub-Zero, No. 40 at p. 6) Sub Zero also commented that built-ins have numerous differences when compared to their free-standing counterparts. Typically, built-in units have more doors and drawers than other products, and may also have glass doors and several different temperature compartments. (*Id.*) Sub Zero supported these statements with additional comments and concluded that DOE's decision on whether to create product classes for built-in units is pivotal to Sub Zero's ability to compete in the market. (Sub Zero, Public Meeting Transcript, No. 28 at p. 104; Sub Zero, No. 40 at p. 7)

AHAM, Whirlpool, and Sanyo all submitted comments supporting Sub Zero's request for separate product classes for built-in units. (AHAM, Public Meeting Transcript, No. 28 at pp. 104–05; AHAM, No. 34 at p. 8; Whirlpool, No. 31 at p. 4; and Sanyo, No. 32 at p. 2) AHAM supported Sub Zero's statement that built-in products provide an important utility to a subset of refrigeration product consumers. (AHAM, No. 34 at p. 8) Whirlpool agreed that the characteristics of built-in units are sufficiently different from free-standing models, and noted that built-ins have significantly different cost requirements to reach higher efficiencies. (Whirlpool, No. 31 at p. 4) Sanyo stated that the design issues affecting standard-sized built-in models affect compact built-ins as well. (Sanyo, No. 32 at p. 2)

To address the built-in issue, AHAM suggested a definition for built-in products:

Refrigerators, freezers and refrigerators with freezer units that are 7.75 cubic feet or greater; are totally encased by cabinetry or panels by either accepting a custom front panel or being equipped with an integral factory-finished face; are intended to be securely fastened to adjacent cabinetry, walls or floor; has sides which are not fully finished and are not intended to be visible after installation.

(AHAM, No. 34 at p. 8)

Despite these comments in favor of establishing a separate built-in class, DOE also received a number of comments opposing this approach. In their joint comments, ACEEE and ASAP voiced concern that lower standards for built-in products would lead to a consumer shift toward the built-in segment, thereby reducing the projected energy savings from the standard. (ACEEE/ASAP, No. 43 at p. 5) IOU agreed with the ACEEE/ASAP concern regarding an increasing built-in market share and noted that the incremental cost and associated price increase that manufacturers would incur to design built-in products that would satisfy the same level of efficiency as their free-standing counterparts is likely to be small when compared to the final retail price. Additionally, IOU, along with Earthjustice and NRDC, indicated that built-in products provide essentially the same amenity and service as free-standing products, and do not warrant separate product classes on the basis of offering a unique customer utility. (IOU, No. 36 at p. 11; Earthjustice, No. 35 at pp. 1–5; NRDC, No. 39 at p. 2)

Requirements for consideration of separate product classes are addressed in 42 U.S.C. 6295(q). That section provides that when creating a separate class of products, certain criteria must be met:

(q) Special rule for certain types or classes of products.

(1) A rule prescribing an energy conservation standard for a type (or class) of covered products shall specify a level of energy use or efficiency higher or lower than that which applies (or would apply) for such type (or class) for any group of covered products which have the same function or intended use, if the Secretary determines that covered 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 from that which applies (or will apply) to other products within such type (or class).

In making a determination under this paragraph concerning whether a performance-related feature justifies the establishment of a higher or lower standard, the Secretary shall consider such factors as the utility to the consumer of such a feature, and such other factors as the Secretary deems appropriate.

(2) Any rule prescribing a higher or lower level of energy use or efficiency under paragraph (1) shall include an explanation of the basis on which such higher or lower level was established.

(42 U.S.C. 6295(q))

Based on the available facts currently before DOE, built-in products appear to provide unique consumer utility by enabling consumers to build these products seamlessly into their kitchen cabinetry. These products are designed with standard dimensions to fit standard cabinet sizes, including a shallow depth of 24 inches. As Sub-Zero pointed out, many of the design differences that permit this capability also have an impact on energy use. DOE's analysis confirms the increased difficulty these products have as compared with freestanding units in achieving further reductions in energy use. This information is presented in detail in the NOPR TSD, and some of the information is summarized below in this section.

However, the use of glass doors or additional doors and drawers do not appear to be unique to built-in products. DOE's Web site research of the product offerings of four built-in manufacturers (Sub Zero, GE Monogram, Kitchenaid, and Viking, Web sites accessed June 3, 2010) showed that most built-in products do not have these features ("Online Research on Built-in Refrigeration Features", No. 51). Table IV.2 shows the results of a review of built-in products on the Web sites of these four major manufacturers of built-in refrigeration products. A very limited number of the available products (13 out of 116) had these special features. Additionally, DOE's review of product offerings of conventional free-standing products shows that many product offerings have French doors or multiple drawers. Because these features are neither exclusive to built-ins nor shared by a vast majority of built-ins, DOE does not consider these features to be particularly relevant to the consideration of the consumer utility provided by built-in products.

TABLE IV.2—BUILT-IN PRODUCT SPECIAL FEATURES

Glass window	One extra drawer	French doors	One extra door and three extra drawers	Number of products
X	....	....	....	3
X	....	....	X	1
	X	....	....	6
		X	....	2
			X	1
No special features				103
Total number of products				116

Note: Based on products on the Web sites of four key manufacturers of built-in refrigeration products.

As noted above, in addition to providing special consumer utility, EPCA requires that the consumer utility offered by the product form the basis for the different efficiency characteristics that would merit the creation of a separate product class. Sub Zero's comments to DOE have enumerated the design differences associated with the utility provided by built-in products that affect their energy efficiency, including the following:

1. Built-ins are typically constrained by kitchen cabinetry, which can increase the exterior surface area and the door perimeter length per interior volume, and also limit manufacturers' ability to increase wall thickness for built-in products more so than for conventional products because depth increase is limited by the standard cabinetry depth.

2. Built-ins have more complex hinge motion to avoid adjacent cabinets, which increases the size of the hinge hardware embedded in the cabinet walls, thus increasing thermal loss.

3. Air flow is more restricted for built-ins, since the installation imposes more limits on access for air movement. Condenser air flow is often in and out of the front of the condenser area, thus reducing condenser air flow rate.

(Sub-Zero, No. 40 at p. 6)

In addition, some built-in products use hot gas rather than warm liquid anti-sweat heating loops. Nearly all conventional free-standing products with refrigerant anti-sweat loop use warm liquid. Warm liquid loops use refrigerant liquid that has left the condenser to warm the surfaces in question, while hot gas loops use hot gas that has not yet entered the condenser. Because the hot gas refrigerant is at a higher temperature than the warm liquid used in a warm liquid loop, it can transfer significantly more heat to the heated surface and, in turn, to the cabinet interior. Hot gas loops are sometimes used in built-ins because the paneling mounted on the doors blocks the door frame surfaces from being warmed by ambient air, which more readily leads to condensation during field use (*i.e.,* in a customer's home). This design can increase cabinet load, resulting in a higher measured energy use.[19]

DOE analyzed four built-in products for the NOPR to determine whether their efficiency characteristics differ significantly from those of conventional free-standing products. These four products represent four key product classes for built-in products, all of standard (not compact) size: All-refrigerator—automatic defrost (proposed product class 3A), refrigerator-freezers—automatic defrost with bottom-mounted freezer without through-the-door ice service (product class 5), refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service (product class 7), and upright freezers with automatic defrost (product class 9). DOE compared the results of these analyses with those conducted for conventional (free-standing) products for product classes 3 (refrigerator-freezer—automatic defrost with top-mounted freezer without through-the-door ice service), 5, 7, and 9.

Product class 3 under the current standard includes both all-refrigerator—automatic defrost and refrigerator-freezer—automatic defrost with top-mounted freezer without through-the-door ice service. Because there are very few shipments of built-in top-mount refrigerators, and all-refrigerators are a minority product for the free-standing market, DOE compared a conventional top-mount refrigerator with the built-in all-refrigerator.

DOE analyzed two conventional products of each examined product class. The max-tech levels for the analyzed built-ins and conventional products are compared in Table IV.3. The max-tech levels for the built-in

[19] Cabinet load refers to the thermal load (heat) entering the cabinet. The refrigeration system must remove this load from the cabinet to maintain compartment temperatures, and it expends energy in doing so.

products are significantly lower than those for the conventional products, by roughly 10 percent for the refrigerator-freezers (product classes 5 and 7) and 15 percent for the upright freezers (product class 9). The difference is greater for upright freezers because DOE considered wall thickness increases appropriate for conventional upright freezers but not for built-in upright freezers, due to the limited-space kitchen installation typical for built-in upright freezers.

TABLE IV.3—MAX-TECH DIFFERENCES BETWEEN BUILT-IN AND CONVENTIONAL PRODUCTS

Product class	Built-in: 3A conventional: 3	5 (see Note 1)	7	9
Design Options	• Larger Heat Exchangers • BLDC Fan Motors • VIPs (see Note 2) • Variable-Speed Compressors. • Adaptive Defrost	• Larger Heat Exchangers • BLDC Fan Motors • VIPs (see Note 2) • Variable-Speed Compressors. • Adaptive Defrost • Variable Anti-Sweat Heater Control (see Note 4).	• Larger Heat Exchangers.. • BLDC Fan Motors. • VIPs (see Note 2). • Variable-Speed Compressors.. • Adaptive Defrost. • Variable Anti-Sweat Heater Control for Ice Dispenser.	• Larger Heat Exchangers • BLDC Fan Motors • VIPs (see Note 2) • Variable-Speed Compressors • Adaptive Defrost • Forced Convection Condenser (see Note 5). • Wall Thickness Increase (see Note 6).
Percentage energy use lower than a baseline-efficiency product				
Built-In Max Tech	29%	27%	22%	27%
Conventional Max Tech	36%	36%	33%	44%

Notes:
1. Percentage reduction is from reference standard curve with increased slope for product class 5.
2. VIPs applied fully to doors and to half of cabinet.
3. Many of the design options such as BLDC fan motors and adaptive defrost are already present in baseline-efficiency built-in products.
4. Variable Anti-Sweat Heater control was not considered for the built-in products of product class 5, since French doors are not common for product class 5 built-ins.
5. Forced convection condenser already present in the baseline built-in upright freezer.
6. Wall thickness increase considered only for the conventional upright freezer, since the built-in upright freezer is designed primarily for installation in a kitchen, where limitations to product growth apply.

Information provided by built-in unit manufacturers during the NOPR Manufacturer Impact Analysis (MIA) discussions is generally consistent with the design differences between built-in and conventional products shown in the detailed analysis described above. For example, achieving the ENERGY STAR efficiency level for built-in standard-size refrigerator-freezers generally requires use of variable-speed compressors, VIPs, or both. In contrast, conventional standard-size refrigerator-freezers generally achieve this efficiency level without use of either of these design options. This situation leaves fewer options available for further efficiency improvements for built-in products. Accordingly, based on this information, there do not appear to be additional design options currently available to enable manufacturers to produce built-ins to an efficiency level matching their free-standing counterparts.

Moreover, the unique consumer utility offered by built-in products is demonstrated in part by the higher costs some customers are willing to pay to obtain this utility. While cost difference alone is generally not considered to be basis for consumer utility, the significantly higher price paid by consumers for built-in products can be considered an indicator that consumers value the utility associated with the built-in design. The cost difference between built-in and conventional products is presented in Table IV.4 for product classes 4 (refrigerator-freezers—automatic defrost with side-mounted freezer without through-the-door ice service), 5, 7, and 9. This comparison is based on proprietary retail price data collected by The NPD Group, which includes retail purchase price information for millions of purchases of refrigeration products. The comparison between the built-in and conventional product types is based on separate consideration of brands that include only built-in products and brands that include only conventional products. Brands that include both built-in and conventional products (*e.g.,* KitchenAid) are not represented in the table because the NPD Group dataset does not clearly distinguish built-in status in the data of such brands. The data show that built-in product average prices are approximately $3,500 to $6,200 higher than those of conventional products.

TABLE IV.4—BUILT-IN PRODUCT COST COMPARED WITH CONVENTIONAL PRODUCTS

	Product class 4	Product class 5	Product class 7	Product class 9
Built-In Median	$6,214	$5,190	$6,637	$3,181
Average	7,017	4,983	7,213	4,062
Std. Deviation	1,990	817	1,018	1,023
Conventional Median	1,073	797	1,019	509
Average	2,220	852	1,048	520
Std. Deviation	1,333	239	485	209

Source: NPD, 2007–2008.

DOE notes that retail price differences alone do not form the basis for consumer utility. In the commercial clothes washer (CCW) rulemaking, Alliance Laundry Systems (Alliance) asserted that the ability to load a clothes washer from the top is a "feature" within the meaning of 42 U.S.C. 6295 because it provides consumers the opportunity to purchase lower cost CCWs. 75 FR 1122, 1130 (January 8, 2010). DOE disagreed and noted that while price is an important consideration to consumers, DOE accounts for these consumer impacts in its LCC and PBP analyses. 75 FR 1134.

In the case of built-in refrigeration products, the facts suggest that the higher price paid for a built-in unit reflects the view of consumers that these products have a special utility when compared to free-standing equivalent products. As a result, unlike in the case of commercial clothes washers, where pricing itself was alleged to be a critical feature within the meaning of EPCA, pricing with respect to built-in products reflects the additional utility provided by these units. This price differential between built-in and stand-alone units indicates that consumers believe that built-in products offer a unique utility or other performance characteristic not offered by stand-alone units—in this case, that utility or performance would be the seamless integration of refrigeration products into kitchen cabinetry and the surrounding environment.

In summary, DOE tentatively concludes that built-in products provide consumer utility associated with the ability to build the products into the kitchen cabinetry, an attribute that is not provided by other products, and that the design details associated with this product characteristic result in the reduced efficiency of these products. DOE has tentatively concluded that these criteria satisfy 42 U.S.C. 6295(q) and is tentatively proposing the creation of a separate built-in product class.

DOE also proposes to adopt a modified version of the draft definition developed by AHAM for built-in products cited above, which would read as follows (changes from the AHAM draft are shown with italics for additions and bracketed text for deletions):

Built-In Refrigerator/Refrigerator-Freezer/Freezer means any refrigerator, refrigerator-freezer or freezer with 7.75 cubic feet or greater total volume *and 24 inches or less depth not including handles and not including custom front panels;* is *designed to be* [totally] encased *on the sides and rear* by cabinetry [or panels by either accepting a custom front panel or being equipped with an integral factor-finish face]; is *designed* [intended] to be securely fastened to adjacent cabinetry, walls or floor; and has sides which are not fully finished and are not designed to be visible after installation.

DOE considered AHAM's draft definition's exclusion of products with volumes less than 7.75 cubic feet. This limitation would exclude compact products, which are currently defined as having total volume less than 7.75 cubic feet and height less than 36 inches. (10 CFR 430.2). The draft definition would also exclude non-compact products that have volume less than 7.75 cubic feet (such products would exceed 36 inches in height). DOE proposes retaining the AHAM draft definition's omission of additional clarification regarding the 36-inch height limitation because DOE proposes to remove this limitation from the definition of compact products (see section IV.A.2.g, below). Sanyo suggested that DOE consider compact products as part of any built-in product classes that the agency establishes. (Sanyo, No. 32 at p. 2) However, DOE notes that special consideration for compact products was provided when the current energy standards were established in 1997. 62 FR 23102 (April 28, 1997). In particular, DOE created separate product classes with less stringent standards for all compact refrigeration products to address their particular characteristics. (*Id.*) As discussed in section IV.A.2.g, the arguments for creating separate product classes for compact products at that time emphasized the issues associated with undercounter products (essentially built-in compact products) rather than compact products in general. For this reason, in DOE's view, the relief sought by Sanyo for compact built-in products has already been provided and, under the available facts, no additional consideration appears to be merited at this time.

Further, DOE understands that undercounter products are generally sold with finished sides to permit both free-standing and undercounter use. As a result, these products would not meet the proposed built-in definition. DOE does not propose relaxing the requirement for unfinished sides to allow for the inclusion of undercounter products. DOE is declining to take this step to prevent potential gaming by manufacturers seeking to claim their conventional products as built-in units.

DOE also proposes to include a depth limitation in the definition for built-in products. The consumer utility and energy impacts associated with the depth limitation are highlighted in stakeholder comments (*see, e.g.,* Sub Zero, No. 40 at p. 6). Investigation of dimensional data for built-in products shows that nearly all of these products have a 24-inch depth. DOE requests comments on whether any adjustment of the 24-inch dimension specified in the proposed definition should be made. *See* Issue 4 under "Issues on Which DOE Seeks Comment" in section VII.E of this NOPR.

DOE does not propose to adopt the portion of AHAM's proposed built-in definition that addresses the front portion of the product—*i.e.,* "* * * by either accepting a custom front panel or being equipped with an integral factory-finished face * * *") DOE declines to adopt this aspect of AHAM's definition because it does not distinguish built-in products from conventional free-standing products, which generally have an integral factory-finished face.

DOE is aware of the potential that manufacturers may attempt to apply the proposed definition in order to avail themselves of the more lenient efficiency levels that DOE proposes to permit built-in units to meet. DOE tentatively believes that the modified definition presented above provides sufficient protection against such improper use of the definition. DOE requests comment on whether the proposed definition is adequate to prevent potential gaming or whether changes are needed to further strengthen it while avoiding disqualifying any legitimate built-in products. (*See* Issue 4 under "Issues on Which DOE Seeks Comment" in section VII.E of this NOPR.)

DOE's investigation of the built-in market through examination of built-in product offerings and discussion with manufacturers shows that the key standard-size built-in product classes include current product classes 4, 5, 7, 9, and the all-refrigerators associated with current product class 3. DOE proposes establishing seven new built-in product classes, as listed in Table IV.1, above. Two of these product classes address the need to separate products with automatic icemakers from those without automatic icemakers, as described in section IV.A.2.d above.

DOE requests comment on its proposal to establish separate product classes for built-in products. (*See* Issue 4 under "Issues on Which DOE Seeks Comment" in section VII.E of this NOPR.) As with all other aspects of this proposal, DOE may adjust its treatment of built-in products depending on the comments and information it receives in response to the NOPR.

DOE also requests comment on whether any additional product classes are required to fully address icemaking and built-in products. (*See* Issue 5 under "Issues on Which DOE Seeks Comment" in section VII.E of this NOPR.)

f. Combining Product Classes 2 With 1, and 12 With 11

In the preliminary analysis phase, DOE proposed combining product class 2 (refrigerator-freezers—partial automatic defrost) with product class 1 (refrigerators and refrigerator-freezers with manual defrost); and product class 12 (compact refrigerator-freezers—partial automatic defrost), with product class 11 (refrigerators and refrigerator-freezers with manual defrost). DOE noted that units in product classes 2 and 12 contain freezer compartments that undergo manual defrost and fresh food compartments that undergo off-cycle defrost, a process which does not require additional energy to defrost. Hence, the defrost energy consumption for these units is expected to be the same as it would be for an identical unit in either product class 1 or 11.

Additionally, DOE noted that shipments for product classes 1 and 2 are very low (representing roughly 0.1 percent of shipments), and the energy consumption standards for those product classes are identical. The shipments for product class 12 are also very low (representing less than 0.1 percent of shipments).

Finally, DOE noted that although the energy consumption standard for product class 12 is currently at a higher energy level than for product class 11, there is no obvious technical basis for this distinction. AHAM supported DOE's proposal to combine these pairs of product classes into two classes (AHAM, Public Meeting Transcript, No. 28 at p. 40 and No. 34 at p. 4) The Joint Comments that DOE received, to which AHAM was a signatory, suggested that DOE continue to maintain these separate classes.

DOE requests comment on whether these proposed combinations (combining product class 2 with product class 1 and combining product class 12 with product class 11) should be adopted. DOE notes that the Joint Comments suggested maintaining the current separation.[20] (See Issue 6 under "Issues on Which DOE Seeks Comment" in section VII.E of this NOPR.) This approach may be adjusted based on comments and information submitted in response to today's NOPR.

g. Modification of the Definition for Compact Products

Sanyo suggested in its comments that DOE remove the current 36 inch height limit for compact products. Sanyo stated that this requirement qualifies some Sanyo products as standard-size units even though they meet the volume provision under the compact unit definition. The energy consumption standards for standard-size products are more stringent than the standards for compact products. Sanyo believes that energy consumption is strongly correlated with volume, and only minimally correlated with height. (Sanyo, No. 32 at p. 2)

DOE recognizes that a relationship between energy consumption and internal volume exists. DOE notes that the compact product classes were created as part of the rulemaking establishing the 2001 energy standards. As DOE explained in a July 1995 NOPR, these classes were created because fewer design options exist for reducing the energy consumption in these products. 60 FR 37388, 37396 (July 20, 1995). The July 1995 NOPR discussed this 36-inch limitation within the context of insulation thickness and noted that issues related to the increase in insulation thickness in top and bottom panels "is recognized in the new definition of the compact class as limited to models below 36 inches in height." 60 FR 37397. U–Line comments summarized in the 1995 NOPR indicated that "consumer uses of undercounter refrigerators and freezers will not permit increased exterior cabinet dimensions; exterior cabinet dimensions cannot exceed 24 inches in depth and width and 34 inches in height." (*Id.*)

However, the majority of compact products are not undercounter products with these specified dimensions. For example, the external dimensions of the compact products examined for reverse engineering during the engineering analysis, are summarized in Table IV.5.[21] Some of these products are smaller than the undercounter maximum dimensions and some are larger. If smaller, increasing the height of these products to a 34-inch height and/or 24-inch depth or width would be possible. If larger, the product would not be used in the restricted undercounter application. The chest freezers would not be used in undercounter applications in any case because such installation would interfere with door operation, since the doors of chest freezer open upwards. As a result, DOE believes that the absolute restriction on external size increase suggested by the undercounter dimension limits (*i.e.,* 24 inches and 34 inches) does not apply to these products. Hence, DOE tentatively concludes that, while the 36-inch height limitation may be relevant for undercounter products, it is not relevant for compact products in general.

TABLE IV.5—EXTERNAL DIMENSIONS OF COMPACT REVERSE-ENGINEERED PRODUCTS

Product	Height (inches)	Width (inches)	Depth (inches) [1]
1.7 cubic foot refrigerator	18.5	17.5	17.6
4 cubic foot refrigerator	32.9	18.6	17.5
4 cubic foot ENERGY STAR refrigerator	33.0	19.5	19.8
3.4 cubic foot chest freezer	32.0	21.0	23.0
7 cubic foot chest freezer	31.5	36.5	20.4
Second 7 cubic foot chest freezer	31.0	37.0	23.0

[1] Depth does not include door handle and condenser (if applicable).

Basic thermal considerations also suggest that the 36-inch limitation is not a particularly reliable indicator of the potential for energy use reduction. For example, consider two 7-cubic foot volume products, one 40 inches high and the other 30 inches high, both with a depth of 20 inches. Assuming a 1.5-inch insulation thickness and ignoring the volume associated with the evaporator, the 40-inch product would have an insulated surface area of 28

[20] DOE Docket No. EERE–2008–BT–STD–0012, Comment 49.

[21] Throughout this notice the term "reverse-engineered product" refers to the products purchased and examined (reverse engineered) as part of the engineering analysis. Many of these products were entirely dismantled (torn down) to completely examine manufacturing details.

square feet (based on external dimensions) and door gasket perimeter length of 121 inches, while the 30-inch product would have both less surface area (27 square feet) and less door gasket perimeter length (114 inches). DOE expects that the taller product would have a greater thermal load as a result (because of the greater surface area and door perimeter length), yet it would not be considered a compact product under the current definition and would, thus, have to satisfy a more stringent energy standard. This example shows that basic theoretical considerations do not support the 36-inch limitation.

Because the justification of limited undercounter space that led to the 36-inch limitation does not apply to most compact products, and because basic thermal considerations suggest that the limitation does not have a firm theoretical basis, DOE proposes to eliminate the limitation from the definition of compact products. DOE requests comment on its proposal to eliminate the 36-inch height limitation for compact products. (*See* Issue 7 under "Issues on Which DOE Seeks Comment" in section VII.E of this NOPR.)

B. Screening Analysis

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 commercially available 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 commercially available products could be achieved on the scale necessary to serve the relevant market at the time the standard comes into effect, DOE would consider that technology practicable to manufacture, install, and service.

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

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

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

In the framework document [22] and accompanying public workshop held on September 29, 2008, DOE identified the technologies for improving refrigeration product efficiency that were under consideration for the rulemaking analyses. These technologies are listed in Table IV.6. *Please see* chapter 3 of the NOPR TSD for detailed descriptions of these technology options.

TABLE IV.6—TECHNOLOGIES DOE CONSIDERED FOR RESIDENTIAL REFRIGERATION PRODUCTS

Insulation:	Expansion Valve:
Improved resistivity of insulation	Improved expansion valves
Increased insulation thickness	Cycling Losses:
VIPs	Fluid control or solenoid valve
Gas-filled panels	Defrost System:
Gasket and Door Design:	Reduced energy for automatic defrost
Improved gaskets	Adaptive defrost
Double door gaskets	Condenser hot gas
Improved door face frame	Control System:
Reduced heat load for TTD feature	Temperature control
Anti-Sweat Heater:	Air-distribution control
Condenser hot gas	Other Technologies:
Electric heater sizing	Alternative refrigerants
Electric heater controls	Component location
Compressor:	Alternative Refrigeration Cycles:
Improved compressor efficiency	Lorenz-Meutzner cycle
Variable-speed compressors	Dual-loop system
Linear compressors	Two-stage system
Evaporator:	Control valve system
Increased surface area	Ejector refrigerator
Improved heat exchange	Tandem system
Condenser:	Alternative Refrigeration Systems:
Increased surface area	Stirling cycle
Improved heat exchange	Thermoelectric
Force convection condenser	Thermoacoustic
Fans and Fan Motor:	
Evaporator fan and fan motor improvements	
Condenser fan and fan motor improvements	

DOE requested, but did not receive any comments, at either the framework workshop or during the framework comment period identifying additional technologies not mentioned that should be considered. Likewise, DOE received no comments recommending additional technologies during the preliminary analysis public meeting or comment period.

As described in chapter 4, Screening Analysis of the NOPR TSD, DOE screened out several of the technologies listed in Table IV.6 from consideration in this rulemaking based on one or more

[22] Available at: *http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/refrigerator_freezer_framework.pdf.*

of the screening criteria described above. A summary of the screening analysis identifying technologies that were screened out and the EPCA criteria used for the screening is presented in Table IV.7. The checkmarks in the table indicate which screening criteria were used to screen out the listed technologies. For greater detail regarding the screening analysis, *see* chapter 4 of the NOPR TSD.

TABLE IV.7—SUMMARY OF SCREENING ANALYSIS

Excluded technology option	EPCA criteria for screening			
	Techno-logical feasibility	Practicability to manufacture, install, and service	Adverse impacts on product utility	Adverse impacts on health and safety
Improved Insulation Resistivity	√			
Gas-Filled Panels	....	√	√	
Improved Gaskets, Double Gaskets, Improved Door Frame	....	√	√	
Linear Compressors	√			
Improved Evaporator Heat Exchange	√	....	√	
Improved Condenser Heat Exchange	√	....	√	
Component Location	....	√	√	√
Lorenz-Meutzner Cycle	√	√		
Two-Stage System	√	√		
Control Valve System and Tandem System	√	√		
Ejector Refrigerator	√	√		
Stirling Cycle	√	√		
Thermoelectric	√	√		
Thermoacoustic	√	√		

In addition to this screening, DOE did not analyze a number of technologies in the engineering analysis because they were judged unsuitable for improving the measured energy use of refrigeration products for one or more of the following reasons:

• Technology already used in baseline products and incapable of generating additional energy efficiency or reducing energy consumption.

• Technology does not reduce energy use.

• Insufficient data available demonstrating benefit of the technology.

The technologies not analyzed for these reasons include Improved Expansion Valve, Off-Cycle Valve, Reduced Energy for Automatic Defrost, Condenser Hot Gas Defrost, Reduced Heat Load for TTD Feature, Warm Liquid or Hot Gas Refrigerant Anti-Sweat Heating, Electric Anti-Sweat Heater Sizing, Electronic Temperature Control, Air Distribution Control, Fan Blade Improvements, and Dual Loop System. Chapter 4 of the NOPR TSD discusses the reasons for not analyzing these technologies in greater detail.

1. Discussion of Comments

AHAM commented that efficiency levels based on noteworthy technologies can have implications on competition within the market, since technologies may be proprietary or in limited supply (AHAM, No. 34 at p. 15) AHAM specifically pointed out VIPs as an example of such a technology. (*Id.*) Neither EPCA nor the CFR (*i.e.,* 10 CFR part 430, subpart C, appendix A) identify the proprietary status of a technology as a reason for screening out technologies. If a technology is in sufficiently limited supply to make its use in manufacturing of products impractical, DOE has the option of screening out such a technology based on one of the EPCA screening criteria. While proprietary status is not a filter for screening out potential technologies, DOE is required to consider "the impact of any lessening of competition * * * that is likely to result from the imposition of the standard" (42 U.S.C. 6295(o)(2)(B)(i)(V)). Section IV.B.1.c below, discusses VIPs. DOE considered whether any others selected design options may be screened out based on supply constraints or whether their use might impact competition. DOE tentatively concluded that these screening criteria did not preclude further consideration of the selected design options in the analysis.

During the NOPR phase manufacturer interviews, some manufacturers expressed concerns that the supply of the highest-efficiency compressors and/or variable-speed compressors might be limited. Initial investigation of the compressor vendors supplying high-efficiency compressors and variable speed compressors during the preliminary analysis phase indicated that one compressor supplier, Embraco, served as the primary source for these components. Embraco is a business unit of Whirlpool S/A, a majority-owned subsidiary of the Whirlpool Corporation. Discussions with compressor manufacturers during the NOPR phase of the rulemaking indicated that most manufacturers are planning to commercialize high-efficiency compressors that would match the peak performance under consideration in the NOPR analysis and that these compressors would be available well before the arrival of the 2014 compliance date that would apply to the final rule under development. In addition, DOE is aware that these other manufacturers have been developing and perfecting variable-speed compressors for over ten years. Information gathered during the NOPR phase indicates that these manufacturers are prepared to commercialize this technology and ramp up production as the market for such compressors emerges and grows.

Based on all of this information, DOE tentatively concludes that neither high-efficiency compressors nor variable-speed compressors would be in limited supply if the efficiency levels selected by DOE were to require the use of these types of compressors. DOE requests comment on these findings, including information that would confirm or cast doubt on DOE's conclusions regarding compressor supply. (*See* Issue 8 under "Issues on Which DOE Seeks Comment" in section VII.E of this NOPR.)

DOE's review of the screened-in technologies did not reveal that they would involve the use of proprietary technologies or that they would be in short supply, or that their use would lead to a lessening of competition.

Additionally, DOE received comments on the screening analysis from several interested parties primarily addressing the following design options: alternative refrigerants, alternative foam-blowing agents, and VIPs. The following sections describe the comments associated with these design options in detail.

a. Alternative Refrigerants

Most refrigeration products sold in the U.S. currently use HFC–134a refrigerant, a hydrofluorocarbon (HFC) with a high global warming potential (GWP).

ACEEE, ASAP, Earthjustice, and the Natural Resources Defense Council (NRDC) all stated that DOE must consider hydrocarbon refrigerants as a design option because hydrocarbons are in widespread use overseas (ACEEE/ASAP, No. 43 at pp. 4–5; Earthjustice, No. 35 at p. 5; NRDC, No. 39 at p. 7) Earthjustice and NRDC both also claimed that DOE has not provided evidence to support the exclusion of isobutane [23] as an alternative refrigerant. (Earthjustice, No. 35 at p. 5; NRDC, No. 39 at p. 7) AHAM commented that the relevant safety standard—Underwriters Laboratories (UL) Standard 250, "Household Refrigerators and Freezers" (UL 250) [24]—currently limits the quantity of hydrocarbon refrigerants permitted to be used in refrigeration products to 50 grams.[25] AHAM suggested that this quantity of refrigerant is insufficient for most typical refrigeration products and that UL had recently reopened the rulemaking process for UL 250 under a proposal calling for a higher hydrocarbon limit. (AHAM, Public Meeting Transcript, No. 28 at p. 49–50) GE stated that although the UL restriction may make it difficult to use isobutane, it does not make it impossible, and that UL may consider increasing the limit. (GE, Public Meeting Transcript, No. 28 at p. 50) Sub Zero agreed with GE's comment but pointed out that there can be a significant capital expenditure associated with adopting isobutane refrigerant or hydrocarbon blowing agents. (Sub Zero, Public Meeting Transcript, No. 28 at p. 50)

Many of the comments addressed issues with HFCs used both as refrigerant and as a blowing agent. These comments are presented in this section, but they apply equally to section IV.B.1.b, below, which addresses blowing agents.

Many stakeholders noted the trend away from HFC use both worldwide and in the United States. The stakeholders commented that DOE's analysis should more thoroughly consider this trend in order to avoid becoming immediately outdated, and that DOE should develop cost-efficiency analyses that account for a mandated phase-down of HFC substances. (GE, Public Meeting Transcript, No. 28 at pp. 47–48; AHAM, Public Meeting Transcript, No. 28 at p. 18; Greenpeace, Public Meeting Transcript, No. 28 at pp. 50–51; ACEEE/ASAP, No. 43 at p. 5; Sub-Zero, No. 40 at p. 7; Greenpeace, No. 42 at pp. 1, 2; GE, No. 37 at p. 2; NRDC, No. 39 at p. 7; Whirlpool, No. 31 at pp. 4, 5; AHAM, No. 34 at pp. 8–9)

AHAM commented that upcoming regulations and legislation on the phase-down of HFCs could have a substantial impact on efficiency in the refrigeration products industry (AHAM, Public Meeting Transcript, No. 28 at p. 18) AHAM, Whirlpool, and Sub Zero further stated that they believe a phase-down of HFCs would have a net negative impact on energy efficiency and manufacturing cost (AHAM, No. 34 at pp. 8–9; Sub Zero, No. 40 at p. 7; Whirlpool, No. 31 at pp. 4–5) AHAM and Whirlpool also argued that any analysis that does not account for an HFC phase-down would likely result in energy consumption standards that are unattainable (AHAM, No. 34 at p. 9; Whirlpool, No. 31 at pp. 4–5)

GE suggested that DOE consider the positions of the current administration and the Environmental Protection Agency (EPA) on HFCs and other macro trends that GE asserts will significantly impact the industry. (GE, Public Meeting Transcript, No. 28 at pp. 47–48) For this rulemaking, GE commented that it is important for DOE to evaluate the potential industry impact of the HFC phase-down from a technical and economic perspective to avoid creating a disincentive for manufacturers to employ low-GWP foams and refrigerants. GE commented that DOE should recognize the potential environmental benefits that could be realized in a transition to low-GWP foams and refrigerants. (GE, No. 37 at p. 2)

Comments from the IOUs supported DOE's use of HFCs in the baseline analysis but encouraged consideration of discontinued or reduced use of HFCs in case legislation is enacted or regulations established limiting their use (IOU, No. 36 at p. 12) Whirlpool stated that it would not switch to non-GWP substances, because of the costs associated with doing so, unless this is required by legislation (Whirlpool, No. 31 at p. 5)

DOE eliminated alternative refrigerants as a design option for most product classes because the available alternatives are either banned, have lower thermodynamic efficiencies, or, as in the case of hydrocarbons, are currently only allowed in limited quantities due to UL safety requirements. The UL proposal for modification of UL 250 calls for transition from an allowance of 50 g refrigerant being permitted to escape from a refrigeration product in case of a leak to a higher limit of 60 g total charge.[26] This proposed change would not significantly affect the amount of refrigerant that can be used because roughly 10 g remains absorbed in the compressor oil during a typical catastrophic leak. DOE notes that UL had not made a final determination regarding changes to UL 250 at the time of the preparation of this notice. UL has indicated that due to the large number of comments to the proposals, UL's next step would be to convene a Standards Technical Panel meeting, which would likely be held no earlier than September 2010.[26]

DOE also considered EPA's recently published proposed rule addressing hydrocarbon refrigerants, which includes a proposal to include isobutane on the EPA's Significant New Alternatives Policy (SNAP) program list of allowed alternative refrigerants. 75 FR 25799 (May 10, 2010). The EPA proposal calls for a total charge limit of 57 g of isobutane. *Id.* at 25803. No final rule had issued at the time of the preparation of this notice.

DOE calculated the potential range of isobutane charge levels that could replace the HFC–134a refrigerant in the products purchased for reverse engineering. DOE converted the actual charge of each reverse-engineered product to an equivalent isobutane charge (measured in grams), by adjusting for the lower density of isobutane. The equivalent isobutane charge levels for these products were in excess of both the EPA-proposed limit and the charge limit in the UL 250 standard for all of the products covered by today's NOPR except in the case of compact refrigerators. In order for a

[23] Isobutane, also known as R–600a, is used as a refrigerant in a large percentage of the world's refrigeration products, particularly in Europe, where it was first adopted in the 1990s.

[24] This UL safety standard sets numerous requirements for refrigeration products and details tests for evaluating compliance with many of the requirements.

[25] The isobutane limitation of UL 250 specifies 50 grams maximum leakage during a system breach. Because some of the refrigerant remains in the system in such a scenario, the total allowable charge is somewhat higher than 50 grams under this standard, generally in a range approaching 60 grams.

[26] Personal communication with Randall J. Haseman of Underwriters Laboratories, February 1, 2010 and June 28, 2010.

standard-size refrigerator-freezer to meet those charge levels, it would be necessary to make engineering changes such as adding a second refrigerant loop. Such a design change would reduce useful interior volume in the appliance, which represents a reduction in consumer utility. DOE is under general legal obligations to avoid promulgating standards that would either reduce the utility of a product, 42 U.S.C. 6295(o)(2)(B)(i)(IV) or eliminate those products with capacities and volumes available at the time that DOE establishes its standard, 42 U.S.C. 6295(o)(4). Therefore, DOE considered use of isobutane refrigerant as a design option only for compact refrigerators.

DOE requests comment on the consideration of conversion to use of isobutane refrigerant as a design option only for compact refrigerators. (See Issue 9 under "Issues on Which DOE Seeks Comment" in section VII.E of this NOPR.)

b. Alternative Foam-Blowing Agents

Blowing agents are included in the materials that are used to form insulation during the manufacturing process. The blowing agents help form the closed cell microstructure of the insulation as the blowing agent gases expand after the insulation components are injected into the wall cavities. Manufacturers selling refrigeration products in the U.S. market have predominantly used HFC blowing agents since 2003, which is when the EPA imposed a ban on the primary hydrochlorofluorocarbon (HCFC) blowing agent most manufacturers were using at the time. *See* 58 FR 65018 (December 10, 1993) (phasing out production of HCFC–141b through the accelerated phase out rule promulgated under section 606 of the Clean Air Act). In response, some manufacturers have started using cyclopentane as a blowing agent rather than HFCs because of its much lower GWP. However, insulation made using cyclopentane during the blowing process has higher conductivity (see for example the preliminary TSD chapter 3, Table 3.3.2), leading to higher energy use.

DOE received many comments encouraging DOE to consider the shift from HFCs to refrigerants and/or blowing agents with low GWP in refrigeration products. These comments are cited in section IV.B.1.a, above. None of the comments specifically indicated that use of alternative foam-blowing agents would reduce energy use. DOE has investigated this issue and has concluded that use of alternative foam-blowing agents would not reduce energy use (see chapter 3 of the NOPR TSD, section 3.3.2.1, for more detail). Hence, DOE did not treat alternative foam-blowing agents as a design option in its analyses.

DOE recognizes that possible legislation or regulations limiting the use of HFCs would have an impact on the industry's transition to higher efficiency designs and, depending on the performance impact of insulation made without HFCs, may reduce the potential for efficiency improvement. Given that this step has not occurred, DOE believes that basing energy conservation standards on the uncertain prospect of passage of certain legislation would be speculative. DOE is, however, prepared to address this issue by evaluating the efficiency improvement and trial standard levels for products using alternative foam insulation materials, if legislation or some other legal requirements banning HFCs should be enacted or otherwise become effective.

c. Vacuum-Insulated Panels

DOE received comments concerning the viability of VIPs as a design option. These comments, examined below, addressed the supply, longevity, durability, and cost of VIPs.

NPCC and ASAP emphasize that the standards are not prescriptive, and therefore manufacturers are not required to use VIPs to meet the standard even if the design options analysis has used VIPs (NPCC, No. 33 at p. 3; ASAP, Public Meeting Transcript, No. 28 at p. 96) DOE agrees with this statement, but without being able to show that alternative design paths can be used to reach certain efficiency levels without VIPs, the viability of this technology must be considered when contemplating these levels.

VIP Supply

AHAM, LG, Sub Zero, and Whirlpool expressed concern regarding the ability of VIP vendors to keep up with the demand that might be generated by more stringent energy conservation standards for refrigeration products (AHAM, Public Meeting Transcript, No. 28 at p. 94; Sub Zero, Public Meeting Transcript, No. 28 at p. 97; LG, No. 41 at p. 4; Sub Zero, No. 40 at p.4; Whirlpool, No. 31 at p. 4; AHAM, No. 34 at pp. 6, 7) Some of these comments raise the concern that VIP costs could increase to levels significantly greater than the levels DOE used in its analysis (AHAM, Public Meeting Transcript, No. 28 at p. 94; Whirlpool, No. 31 at p. 4; AHAM, No. 34 at pp. 6, 7) AHAM, LG, Whirlpool, and Sub Zero recommended that DOE assess the market's ability to mass-produce VIPs (AHAM, Public Meeting Transcript, No. 28 at p. 94; Sub Zero, Public Meeting Transcript, No. 28 at p. 97; LG, No. 41 at p. 4; Sub Zero, No. 40 at p. 4; Whirlpool, No. 31 at p. 4; AHAM, No. 34 at pp. 6–7) An additional factor cited by stakeholders that could potentially exacerbate any VIP supply issue is the increase in stringency of refrigeration product standards in other regions of the world, such as India and Europe. (Whirlpool, Public Meeting Transcript, No. 28 at p. 95; AHAM, Public Meeting Transcript, No. 28 at p. 94) Whirlpool commented that it is expensive to increase VIP production capacity (Whirlpool, No. 31 at p. 4)

In contrast, IOU, ACEEE/ASAP, NRDC, and NPCC stated that the VIP industry is prepared to ramp up production to meet the high demand predicted for the refrigeration industry (IOU, No. 36 at p. 9; ACEEE/ASAP, No. 43 at pp. 2–4; NRDC, No. 39 at p. 3; NPCC, No. 33 at p. 2) IOU estimated that demand would rise to the low millions to tens of millions of panels at most based on the results of the preliminary DOE analysis (IOU, No. 36 at p. 9) IOU also noted that there is rising interest for VIP use as building insulation, which could further stimulate growth in the market. (IOU, No. 36 at p. 10) ACEEE/ASAP also reported that the VIP manufacturers were confident about scaling up to meet global demand (ACEEE/ASAP, No. 43 at p. 4)

As Sub Zero notes, manufacturers have installed VIPs in refrigeration products for at least 20 years. (Sub Zero, No. 40 at p. 4) Sub Zero, which has installed VIPs in their products for the past 10 years, commented that three VIP suppliers are confident that they can meet the expected VIP demand, but that it is unclear whether they could meet the potential demand associated with major manufacturers and millions of refrigeration products. (*Id.*) IOU and the ACEEE/ASAP joint comment stated that VIPs have been incorporated into various new refrigerator models (IOU, No. 36 at p. 7; ACEEE/ASAP, No. 43 at p. 4)

Several adjustments made to the assumptions in the engineering analysis reduced the relative importance of VIPs in meeting the proposed standard levels decreased when compared to the preliminary. Specifically, the adjustments involved reduced panel coverage, reduced effectiveness, and application only after all other design options were considered. (Details about the changes in relevant assumptions can be found in chapter 5, section 5.8.3 of the NOPR TSD.) In response to stakeholder comments, DOE conducted an assessment of the VIP market and the potential ramp-up required by proposed standards and concluded that the market does not show ramp-up to be a critical issue leading to price pressure. From this analysis, DOE does not expect the estimated lead time for expanded VIP production to limit the availability of VIPs at mass-production levels.

DOE contacted several VIP suppliers during the NOPR analysis phase to better assess the current production capacity and the ability of the industry to ramp up to expected demand by 2014. These suppliers include Porextherm (Germany), Va-Q-tec (Germany), ThermoCor (U.S.), NanoPore Insulation LLC (U.S.), Glacier Bay (U.S.), and ThermalVisions (U.S.). DOE did not receive a response from any Asian companies it attempted to contact during this phase, but Porextherm estimated that there are five VIP producers based in China and Japan.

DOE estimates the current worldwide VIP market to be in the range of 2.5 to 5 million square meters based on input from VIP manufacturers. Va-Q-tec estimated that world demand is approximately 2 million square meters. ThermoCor estimated it to be about 5 million square meters. Other vendors interviewed declined to provide estimates.

ThermoCor noted that most of the growth in the U.S. market has happened since 2008, driven largely by the Federal manufacturer tax credit available for high efficiency refrigerators. (Energy Improvement and Extension Act of 2008, Pub. L. 110–343, Div. B, Sec. 305 (October 3, 2008)) In the U.S., major refrigerator manufacturers have started using VIPs in commodity models in addition to higher end products as a result of the manufacturer tax credit (available from 2008–2010). Manufacturers can receive $200 per unit for units with energy use at least 30 percent lower than the standard. Va-Q-tec stated that the VIP demand was largely concentrated in Japan prior to 2008, and that the U.S. tax credit rapidly changed the landscape for VIP manufacturers, creating much greater demand. The VIP industry responded with a dramatic ramp-up in production, which demonstrates the industry's ability to respond quickly to rapid increases in demand.

DOE estimates that approximately 5.8 million square meters of VIPs would be needed in the U.S. to meet the proposed standard levels in 2014 based on the design options presented in the NOPR engineering analysis (see the discussion of this estimate in TSD appendix 4–A, Investigation of VIP Supply, section 4–A–2).

DOE also considered the potential increase in demand for VIPs in Europe and India, as highlighted by stakeholders during the preliminary analysis public meeting (Whirlpool, Public Meeting Transcript, No. 28 at p. 95; AHAM, Public Meeting Transcript, No. 28 at p. 94)

As part of this examination, DOE reviewed a variety of European directives aimed at improving energy efficiency. The European Energy Labeling Directive (94/2/EC) for cold appliances, which was issued by the European Commission on January 21, 1994, established 7 efficiency levels for these products, from least efficient (G) to most efficient (A). In 2003, additional higher efficiency levels A+ and A++ were established. These levels all represent different percentages of reference energy use (representative energy use when the labeling directive was first established), called Energy Efficiency Index (EEI). The levels range from less than 30 percent of the reference value for A++ (the most efficient) to 125 percent of the reference value for G. The European Union established efficiency standards for residential refrigeration products with EU Council Directive 96/57/EC, dated September 3,1996. Maximum energy use standards were established for 10 "product categories," the equivalent of the different product classes associated with DOE regulations. Commission Regulation (EC) No 643/2009 requires that the maximum allowable EEI will be 55 starting July 1, 2010 ("European Commission Regulation 643/2009", No. 52). This level will drop to 44 on July 1, 2012, and to 42 (equivalent to current efficiency level A+) on July 1, 2014.

DOE received estimates from various VIP manufacturers that European demand is expected to rise to 2–5 million square meters in response to the new standards. Information obtained from a manufacturer that has used VIPs in multiple products suggests that VIPs will be used primarily for A++ products, which may be considered the equivalent of the U.S. ENERGY STAR products.

Along similar lines, India introduced a labeling program in 2006 that was initially voluntary but became mandatory in January 2010 ("Indian Refrigerator Regulations", No. 53). The program establishes efficiency levels represented by ranges of energy use. The product label is required to indicate the product's efficiency level. The allowable maximum energy use values associated with the efficiency levels are scheduled to be reduced in three steps between 2010 and 2014. Based on discussions with manufacturers, India's proposed standards for 2014 are not expected to be as stringent as those in the U.S. or Europe, and are not expected to require use of VIPs.

Based on the available data, DOE estimates that the potential VIP demand for the U.S. and Europe would reach an annual level of roughly 10 million to 15 million square meters. While this represents significant growth compared to the current market, it is consistent with the growth that the market has experienced recently for which VIP vendors have successfully ramped up their production.

Several VIP manufacturers are currently expanding their facilities, while others have plans to expand if the increased demand becomes more reliable. Overall, the VIP manufacturers interviewed were confident that neither the time nor the capital investment is a limiting factor as long as they have a stable backlog. Five of the manufacturers interviewed have recently undergone significant expansion efforts. One manufacturer has increased its production capacity by 10 times between 2008 and spring 2010 to reach a level of about 1.5 million square meters. Two other manufacturers have doubled their capacities in the past 9 months, one reaching 1 million square meters and another reaching 120,000 square meters. A fourth manufacturer has reached the capacity of about 300,000 square meters over the past 1.5 years. Lastly, as mentioned by ACEEE/ASAP, NanoPore has recently doubled its capacity and has plans to expand to 0.9 million square meters of capacity by 2010. (ACEEE/ASAP, No. 43 at p. 4)

VIP manufacturer estimates of the time required to bring a new plant on-line ranged from 6 to 18 months. The required time depends on whether existing production technology is replicated, or whether further improvements in production technology are designed and incorporated into new plants. Possible improvements include increased automation of the panel assembly and a shift to continuous rather than batch processing. Automation may involve the drying of the core material and the cutting of the bag and core. DOE visited a VIP production facility during the course of this investigation and concluded that the estimates provided by VIP vendors of time required to bring new production capacity online are consistent with the production process, given the equipment used.

Sub Zero noted that large volume refrigerator manufacturers could produce VIPs in-house to control costs, though Sub Zero and other small manufacturers would not have that ability (Sub Zero, No. 40 at p. 4)

ThermoCor agreed that large manufacturers would have the means to develop VIP production capability in-house by 2014. Several VIP manufacturers have considered joint ventures and licensing opportunities with refrigerator manufacturers. Manufacturers of VIPs suggest that transferring the knowledge and expertise of VIP production would be a straightforward process. A new VIP fabrication facility would need to have a production capacity between 300,000 and 1.5 million square meters per year to be cost-effective at today's VIP price levels. The capacity will typically vary based on the manufacturer, the panel type, and the facility location.

VIP manufacturers do not anticipate the supply of raw materials to be an issue as production ramps up. The industry uses multiple suppliers for both the barrier film and the fill material. Materials used for the fill include glass fiber, fumed silica, and aerogel. Glass fiber is produced for a wide range of uses worldwide. Fumed silica, used as fill by some VIP manufacturers, currently is produced on a much smaller scale. Asked if the more limited range of uses of fumed silica could present material supply issues due to capacity ramp-up delays or intellectual property issues, Porextherm noted that intellectual property issues would not prevent new suppliers from building new fumed silica plants, citing several new production facilities that have come online recently in Asia. Porextherm also noted that the solar collector industry in particular is helping to expand the production of pure silica, which produces fumed silica as a by-product. Va-Q-tec estimates that it would take approximately 2.5 years to build a new fumed silica plant, but that current worldwide production capacity is sufficient to provide enough fumed silica for production of 100 million m^2 of VIPs annually. Thermal Visions did not anticipate suppliers needing more than one year to respond to the ramp-up in production.

NRDC recommended that DOE explore other applications in which durable vacuum-sealing is required in large production volumes for lessons and strategies (NRDC, No. 39 at p. 4) DOE interprets this comment to mean that the production technologies required for this aspect of VIP production may have already been developed for other industries, thus potentially limiting the required time to development the process for the VIP industry. Through its research discussed above, DOE confirmed that current technology is already enabling mass production of VIPs, so an additional survey of other applications was unnecessary.

In summary, based on all of the above, DOE tentatively concludes that the VIP industry has the ability to increase production to meet the potential demand for VIPs within the three year gap between the final rule's issuance and the compliance date for any amended standard.

VIP Longevity

AHAM questioned whether the average lifetime of VIPs is consistent with lifetime expectations for refrigeration products (AHAM, Public Meeting Transcript, No. 28 at p. 94–95) In response, DOE investigated the issue of VIP longevity in more depth. ACEEE and ASAP commented that VIP manufacturers have used accelerated aging techniques to estimate panel life. Manufacturers have estimated lifetimes between 20 and 50 years for silica core panels, and generally up to 15 years for panels constructed of other core materials. (ACEEE/ASAP, No. 43 at p. 3)

ThermoCor and Va-Q-tec provided data on VIP degradation. ThermoCor panels, which have a glass fiber core, have been shown to retain about 75 percent of their insulation value over 10 years, a finding extrapolated from 7 years of data collected from panels aged at room temperature. Va-Q-tec determined that their panels would yield a 15 percent increase in thermal conductivity over 15 years, based on 7 years of observation of panels held in storage ("Va-q-tec Lifetime Analysis", No. 55). In both cases, the data suggest that the degradation in insulation value is similar to that of polyurethane foam (Wilkes 2001),[27] the insulating material used currently in nearly all products, and the insulation value would remain well above that of the baseline polyurethane foam for the lifetime of the refrigerator. As such, DOE did not factor VIP degradation into its analysis.

VIP Quality and Durability

AHAM and LG expressed concern that a short transition time to mass produce VIPs would adversely impact their quality (AHAM, No. 34 at p. 7; LG, No. 41 at p. 4) Sub Zero commented that there is a significant learning curve for commercialization of VIPs that will be steepened if standards require the wholesale transition to use of VIPs (Sub Zero, No. 40 at p. 4).

[27] Wilkes, K., *et al.* "Aging of Polyurethane Foam Insulation in Simulated Refrigerator Panels—One-Year Results with Third-Generation Blowing Agents." 29 Sep. 1999. *http://www.ornl.gov/webworks/cpr/pres/107629.pdf.* Accessed 14 June 2010.

Sub Zero also pointed out that shipping and handling may weaken a panel, causing it to fail slowly, without becoming apparent during visual inspections prior to installation. In addition, Sub Zero commented that panel installation is more critical to performance and reliability than it is for most other components, contributing to a steepened learning curve. In Sub Zero's experience, VIP failure can cause the wall to bulge, leading to higher rejection rates, installation problems for built-ins, condensation, and compromised door structures. Sub Zero added, however, that their own service records for VIPs indicate that these panels have performed well in the field. (Sub Zero, No. 40 at p. 4; Sub Zero, Public Meeting Transcript, No. 28 at p. 105)

The IOUs asserted that technological advancements have occurred in core materials, external barriers, and methods to maintain vacuum integrity, all of which would help to improve panel durability. Additionally, VIP manufacturers are taking steps to maintain quality throughout the installation process, including the use of on-site quality checking devices and training programs for workers to help ensure that proper handling techniques are used. Also, the IOUs pointed out that some products have high insulation values even when the vacuum has been compromised (IOU, No. 36 at pp. 6–8) NRDC commented that the risk of premature failure is overstated given the ample opportunities for detection (NRDC, No. 39 at p. 4) NPCC concurred that concerns over VIP durability are overstated, but recommended that DOE assess efficiency improvements feasible without VIPs to identify efficiency levels that are particularly "robust". (NPCC, No. 33 at p. 2–3)

DOE acknowledges that VIPs are more sensitive to handling issues during transport and installation when compared to other components. With this fact in mind, DOE still anticipates that manufacturers will make adjustments to their handling procedures to improve success rates of applying VIPs to their products, including taking those needed steps to ensure that VIPs remain intact after fabricating a refrigeration product. DOE also believes that innovations such as (1) the rapid VIP integrity testing system that one VIP manufacturer has developed for installation into each panel, which allows verification of each panel's integrity even after installation into the product, and (2) the compartmentalized design of another available VIP technology that limits performance degradation to a small region of a VIP will mitigate the potential impacts of VIP damage prior to installation. DOE believes that, after installation, VIPs would likely be very well protected from damage because they are encased inside the product walls or door, protected on one side by the product's external shell (or interior liner) and on the other side by the polyurethane foam insulation. DOE notes that its discussions with manufacturers did not reveal a single instance in which a VIP field failure occurred. While this tentative finding does not imply that there have been no failures, DOE believes, based on the information made available for review, that this particular issue has had minimal to no impact on manufacturer warranty or maintenance costs. DOE tentatively concludes that the risk of VIP failure is an issue that can be sufficiently addressed through design innovations and careful handling procedures during the manufacturing process.

VIP Cost Assumptions

Several specific comments were made regarding VIP cost assumptions. These comments address treatment of the technology in the engineering analysis, and are addressed later in section IV.C.4.d, below.

DOE requests comment and information on aspects of VIP technology that affect its suitability for consideration as a design option. Particularly, DOE seeks any new information not already discussed or considered in the rulemaking. (*See* Issue 10 under "Issues on Which DOE Seeks Comment" in section VII.E of this NOPR.)

2. Technologies Considered

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

TABLE IV.8—TECHNOLOGIES CONSIDERED BY DOE FOR RESIDENTIAL REFRIGERATION PRODUCTS, BY PRODUCT GROUP

Design option	Standard-size refrigerator-freezers	Standard-size freezers	Compact refrigerators	Compact freezers
Increased Insulation Thickness	....	√ (see Note 1)	√	√
Isobutane Refrigerant	....	....	√	
VIPs	√	√	√	√
Improved Compressor Efficiency	√	√	√	√
Variable-Speed Compressor	√	√	√	√
Increased Evaporator Surface Area	√	√	√	√
Increased Condenser Surface Area	√	√	√	√
Forced Convection Condenser	....	√		
Brushless DC Evaporator Fan	√	√		
Brushless DC Condenser Fan	√	√		
Adaptive Defrost	√	√		
Variable Anti-Sweat Heater Control	√			

Note 1: Increased Insulation Thickness was not considered for built-in, standard-size freezers.

C. Engineering Analysis

The engineering analysis uses cost-efficiency relationships to show the manufacturing cost increases associated with 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.

DOE conducted the engineering analysis for this rulemaking using a combined efficiency level/design option/reverse engineering approach. DOE defined efficiency levels using percentages representing energy use reductions. The reductions are defined to apply to energy use (not including icemaking energy use) measured using the proposed new test procedure, DOE's premise that efficiency levels expressed as a percentage of energy use lower than that of baseline products are equivalent when calculated based on both the current test procedure and the proposed new test procedure (without icemaking energy use) allowed DOE to compare information developed from different sources. However, DOE's analysis is based on the efficiency improvements associated with groups of design options. DOE developed estimates for efficiency improvements for design options through energy use modeling analysis conducted for selected reverse-engineered products. The energy models were first established based on the existing product designs, and the models were subsequently adjusted to reflect application of the groups of design options considered for analysis. DOE based some of the design option information on data gained through reverse-engineering analysis, but also used other sources, such as component vendor inquiries and discussions with manufacturers as appropriate. Details of the engineering analysis are provided in the NOPR TSD chapter 5.

DOE received several comments from interested parties on its approach to the engineering analysis, as described below.

1. Product Classes Analyzed/Representative Products

DOE initially selected seven key product classes for direct analysis.

These product classes are summarized in Table IV.9. The direct analysis included reverse engineering, manufacturing cost modeling, and energy use modeling.

TABLE IV.9—PRODUCT CLASSES DIRECTLY ANALYZED IN THE PRELIMINARY ENGINEERING ANALYSIS

Product category	Product class
Standard-size refrigerators and refrigerator-freezers	3. Refrigerator-freezer—automatic defrost with top-mounted freezer without through-the-door ice service.
	5. Refrigerator-freezers—automatic defrost with bottom-mounted freezer without through-the-door ice service.
	7. Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service.
Standard-size freezers	9. Upright freezers with automatic defrost.
	10. Chest freezers and all other freezers except compact freezers.
Compact refrigerators	11. Compact refrigerators and refrigerator-freezers with manual defrost.
Compact freezers	18. Compact chest freezers.

DOE selected representative products from each of these product classes to analyze and assess the products' potential for energy use reduction. DOE selected these products by reviewing product offerings on manufacturer and retailer Web sites and selecting products for analysis that had features affecting energy use that are typical for the product classes. DOE selected products of two volumes for each analyzed product class and attempted to select two products of one of these volumes to serve as a product pair. Each product of this pair would be nearly identical in design except that one would be rated at the maximum allowable energy use and the other would satisfy the ENERGY STAR requirements. DOE presented these representative product selections at the Framework Workshop. For these directly-analyzed product classes, DOE developed two cost-efficiency curves for each class based on two of the three products purchased for reverse engineering that represented distinct designs. (The third reverse-engineered product of each class, as mentioned above, was typically a variant of one of the other products, and full analysis of this third product would not have provided additional useful information.)

During the preliminary analysis public meeting, DOE again requested comment on the variation present in refrigeration product design, and the distribution of incremental costs to achieve energy use reductions as compared to the designs selected for analysis.

AHAM commented that it is unable to provide detailed design data for its members, because such data are impossible to aggregate. AHAM suggested that DOE work with individual manufacturers during the MIA interviews to obtain this specific information. (AHAM, Public Meeting Transcript, No. 28 at p. 55; AHAM, No. 34 at p. 5) Whirlpool commented that detailed study would be required to gather such information, and this analysis should be discussed in NOPR-phase manufacturer interviews. (Whirlpool, No. 31 at p. 2) LG suggested that DOE review company Web sites to determine product design options. (LG, Public Meeting Transcript, No. 28 at p. 56)

DOE discussed with individual manufacturers the improvement potential of design options and the design option groupings required to achieve different efficiency levels for different product classes during the MIA interviews. Alone, this information was insufficient to clearly identify the design option pathways required to achieve all of the considered efficiency levels, but DOE made many engineering analysis adjustments based on the information gathered in these discussions (*see* Table IV.10 for a summary of key changes in the analysis).

Based on the manufacturer discussions and accompanying analytical work, DOE concluded that the average characteristics of the products initially purchased for reverse engineering and subsequently used as the basis for the engineering analyses provide a reasonable representation of baseline products. DOE calculated the representative engineering cost-efficiency curve for each product class listed in Table IV.9, above, as the average of the two cost-efficiency curves developed for the two reverse-engineered products of that class. Regarding LG's suggestion that DOE examine manufacturer Web sites to obtain the information sought for its analysis, DOE notes that the detailed information DOE requires for its analysis is unavailable on these Web sites.

TABLE IV.10—SUMMARY OF KEY ADJUSTMENTS TO THE ENGINEERING ANALYSIS

Parameter(s)	Preliminary	Changes for the proposed rule
VIP Surface Coverage	Full product coverage, except for chest freezer walls.	Full coverage of doors, 50% coverage of cabinet to assure structural integrity, preference for coverage of freezer compartments, no change to exception for chest freezer walls.
VIP Effectiveness	Full effectiveness as determined by the ERA energy model.	50% of ERA energy model effectiveness to better match results reported by manufacturers.
Cost Increase for Higher-Efficiency Components.	....	Adjusted based on additional information.
Conversion Costs for Increase of Door and Cabinet Insulation Thickness.	Based on Manufacturing Cost Model.	Increased due to updating of production equipment costs in manufacturing cost model. Shift in allocation of this cost to increase the portion allocated to the door thickness increase.

TABLE IV.10—SUMMARY OF KEY ADJUSTMENTS TO THE ENGINEERING ANALYSIS—Continued

Parameter(s)	Preliminary	Changes for the proposed rule
Heat Exchanger (Condenser and Evaporator) Size Increase.	Application of a 20% increase in the UA value (inverse of thermal resistance) of the heat exchangers.	Application of this design option based on examination of product design details only for products for which size increase was possible. Direct modeling of heat exchanger performance based on selected geometry changes. Increase of fan power requirement for heat exchanger depth increases.
Standby Power for Variable Speed Controls.	Not included	Addition of 1.5W load outside the cabinet for products not already having electronic control.
Variable Speed Compressor System Fan Control.	Inconsistent selection of fan speed	Fan operation at reduced speed to deliver reduced air flow at 50% power input consistent with cubic fan law.
Variable Speed Compressor Performance for Compact Products.		Degradation of compressor capacity in ERA energy modeling based on performance data obtained from a manufacturer.
Isobutane Refrigerant	Not considered	Consideration of isobutane refrigerant for compact refrigerators, with 5% energy use reduction.
Variable Anti-Sweat Heater Control	Considered for product class 5 *	Considered for product classes 5 * and 7 **.
Baseline Anti-Sweat Heater Operation (Product Class 5* only).		Baseline average wattage reduced for both directly analyzed products.
Variable Defrost Compressor Run time between defrosts.	38 hours	30 hours; Also, adjustment made in this value when converting to variable speed compressors to avoid modeling excessive defrost frequency.

* Refrigerator-freezers—automatic defrost with bottom-mounted freezer without through-the-door ice service.
** Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service.

DOE also analyzed four product classes of built-in products (see Table IV.11). DOE selected one representative built-in product for analysis for each of these product classes. DOE judged the representativeness of these product selections based on discussions with manufacturers regarding design option groupings required to meet key efficiency levels with built-in products.

TABLE IV.11—BUILT-IN PRODUCT CLASSES ANALYZED

Product category	Product class
Standard-size refrigerators and refrigerator-freezers	3A–BI. All Refrigerators with automatic defrost. 5–BI. Refrigerator-freezers—automatic defrost with bottom-mounted freezer without through-the-door ice service. 7–BI. Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service.
Standard-size freezers	9–BI. Upright freezers with automatic defrost.

DOE's proposal to directly analyze a limited number of product classes was initially presented in the framework document and discussed at the framework workshop. ("Framework Document Public Meeting on Energy Conservation Standards for Refrigerators, Refrigerator-Freezers, and Freezers," No. 6 at p. 45) DOE did not conduct a full analysis of all product classes in light of limited resources and the limited value this additional data would have yielded given the small number of product shipments associated with the non-analyzed product classes. Instead, DOE developed an approach to extend the energy standards to these product classes. Discussion of this extension of the standards and associated comments is presented in section IV.C.7, below.

2. Baseline Energy Use Curves

a. Baseline Energy Use Under the Proposed New Test Procedure

As described in section III.A, above, DOE has proposed new test procedures for refrigeration products that will affect their measured energy use. DOE developed equations for baseline product energy use as a function of adjusted volume under the proposed new test procedures (which excludes the energy required to make ice—*i.e.,* icemaking energy use) based on information provided by AHAM, as described in chapter 5, section 5.4.2, of the preliminary TSD. (Icemaking energy is the additional energy used to produce ice, which is distinct from the energy expended by an automatic ice dispensing system to dispense ice.) These equations address the test procedure changes associated with compartment temperatures and volume calculation method.

DOE sought comment on the proposed baseline energy use/adjusted volume relationships under the proposed new test procedure. AHAM and Whirlpool supported the DOE approach and found it to be well-summarized and sufficiently rigorous. (AHAM, No. 34 at p. 5 and Public Meeting Transcript, No. 28 at p. 61; Whirlpool, No. 31 at p. 1)

LG questioned the development of baseline energy use equations that do not include automatic icemaker energy use for products with automatic icemakers and suggested that the energy use of automatic icemakers should be included in the DOE analysis and in the baseline energy use equations. (LG, Public Meeting Transcript, No. 28 at p. 60) The LG comment also suggests that it would not be possible to develop a baseline energy use equation prior to finalization of the applicable test procedure, indicating that the portion of the measurement associated with automatic icemakers is still in development. (*Id.*)

The proposed test procedure includes a value for icemaking energy use for those products that have automatic icemakers. 75 FR 29846 (May 27, 2010). However, the discussion regarding efficiency levels is based on the percentages of energy use reductions from baseline energy use excluding icemaking energy use. In this context, icemaking energy use is the 84 kWh assigned to icemaking in the proposed test procedure. *Id.* at 29847. As described in section III.A, above, sufficient information is unavailable to accurately determine the variation of icemaking energy use as a function of efficiency level. Hence, DOE is not considering reductions of the 84 kWh allocated to icemaking energy use as part of this standard. Instead, the examined energy use reductions exclude icemaking energy use. DOE believes this treatment also allows more meaningful comparisons to other information sources, such as information obtained from discussions with manufacturers regarding design option groups required to achieve efficiency levels.

Electrolux requested that DOE clarify its definition of baseline energy use, as referenced throughout the preliminary TSD. (Electrolux, Public Meeting Transcript, No. 28 at pp. 62–63) Sub Zero also commented that it is unclear in the preliminary TSD whether references to baseline energy refer to calculations under the current test procedure or under the proposed test procedure. (Sub Zero, Public Meeting Transcript, No. 28 at pp. 63–66)

DOE interprets these comments to mean that the preliminary TSD did not clearly explain in its discussion of cost-efficiency curves and efficiency levels whether the examined percentage energy use reductions applied to the current energy standard (*i.e.,* a baseline product tested using the current test procedure) or to a baseline product tested under the new proposed test procedure. To clarify stakeholders' concerns, DOE notes that standards determined by reducing the current standard levels by the stated percentage reductions applied to products tested under the proposed new test procedure would have hidden in them the additional energy use reductions associated with the impacts of applying the proposed new test procedure. The equation below indicates, for products with automatic icemakers, how energy use associated with the analyzed efficiency levels would be calculated. For products without automatic icemakers, the icemaking energy use would not be added (*i.e.,* the last term in the expression would be eliminated).

$$TEC_{EL+ICE,NEW} = TEC_{STD,NEW} \times (1 - R) + TEC_{ICE}$$

Where:

$TEC_{EL+ICE,NEW}$ = Test energy consumption at a given efficiency level, including icemaking energy consumption, using the new test procedure

$TEC_{STD,NEW}$ = Test energy consumption under the current standard, not including icemaking energy consumption, using the new test procedure

R = Reduction in energy consumption (expressed as fraction) due to efficiency improvements at a given efficiency level

TEC_{ICE} = Icemaking test energy consumption

DOE conducted the analysis based on the proposed new test procedure. However, as discussed, DOE applies the energy use reduction associated with the efficiency level to the baseline energy use, excluding icemaking energy use. For the purposes of this discussion, DOE defines the Proposed Procedure Reduced Baseline Energy Use as the representative energy use[28] not including the icemaking energy use of a minimally compliant product measured under the proposed new test procedure. For a product with a 20 percent efficiency level (*i.e.,* with energy use 20 percent lower than the maximum allowable energy use) and with an automatic icemaker, the energy use measured under the proposed test procedure would be equal to the icemaking energy use plus 80 percent of the Proposed Procedure Reduced Baseline Energy Use. Equations representing the Proposed Procedure Reduced Baseline Energy Use are presented in Table 5.4.10 of the preliminary TSD. For a product at a 20 percent efficiency level without an automatic icemaker, the energy measured under the proposed new test procedure would be 80 percent of the Proposed Procedure Reduced Baseline Energy Use.

Whirlpool questioned the change in adjusted volume for product class 7 (refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service) associated with the new test procedure, as reported in the preliminary TSD (Tables 5.4.5 through 5.4.7), suggesting that the new volume calculation method, which has eliminated the insulating hump and cup recess areas from the volume calculation, should result in lower volumes. The cup recess area is the recess on the outside of the product under the dispenser, where a cup would be placed to fill it with ice or water. The insulating hump is the "bulge" towards the inside of product that is necessary to provide insulation around the back of the cup recess and around the ice dispensing chute. (Whirlpool, Public Meeting Transcript, No. 28 at pp. 58–59)

DOE notes that the data associated with the tables were provided by AHAM as aggregated data, which limited the extent to which DOE could draw conclusions about these data. However, the information indicates that the average freezer volume for the 24 examined product class 7 samples dropped from 9.3 cubic feet under the current test procedure to 9.0 cubic feet under the proposed new test procedure, consistent with expectations of a reduction in volume. The larger volume adjustment factor associated with the proposed new test temperatures (the volume adjustment factor for the freezer compartment increases from 1.63 to 1.76 under the proposed test procedure) more than compensates for the reduction in volume and results in a small increase in adjusted volume.

b. Change of Energy Use Equation Slope

The energy standards for refrigeration products are expressed as a product's adjusted volume multiplied by a parameter called the slope and added to another parameter called the intercept. Energy use is expressed using an equation rather than as a fixed value to reflect the fact that a larger product consumes more energy. An energy use equation with a larger slope means that energy use increases more rapidly as the size increases (*i.e.,* is more sensitive to product size), while a lower slope means that energy use increases less rapidly. Different slope and intercept parameters are established to represent the energy standard for each product class. Casting the energy standards in this fashion allows DOE to set a standard for each product class as a single relationship applicable for a wide range of product volumes, rather than providing separate standards for many limited volume ranges.

Based on information derived from energy use modeling, the preliminary TSD (see chapter 5, section 5.4.2) suggested that the slopes for at least some of the examined products may need adjustment. DOE sought comment on whether to adjust the slopes of the baseline energy use curves under the new test procedure for any of the proposed product classes.

AHAM requested additional information on (a) How product classes were selected for evaluating the slope adjustment, (b) how the modified slopes were determined, and (c) how the intercepts would change with proposed slope changes. (AHAM, No. 34 at p. 6 and Public Meeting Transcript, No. 28 at pp. 68–69) AHAM supported DOE's proposal to increase the slope for

[28] The word "representative" is inserted here to indicate that the Proposed Procedure Reduced Baseline Energy Use is intended to be representative of the products in a product class, rather than applying to any one particular product that is minimally-compliant under the current standard. This distinction is made because there is variation in the change in measured energy use when applying the proposed test procedure.

current product class 5 (refrigerator-freezers—automatic defrost with bottom-mounted freezer without through-the-door ice service) to 12.3 assuming the intercept value remains the same, since the slope for this product class was 16.5 in 1993 and it dropped to 4.6 with the 2001 rulemaking, thus making the standard more stringent for large products than for small products. (AHAM, No. 34 at p. 6 and Public Meeting Transcript, No. 28 at p. 68) AHAM expressed concerns about the slopes for the product classes the preliminary TSD did not analyze, such as product classes 17 (compact upright freezers with automatic defrost), 3A (all-refrigerators—automatic defrost), 5A (refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service), 10A (chest freezers with automatic defrost), and 11A (compact refrigerators and refrigerator-freezers with manual defrost). However, AHAM's comments regarding product class 17 appear to address the magnitude of the energy standard rather than the slope of the energy use equation for this product class. (AHAM, Public Meeting Transcript, No. 28 at p. 69) Finally, AHAM commented that the slopes determined using energy modeling should be validated if possible to determine if the proposed slope values are realistic. (AHAM, Public Meeting Transcript, No. 28 at p. 68) Whirlpool commented that the preliminary TSD provides insufficient information on the assessment of energy equation slopes to allow the company to either support or reject of the proposal. (Whirlpool, No. 31 at p. 1)

DOE presented during the preliminary analysis meeting background information regarding the slopes of different product classes based on energy modeling. DOE highlighted the need to obtain data and feedback to properly assess which slopes should change and what the new slope and intercept values should be. DOE explicitly asked for information that might help in making slope adjustments at the preliminary analysis public meeting and as part of the preliminary analysis comment period, but did not receive any relevant data at that time. DOE also asked for data on this topic during the NOPR phase manufacturer interviews and received information for two pairs of product class 5 products. As described in the NOPR TSD in chapter 5, section 5.4.2, DOE incorporated this information into its evaluation of the applicable energy efficiency equation for this product class. DOE proposes to apply the slope for product class 7 (refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service) to product class 4 (refrigerator-freezers—automatic defrost with side-mounted freezer without through-the-door ice service) because the presence of through-the-door ice features for product class 7 products should have only a limited impact on the increase in energy use associated with cabinet growth, which the slope represents. These adjustments are also described in section 5.4.2 of chapter 5 of the NOPR TSD. Otherwise, DOE is not proposing any slope changes based solely on energy modeling information. DOE will consider modifying its slope and intercept values if sufficient data are received.

In assessing possible slope changes, DOE primarily chose products for which energy use models had already been prepared as part of the preliminary analysis. As described in the preliminary TSD, chapter 5, section 5.4.2, the analysis started with the energy models of minimally-compliant products based on the two reverse-engineered products for each product class DOE examined. DOE examined the trend in calculated energy use as the product size changes with insulation thickness remaining constant. For the smaller of the two reverse-engineered products, DOE examined the trend as size increases, and for the larger of the two products, DOE examined the trend as size decreases. DOE averaged these two results.

For the analysis of compact refrigerators, DOE considered the change in efficiency of typically available compressors sized appropriately for the products examined. For standard-size products, DOE used a constant compressor efficiency in the analysis. DOE selected this approach based on observed data indicating that compressor efficiency does not vary significantly in the capacity range suitable for most standard-size products (see, *e.g.,* Figure 5.8.1 of chapter 5 of the preliminary TSD).

The preliminary TSD did not address the approach for determining new intercepts for baseline energy use equations with modified slopes. Changing the slope without a corresponding change to the intercept value would result in a dramatic increase or decrease in the calculated baseline energy use. For example, consider the preliminary baseline energy use equation for product class 5, which is $5.32 \times AV + 542.5$. DOE proposes to change this slope from 5.32 to 11.0. If the intercept remains equal to 542.5, the calculated energy use of a product with an adjusted volume equal to 20 would increase from 648.9 to 762.5, an increase of 17.5 percent. A lower intercept would be needed in order to offset this change and permit the calculated baseline energy use for products with typical adjusted volumes to remain constant. Without this corresponding adjustment, the resulting equation would not be representative of baseline product energy use. For a product with an adjusted volume equal to 20, an intercept equal to 428.9 would assure that the energy use remains 648.9.

Rather than keep the same intercept value, as suggested by AHAM (AHAM, No. 34 at p. 6), DOE proposes, in developing a new baseline energy use equation, that the calculated baseline energy use for the typically-shipped range of products of the class remains constant. Ideally, this approach would require knowledge of shipment quantities for the product class disaggregated by adjusted volume. DOE does not have access to such shipment data and cannot conduct a calculation to determine an intercept that is known to result in zero change in the shipment-weighted average baseline energy use. To work around this limitation, DOE proposes to select a new intercept so that the increase in the baseline energy calculated for the largest adjusted volume (based on the new proposed test procedure with its modified volume adjustment factor) typical for the examined product class is equal to the decrease in the baseline energy use for the smallest adjusted volume typical for that product class. For product class 5, DOE selected representative minimum and maximum adjusted volumes for this calculation equal to the adjusted volumes of the 18.5 and 25 cubic foot reverse engineered products. The adjusted volumes for these products are 22.4 and 29.8 cubic feet. With the proposed new intercept of 394.2, the baseline energy use for the smaller product decreases 21.2 kWh from 661.6 to 640.4 kWh, while the baseline energy use for the larger product increases 21.2 kWh from 701.3 to 722.5 kWh. A similar approach is proposed for product class 4, as described in section 5.4.2 of chapter 5 of the NOPR TSD. The chapter also discusses development of a baseline energy use equation for product class 5A. DOE's Proposed Procedure Reduced Baseline Energy Use equations for all of the proposed product classes are presented in Table 5.4.12 of chapter 5 of the NOPR TSD. These equations are the basis for development of the energy standards in this NOPR.

DOE requests comment on the approach used to develop Proposed Procedure Reduced Baseline Energy Use equations with adjusted slopes for product classes 4, 5, and 5A. DOE also seeks relevant data that would allow more rigorous adjustment of the curve intercept to ensure that the shipment-weighted average impact of the slope change would be neutral (*i.e.,* zero change) with respect to energy use. DOE also seeks any additional information that would support similar development of adjusted-slope baseline energy curves for other product classes. (*See* Issue 11 under "Issues on Which DOE Seeks Comment" in section VII.E of this NOPR.)

c. Energy Use Measurement Changes Associated With Other Test Procedure Changes

As described in section IV.C.2.a, above, DOE developed the Proposed Procedure Reduced Baseline Energy Use equations based on energy use measurement changes associated with proposed test procedure changes associated with compartment temperatures and volume calculation methods. DOE calculated the new energy conservation standards proposed in this notice by applying efficiency level percentages to the Proposed Procedure Reduced Baseline Energy Use equations. Section III. A, above, describes the test procedure rulemaking and its associated NOPR, which has proposed numerous test procedure changes in addition to the compartment temperature and volume calculation method changes. The test procedure final rule has not yet been published. However, DOE tentatively concludes, based on its analysis and the comments received in response to the proposed procedure, that none of these other proposed test procedure changes will affect measured energy use. Therefore, DOE has used the Proposed Procedure Reduced Baseline Energy Use equations developed during the preliminary analysis (subject to changes in some of these equations to address equation slope) to establish the proposed standards in this notice.

3. Efficiency Levels Analyzed

DOE selected baseline products as reference points for all of the product classes and compared these baselines to projected changes resulting from using energy saving design options. The baseline products in each product class represent the common characteristics of equipment in that class.

DOE established a series of incremental efficiency levels for which it has developed incremental cost data and quantified the cost-efficiency relationship for each of the eleven analyzed product classes. In each product class, the highest efficiency level is the max-tech level, which represents the theoretical maximum possible efficiency if all available design options are incorporated. Because the two products selected for reverse engineering for each of the seven conventional (free-standing) product classes had differing characteristics, the max-tech levels for the two products were not the same. DOE did not consider that the higher of the two max-tech levels would be representative of the entire product class. Instead, DOE calculated max tech for the product class as the average of the max-tech levels for the two products analyzed.

DOE sought comment on the incremental efficiency levels and the max-tech level for each product class. Stakeholders primarily made comments about the max-tech levels. The comments primarily addressed (a) Validity of max tech that is calculated based on technology options that are used in commercialized products but whose combinations in the max-tech designs may not be represented by products or prototypes, (b) validity of DOE's consideration of variable speed compressors for compact products, (c) questions regarding whether some of the design options, particularly heat exchanger size increases, fit physically in the products, and (d) questions regarding validation of the energy modeling predictions. The specific comments are detailed below. The comments described by topics (b) and (c) address the treatment in the engineering analysis of design options that have been screened-in, and are discussed in section IV.C.4, below. DOE modified its treatment of some of these design options in the NOPR analysis, which resulted in adjusting the max-tech levels. The comments described by topic (d) address validation of the energy modeling tool DOE used in the analysis and are discussed in section IV.C.5, below. Comments that specifically address max-tech levels but not energy model validation or treatment of design options in the analysis are discussed in section III.B.2, above.

4. Engineering Analysis Treatment of Design Options

GE recommended that DOE reevaluate its assumptions underlying the technologies included in the max-tech levels, because some of the design options are not feasible for certain product classes and some design options are not as effective when combined with other design options. (GE, No. 37 at p. 2) But GE did not identify specific options it believed were problematic. DOE cannot directly respond to comments that do not address particular design options in question and the specific concerns with the way they were evaluated. The energy modeling used to determine impacts of groups of design options modeled the design option groups rather than modeling each design option individually. The modeling showed the reduced effectiveness of design options added after other design options had already been considered. This resulted in less reduction in energy use for such design option groups. Hence, the analysis captured the reduced effectiveness associated with the grouping of design options and DOE did not modify its analysis in response to this comment.

a. Heat Exchangers

AHAM, Sub Zero, and GE commented that some of the design options considered could not be implemented due to cabinet size limitations. (AHAM, Public Meeting Transcript, No. 28 p. 73; Sub Zero, Public Meeting Transcript, No. 28 p. 73; GE, Public Meeting Transcript, No. 28 p. 74) GE did not offer any specifics in its statements or comments. When asked to identify specific design options that were size-dependent, Sub Zero cited heat exchangers (Sub Zero, Public Meeting Transcript, No. 28 p. 73) As a result, DOE revised its assessment of the benefits from increased heat exchanger sizes in the NOPR analysis by (a) evaluating the potential to increase heat exchanger size in each analyzed product based on the reverse-engineered product details and limiting the size increase—in some cases, to no increase—and (b) revising the analysis to analyze the heat transfer benefit, the increase in refrigerant-side pressure drop, and the added airside pressure drop and/or possible fan power increase associated with the change. DOE adopted the latter approach rather than applying a factor representing an increase in performance, as was done for the preliminary engineering analysis. This revised assessment is discussed in detail in chapter 5 of the NOPR TSD in sections 5.8.6 and 5.8.7.

b. Variable Speed Compressors for Compact Products

Whirlpool and Electrolux commented that variable speed compressors may not be available in the market for product class 11 (compact refrigerators and refrigerator-freezers with manual defrost). (Whirlpool, Public Meeting

Transcript, No. 28 at p. 75; Electrolux, Public Meeting Transcript, No. 28 at p. 75) DOE utilized performance data for commercialized variable-speed compressors in its analysis. For the compact product classes, DOE considered the smallest-capacity variable speed compressors operating at their lowest rated speed. For the smallest compact refrigerator analyzed, DOE considered replacement of the baseline compressor, nominally rated at 211 Btu/hr capacity and an EER of 3.02 Btu/hr-W, with a variable speed compressor with ratings of 139 Btu/hr capacity and 4.96 Btu/hr-W EER at low speed (capacity, power input, and EER all vary as compressor speed varies). DOE confirmed with the compressor vendor that these compressors can be used in this fashion, although doing so may not be cost effective. Based on data provided by a manufacturer, DOE also degraded the modeled performance of variable speed compressors when applied to compact products, by reducing their modeled capacity by 11 percent.

c. Variable Anti-Sweat Heaters

Whirlpool commented that the variable anti-sweat heater design option would apply to product class 7 (refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service) and possibly 6 (refrigerator-freezers—automatic defrost with top-mounted freezer with through-the-door ice service), in addition to product class 5 (refrigerator-freezers—automatic defrost with bottom-mounted freezer without through-the-door ice service). (Whirlpool, Public Meeting Transcript, No. 28 at pp. 44–45) In response, DOE included this design option for analysis of product class 7. The design option had already been incorporated into the analysis for product class 5, with respect to the gasket heaters used between this product class's French Doors (see Preliminary TSD, chapter 5, section 5.8.9). DOE did not develop cost-efficiency curves for product class 6, as this was not one of the directly-analyzed product classes (see section IV.C.1, above).

d. Vacuum-Insulated Panels

Section IV.B.1.c, above, discusses VIPs from the perspective of the screening analysis. As described in that section, VIPs were not screened out for the NOPR analysis. This section addresses comments associated with the treatment of VIP technology in the engineering analysis.

AHAM stated that the VIP application cost is higher for cabinets than it is for doors and questioned whether DOE had incorporated the additional cost in its analysis (AHAM, Public Meeting Transcript, No. 28 at p. 94; AHAM, No. 34 at p. 7) In addressing this issue, DOE assumed for the preliminary analysis that VIP installation in a cabinet requires 10 times as much labor as installation in a door. Information DOE obtained during manufacturer interviews during the NOPR suggests that its labor cost estimates are appropriate. DOE used these assumptions in calculating its VIP labor cost assumptions in the NOPR analysis.

LG urged DOE to study the incremental installation, maintenance, and service costs for products using VIPs. (LG, No. 41 at p. 4) As discussed in more detail in chapter 5 of the NOPR TSD, the VIP cost estimate includes labor costs and a cost contribution attributable to overhead and capital costs. As discussed in section IV.B.1.c, above, no information is available regarding any VIP field failure. DOE is also unaware of any specific maintenance or service costs associated with VIPs. Hence, DOE did not include these costs in the analyses for VIPs.

Sub Zero commented that VIP costs offered by three different VIP manufacturers are similar, indicating that an industry standard has been established at present levels of technology, maturity, and volume. It added that costs may rise to ensure that shipping and handling are conducted in a way that does not damage the panels. (Sub Zero, No. 40 at p. 4) IOU agrees with the costs used by DOE in the preliminary analysis and expects that costs will likely decline in the future due to economies-of-scale (IOU, No. 36 at p. 10) ThermoCor, a VIP vendor contacted as part of DOE's investigation of VIP supply issues (see section IV.B.1.c, above), expects the increase in supply to drive down raw material prices and the transition to increased automation to reduce production cost. DOE did not change the VIP cost assumptions from the preliminary analysis, because, based on available information, (1) DOE expects that VIP production capacity can be increased as needed within the necessary timeframe, thus avoiding a supply/demand imbalance that would lead to cost increases, and (2) adjustments to shipping costs to reduce VIP failure risk during transport are insignificant compared to overall VIP application cost. (DOE projects that if, in order to account for the need for special handling, transport costs are twice as high as normal bulk materials transport costs via truck, they would still only amount to about 2 percent of total VIP costs).

IOU predicted that the cost premium for VIPs could become less significant under future regulations that require manufacturers to switch from HFC blowing agents to alternatives (IOU, No. 36 at p. 10) DOE does not agree with this statement. Information obtained through manufacturer interviews and discussion with an insulation vendor indicates that material cost for insulation made using HFC–245fa is more expensive than for insulation made using the most likely replacement blowing agent, cyclopentane. Hence, the cost premium for VIPs may more likely increase slightly. As an example, HFC–245fa may represent 12.5 percent of the mass of the foam insulation. At a cost of roughly $5/lb and insulation density of roughly 2 pounds per cubic foot, the blowing agent represents $1.25 per cubic foot of insulation. Cyclopentane costs roughly $1 per pound. Hence, when switching to cyclopentane-blown insulation, the blowing agent represents $0.25 per cubic foot of insulation. DOE used a VIP price in its analysis of $3.19 per square foot at a thickness of one-half inch—this is equal to $76.56 per cubic foot on a volume basis. The total cost of the displaced HFC–245fa foam insulation when applying VIPs is roughly 2 percent of the VIP cost, or $1.53. Hence, switch from HFC–245fa to cyclopentane blowing agent will increase the cost of the use of VIPs from $75.03 to $76.03 per cubic foot. This increase is very small compared to the overall cost of implementing VIPs.

The IOU comment also suggests that VIPs could be used to maintain thermal performance with reduced impact on external size or internal volume (IOU, No. 36 at p. 10) DOE agrees with this statement, and expects that some manufacturers might use this approach to maintain internal volume. However, this possibility has no bearing on DOE's engineering analysis, in which DOE must determine the most cost effective groups of screened-in design options that are needed to achieve each considered efficiency level.

NRDC stated that VIPs could alleviate some of the cost burden associated with potential climate change legislation or regulation that would increase the cost of HFC blowing agents by reducing the amount of foam insulation needed (NRDC, No. 39 at p. 4) At this time, DOE does not believe that a scenario involving limits on HFC use would involve manufacturers switching to increased use of VIPs while continuing to use HFC blowing agent. Instead, the available information leads DOE to predict that manufacturers would instead switch to insulation not containing HFC blowing agent, since this approach is much more cost effective than the adoption of VIPs. This result assumes that additional moderate-cost design options can be applied to make up for any efficiency loss associated with the switch to alternative blowing agents. DOE believes that VIPs would be used only if they are the most cost-effective design option for making up this efficiency difference.

DOE requests comment on its treatment of design options in the engineering analysis. (See Issue 12 under "Issues on Which DOE Seeks Comment" in section VII.E of this NOPR, below.)

5. Energy Modeling

DOE upgraded the ERA program used in the previous refrigerator rulemaking in preparation for the energy analysis conducted for this rulemaking. Upgrades, including use of heat exchanger models based on more recent literature and development for a Windows platform are described in more detail in appendix 5–B of the NOPR TSD. The program has also been made available on the DOE rulemaking Web site at the following URL: *http://www1.eere.energy.gov/buildings/appliance_standards/residential/refrigerators_freezers_prelim_analytical_spreadsheets.html.*

Sub Zero asked DOE whether and to what extent it used actual test data to calibrate ERA models, and how well it predicted performance over a range of operating conditions. (Sub Zero, No. 40 at p. 8) AHAM questioned the evaluation of design options and requested that the ERA simulation program be made available. (AHAM, No. 34 at p. 10) Electrolux also posed questions regarding calibration of the ERA model and asked whether the model could be made available. (Electrolux, Public Meeting Transcript, No. 28 at p. 76)

DOE notes that the ERA program has been posted on the DOE's rulemaking Web site since the end of February 2010. Additionally, the preliminary TSD described many of the inputs that were used in developing of the energy use models for the reverse-engineered products that served as the basis of DOE's efficiency improvement calculations. DOE tested many of the reverse-engineered products, including tests for standard-size refrigerator-freezers for both the current test procedure compartment temperatures and the proposed new compartment temperatures. DOE instructed the test facility to measure refrigerant tube temperatures during these tests to indicate refrigerant conditions during compressor on-cycles. DOE measured the power input of fans as part of the reverse-engineering process, and used this information as input for the models. DOE also used the compressor power input during on-cycles during testing to help calibrate teardown product energy models. DOE adjusted input data for the energy models based on all available information to obtain energy use estimates within a few percentage points of the rated or measured energy of the products analyzed. In some cases, DOE adjusted the input using additional load and/or other input factors to degrade or improve system or cabinet thermal performance to match measured energy use or operating parameters. Examples include (1) boost of performance of one style of condenser to match measured condensing temperature and compressor power input during the on-cycle, and (2) addition of thermal load for some products, particularly side-mount refrigerator-freezers and upright freezers, to match total energy use. The energy model input data for the reverse-engineered products are presented in appendix 5–A of the NOPR TSD.

DOE also examined whether model predictions for the design options groups required to achieve higher efficiency levels matched the design options used in actual products, where such information was available. For example, DOE obtained information from manufacturers during the NOPR phase discussions regarding the combination of design options required to achieve a 30 percent reduction in energy use in standard-size refrigerator-freezers as compared with the current standard. Achieving this level generally required using the highest-efficiency single-speed compressors, brushless-DC fan motors, and substantial use of VIPs. The energy model results were consistent with this information.

DOE requests comments, information, and data that would help adjust its energy modeling input and/or results that would allow more accurate representation of the energy use impacts of design options using the ERA energy model. (See Issue 13 under "Issues on Which DOE Seeks Comment" in section VII.E of this NOPR, below.)

6. Cost-Efficiency Curves

Chapter 5 of the NOPR TSD provides the full list of manufacturer production costs (MPCs) and MSPs at each efficiency level for each analyzed product class.

ACEEE/ASAP stated that DOE should not rely principally on manufacturer-provided cost curves. (ACEEE/ASAP, No. 43 at p. 6) This comment addresses the variation in the cost information provided to DOE by AHAM. ACEEE/ASAP cited (a) the lack of transparency of consolidated data provided by AHAM and (b) the expectation that such data do not accurately predict future costs as reasons why DOE should not rely on these data. The commenters urged DOE to use the lowest cost information provided by any manufacturer, since other manufacturers would have to adopt the lowest-cost design approaches to remain competitive, or they would lose market share, thus increasing the representativeness of the lowest-cost designs. (*Id.*) AHAM expressed concerns regarding how manufacturers reported cost data and will reevaluate its submissions to DOE. (AHAM, Public Meeting Transcript, No. 28 at pp. 89–90)

DOE has not received updated information. Because of the questions cited above regarding AHAM's data collection and aggregation, DOE has not attempted to present comparisons of DOE's NOPR analysis results with the preliminary analysis data provided by AHAM. DOE has developed curves representing the cost of achieving the analyzed efficiency levels using manufacturing cost modeling and energy modeling based on reverse engineering. DOE used its own curves in the downstream analyses such as the LCC/PBP and NIA analyses.

AHAM and GE requested clarification regarding the cost-efficiency curve presented on page 55 of the preliminary TSD, specifically asking which of the two design options labeled "VIP to FZR door" was actually the "VIP to FZR door" design option. (AHAM, No. 34 at p. 10; GE, Public Meeting Transcript, No. 28 at p. 85) DOE has since adjusted the analyses on which this comment was based (see the changes made to analyses between the preliminary analysis and NOPR phases listed in Table IV.10, above). Accordingly, this comment has been superseded by intervening events.

7. Development of Standards for Low-Volume Products

DOE sought comment on its approach to developing energy standards for low-volume products. Sub Zero commented on the high degree of uncertainty of the analysis which was based on computer models and selective teardowns, and suggested adding margins of uncertainty to the results. (Sub Zero, No. 40 at p. 3–4) AHAM recommended that DOE generate cost-efficiency curves for all product classes, since low shipment product classes (*i.e.,* low-volume compacts) have much smaller economies of scale and greater design challenges due to size and special constraints. As a result, these product classes have much higher costs and reduced energy efficiency improvements compared to the high-volume product classes. AHAM suggested that DOE request data to estimate cost-efficiency curves for low-volume products during MIA interviews. Finally, AHAM stressed that low-volume product classes can make up a major portion of a niche manufacturer's sales, so it is critical to evaluate these product classes as realistically as possible to be fair to these manufacturers. (AHAM, Public Meeting Transcript, No. 28 at pp. 98, 99 and No. 34 at pp. 7–8) Whirlpool agreed with AHAM and offered to provide data for all product classes in an effort to help DOE model low-volume product classes accurately. (Whirlpool, No. 31 at p. 2)

In response, DOE adopted AHAM's suggestion for certain low-volume products such as built-ins, for which DOE obtained detailed engineering data from a built-in manufacturer to allow development of cost-efficiency curves. However, because of limited resources, DOE cannot conduct a complete analysis for every product variation. DOE explained the proposed approach thoroughly during the framework meeting and in the framework document and was not urged by stakeholders at that time to consider detailed analyses of more product classes.

D. Markups To Determine Product Cost

The markups analysis develops appropriate markups in the distribution chain to convert the estimates of manufacturer cost derived in the engineering analysis to consumer prices. DOE determined the distribution channels for refrigeration products and the markups associated with the main parties in the distribution chain, manufacturers and retailers. DOE developed an average manufacturer markup by examining the annual Securities and Exchange Commission (SEC) 10–K reports filed by four publicly-traded manufacturers primarily engaged in appliance manufacturing and whose combined product range includes residential refrigeration products. For retailers, DOE developed separate markups for baseline products (baseline markups) and for the incremental cost of more-efficient products (incremental markups). Incremental markups are coefficients that relate the change in the manufacturer sales price of higher-efficiency models to the change in the retailer sales price.

Commenting on the preliminary TSD, AHAM filed supplemental comments that criticized DOE's application of "incremental" markups to the incremental manufacturer selling price of products more efficient than the baseline products. (AHAM, No. 34 at p. 14) In Exhibit B accompanying this comment, AHAM stated that (1) DOE provides no empirical evidence to validate that retailers obtain only incremental markups on products with greater features and costs; and (2) DOE is asserting a normative approach without any support showing that its model reflects actual retail practices. These comments effectively criticized two of the key assumptions in DOE's theoretical construct. The first of these assumptions is that the costs incurred by appliance retailers can be divided into costs that vary in proportion to the MSP (variable costs), and costs that do not vary with the MSP (fixed costs). The second of these assumptions is that retailer prices vary in proportion to retailer costs that are included in the balance sheets.

Regarding the first assumption, AHAM stated that DOE has offered no evidence that the fixed/variable cost mix of a retailer has anything to do in practice with the markups that will be earned by a retailer on products that meet a new energy conservation standard. It added that DOE uses a "spurious analogy" of HVAC contractors as a basis for considering the costs of a retailer, and that DOE did not analyze the actual drivers of retail costs, where the cost structure has considerably different characteristics from those of an HVAC contractor. It stated that DOE has not presented any data or analysis that would yield a fixed versus variable cost allocation applicable to retailers. Regarding DOE's second assumption, AHAM stated that DOE's approach depends on the presence of a relatively high level of competition in the retail industry. AHAM presented data showing that the four firm concentration ratio (FFCR) of the sectors that sell major appliances ranges from 42 to 65 percent, which verges on the standard definition of an oligopoly.[29]

In conclusion, AHAM viewed DOE's incremental markup approach as lacking a credible theoretical underpinning and demonstrated reliability and asserted that the data required for the approach are not available. AHAM stated that DOE should return to its traditional practice of using average markups for both the baseline products and for the added costs of efficiency improvements. In AHAM's view, the stability of markups in the retailing sectors leads to the reasonable inference that such markups will continue and apply to higher-efficiency products in the future when they become the bulk of sales under amended standards. (AHAM, No. 34, Exhibit B, p. 12) In addition to AHAM's comment, GE expressed concerns with the assumptions DOE is using in proposing a lower markup on energy efficiency improvements. (GE, No. 37 at pp. 2–3)

In response to the above comments, DOE extensively reviewed its incremental markup approach. It assembled and analyzed relevant data from other retail sectors, and held preliminary discussions with an expert retailing consultant. As a result of this research, DOE found that empirical evidence is lacking with respect to appliance retailer markup practices when a product increases in cost (due to increased efficiency or other factors). DOE understands that real-world retailer markup practices vary depending on market conditions and on the magnitude of the change in cost of goods sold (CGS) associated with an increase in appliance efficiency.

Given this uncertainty with respect to actual markup practices in appliance retailing, DOE uses an approach that reflects two key concepts. First, changes in the efficiency of the appliances sold are not expected to increase economic profits. Thus, DOE calculates markups/gross margins to allow cost recovery for retailers (including changes in the cost of capital) without changes in company profits. Second, efficiency improvements only impact some distribution costs. DOE sets markups to cover only the variable costs expected to change with efficiency.

DOE's separation of operating expenses into fixed and variable components to estimate an incremental markup follows from the above concepts. DOE defines fixed expenses as including labor and occupancy expenses because these costs are not likely to increase as a result of a rise in CGS due to amended efficiency standards. All other expenses, as well as the net profit, are assumed to vary in proportion to the change in CGS. DOE acknowledges that its allocation of expenses into fixed and variable categories is based largely on limited information and seeks additional information from interested parties to help refine its allocation approach.

[29] The FFCR represents the market share of the four largest firms in the relevant sector. Generally, an FFCR of less than 40 percent indicates that a sector is not concentrated and an FFCR of more than 70 percent indicates that a sector is highly concentrated.

DOE's method results in an outcome in which retailers are assumed to cover their costs while maintaining their profit margins when the CGS of appliances changes. Market competition is a main reason why DOE believes that profit margins would not change in a significant way. Regarding AHAM's assertion that the degree of competition in appliance retailing is not sufficient to support DOE's model, DOE believes that AHAM's measure of competition is faulty. AHAM measured the FFCR of three retail channels: Electronics and Appliance Stores, Building and Material and Supplies Dealers, and General Merchandise Stores. These values represent competitiveness within each sector, but refrigerators are sold across all three sectors, preventing major retailers in each sector from exercising significant market power. To properly measure the competitiveness within appliance retailing, DOE believes that one should measure the FFCR for only the appliance sub-sector within the above channels, and accordingly estimated the "appliance sales" FFCR, equal to the sector FFCR times the percent of appliance sales within each sector. DOE estimated that these sub-sector FFCRs are under the 40 percent threshold. Furthermore, "Household Appliance Stores," a subsector of the Electronics and Appliance Stores sector that specifically represents appliance retailers, rather than computer or other electronics stores, has an FFCR of 17 percent, signifying an unconcentrated sector.

Regarding AHAM's observation about the relative stability of average markups for the major retail channels that sell home appliances, DOE believes that the usefulness of this information for estimating markups on specific product lines is limited. The markups implied by gross margin at the level of major retail channels [30] are averaged over multiple product lines and many different store types. The empirical data at this level do not provide useful guidance for estimating what happens to the markup on specific products when their costs change. Applying the same markup as CGS increases, as AHAM recommends, would mean that the rise in CGS associated with higher-efficiency products would translate into higher retail gross margins for that product line. Since the majority of operating expenses would not be affected by the rise in CGS, the result would be an increase in net profit as a share of sales. While such an outcome could occur in the short run, DOE believes that competitive forces in the market would tend to decrease the profit margin over time.

Based on the above considerations, DOE has decided to continue to apply an incremental markup to the incremental MSP of products with higher efficiency than the baseline products. As part of its review, DOE developed a new breakdown into fixed and variable components using the latest expense data provided by the U.S. Census for Electronics and Appliance Stores, which cover 2002. The newly-derived incremental markup, which would be applied to an incremental change in CGS, is 1.17, which is slightly higher than the value of 1.15 that DOE used in the preliminary analysis. Chapter 6 of the NOPR TSD provides a description of both the method and its current application using the afore-mentioned data.

DOE requests information regarding the response of retailers to incremental change in the CGS of appliances associated with energy conservation standards. (See Issue 14 under "Issues on Which DOE Seeks Comment" in section VII.E, below.)

Chapter 6 of the NOPR TSD provides additional detail on the markups analysis.

E. Energy Use Analysis

DOE's analysis of the energy use of refrigeration products estimated the annual energy use of products in the field that would meet the considered efficiency levels, *i.e.,* as they are actually used by consumers. The energy use analysis provides the basis for other analyses DOE performs, particularly assessments of the energy-savings and the savings in consumer operating costs that could result from DOE's adoption of 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 refrigeration products in U.S. homes.

To determine the field energy use of products that would meet possible amended standard levels, DOE used data from the Energy Information Administration (EIA)'s 2005 Residential Energy Consumption Survey (RECS), which was the most recent such survey available at the time of DOE's analysis.[31] 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. RECS provides sufficient information to establish the type (product class) of refrigeration product used in each household, and also provides an estimate of the household's energy consumption attributable to "refrigerators" or "freezers". As a result, DOE was able to develop household samples for the representative product classes for standard-size units. DOE did not use RECS for compact refrigerators and freezers because a large fraction of these products are used outside the residential sector. Instead, it based the energy use for these products on the DOE test procedure.

The preliminary analysis treated the energy consumption attributed by RECS to refrigerators or freezers as the field energy consumption, referred to as FEC_{RECS}, of the refrigeration product(s) in each sample household. DOE derived a multiplicative 'usage adjustment factor' (UAF) that relates this quantity to the estimated test energy consumption of the products in each household. To develop a UAF for each RECS household, DOE utilized information that RECS provides on the size (*i.e.,* volume), age and the product class of the refrigeration product in use. DOE determined, for each household's unit, the corresponding maximum allowable tested energy consumption, referred to as TEC_{STD}, based on the energy conservation standard that was in effect at the time the household purchased the refrigeration product. Using FEC_{RECS} and TEC_{STD}, DOE then developed the UAF for each household to capture the combined effects of consumer behavior (*e.g.,* door openings), operating conditions (*e.g.,* room temperature and humidity), and product characteristics (*e.g.,* efficiency relative to the minimum allowable). The UAF represents the adjustment that needs to be made to the maximum allowable tested energy use to arrive at the field energy consumption of the refrigeration product.

Commenting on the preliminary TSD, AHAM criticized DOE's proposed approach for estimating the energy use of refrigerator-freezers, and stated that DOE should instead rely on the test procedure. (AHAM, No. 34 at pp. 11–12) Accompanying its comment, AHAM submitted Exhibit A, which elaborated

[30] The channels for which AHAM provided gross margin data for 1993–2007 are Electronics and Appliance Stores, General Merchandise Stores, and Building Material and Supplies Dealers. According to AHAM, these channels accounted for 43%, 31% and 17% of major appliance sales in 2007, respectively.

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

on AHAM's concerns criticisms.[32] In AHAM's view:

1. RECS data has served well as a directional, general guidance tool in energy policymaking, but the preliminary TSD proposes an unprecedented use of these data in a specific appliance energy efficiency rulemaking.

2. Use of RECS data to set a refrigerator/freezer standard is improper, legally flawed and is arbitrary and capricious. The proposed RECS data approach operates as a "black box," the inner workings of which are not well understood. The input data are not direct and actual measurements of energy use, but rather statistical inferences.

3. While the current, long-standing methodology that relies on the test procedure for determining future energy savings and PBP under a new or amended efficiency standard has a very clear basis in current law, the preliminary TSD proposal to use RECS data does not.

4. Because of its statistical deficiencies, the UAF approach does not permit the Secretary to rationally and substantially meet his legal obligation in this rulemaking to determine savings in operating costs and total projected amount of energy savings likely to result directly from imposition of the standard.

5. Rather than use RECS data, as the preliminary TSD proposes, DOE should amend and use the test procedure.

Whirlpool and LG also questioned DOE's approach, and recommended that DOE should use the test procedure and drop UAFs from the analysis. (Whirlpool, No. 31 at p. 2; LG, No. 41 at p. 1)

In response, DOE first addresses the appropriateness of using RECS data to estimate appliance energy use (AHAM's points 1 and 3, above). As further discussed below, DOE has used RECS data to help determine the energy use of covered products in many residential appliance standards rulemakings over the past decade. Regarding the legal basis for using RECS data, DOE uses RECS data because it helps DOE to evaluate two of the factors that EPCA directs the Secretary to consider in determining whether an energy conservation standard for a particular covered product is economically justified. The first of these is the economic impact of potential standards on the manufacturers and the consumers of the covered products. (42 U.S.C. 6295(o)(2)(B)(i)(I)) The second factor is the savings in operating costs throughout the estimated average life of the covered product in the type (or class) compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered products which are likely to result from the imposition of the standard. (42 U.S.C. 6295(o)(2)(B)(i)(II))

To evaluate economic impacts on consumers and the savings in operating costs as accurately as possible, DOE needs to determine the energy savings that are likely to result from a given standard. Such a determination requires knowledge of actual use of covered products by consumers. RECS provides information that helps DOE to determine such use.

In addition, DOE uses RECS data because it is consistent with the guidance contained in 10 CFR part 430, subpart C, appendix A—Procedures, Interpretations and Policies for Consideration of New or Revised Energy Conservation Standards for Consumer Products. Specifically, section 11 of appendix A lists variation in consumer impacts as one of the principles for the analysis of impacts on consumers. Because RECS is a representative sample of U.S. households that provides considerable information about each household in the sample, it allows DOE to evaluate factors that contribute to variation in the energy use of covered products. In turn, this allows DOE to estimate the fraction of consumers that will benefit from standards at various efficiency levels.

Consistent with the statute and DOE's regulatory guidance, DOE has used RECS data in a variety of ways over the past decade. In most cases, DOE has used the relevant DOE test procedure or a similar procedure as the basis for energy use calculation, and used RECS data to provide a range for key input variables concerning the operation of covered products. Examples include the standards rulemaking for water heaters concluded in 2001 (66 FR 4474 (January 17, 2001)), and in the recently-concluded rulemaking that amended standards for water heaters (75 FR 20112 (April 16, 2010)). In both rulemakings, DOE used data for each of the households in the RECS sample to estimate the amount of household daily hot water use, and to specify certain factors that affect water heater operating conditions.

Additionally, DOE's 2001 final rule for central air conditioners and heat pumps relied on annual energy use based on the annual end-use energy consumption values in RECS. 66 FR 7170 (January 22, 2001). DOE determined that basing the energy use on RECS household data provided a more accurate measure of the savings possible from more-efficient equipment, and accounted for variability due to climatic conditions and consumer behavior. The particular use of RECS data in the preliminary TSD to derive UAFs reflected a new analytical approach, but it was consistent with the purposes underlying DOE's use of RECS in previous rulemakings.

Regarding AHAM's recommendation that DOE should use the amended test procedure for refrigerator-freezers to estimate energy use for the purposes of its analysis of standards, test procedures must be reasonably designed to produce test results which measure energy efficiency, energy use or estimated annual operating cost of a covered product during a representative average use cycle or period of use. (42 U.S.C. 6293(b)(3)) Relying solely on a representative average use cycle or period of use does not provide an accurate measure of the possible energy savings since this approach inadequately evaluates the economic impact of the standard on consumers, and the savings in operating costs throughout the estimated life of the product—two factors under EPCA that DOE must consider when promulgating an amended energy conservation standard. Further, the approach suggested by AHAM would not account for the variability stemming from household differences or be consistent with the above-cited guidance contained in 10 CFR part 430, subpart C, appendix A. In contrast, the approach that DOE has used in residential product rulemakings for over a decade accounts for all of these factors.

DOE applies the test procedure to ascertain whether the consumer costs associated with the purchase of a product that complies with the proposed standard level is less than three times the value of the energy savings the consumer will receive during the first year of ownership. (42 U.S.C. 6295(o)(2)(B)(iii)) This calculation is separate from the payback periods calculated in the LCC and payback period analysis, as the latter is intended to assess the economic impact of potential standards on the consumers of the covered products. Both calculations are part of DOE's routine analysis when evaluating potential standards for a given product.

AHAM also questioned how DOE justifies using the test procedure to carry out its engineering analysis and manufacturing impact analysis while using a different set of values for

[32] Exhibit A: Evaluation of the Proposed Use by the Department of Energy of RECS Data in its Energy Use Determination Under the Preliminary Technical Support Document (TSD) for Refrigerators, Freezers and Refrigerator-Freezers.

carrying out a life-cycle cost and national impact analysis. (AHAM, No. 34 at p. 11) In the engineering analysis, DOE uses the test procedure to evaluate the relative improvement in energy efficiency provided by different design options. The manufacturing impact analysis uses the same cost-efficiency curves developed in the engineering analysis to calculate industry revenue. DOE does not rely solely on the test procedure in the LCC and payback period analysis or the national impact analysis for the reasons stated above.

AHAM's criticism of the statistical technique that DOE used to develop UAFs for refrigerator-freezers was echoed by other interested parties who raised issues regarding use of the RECS data. Whirlpool and GE stated that DOE should refrain from using RECS data for the rulemaking because it will be outdated and it does not discriminate between top- and bottom-mount refrigerators. (GE, No. 37 at p. 2; Whirlpool, No. 31 at p. 2) LG also commented that the RECS data are outdated, as many factors involved in household usage have changed since 2005. (LG, No. 41 at p. 2)

ACEEE supported DOE's efforts to develop UAFs to capture the difference between measured energy use in the lab and in-field energy use, but commented that the suggested approach is flawed. It urged DOE to look for any existing sets of metered field data that can be used to develop UAFs. (ACEEE, No. 43 at p. 2) NRDC also cautioned against the use of RECS data without metered data to help justify the conclusions, and urged DOE to collect metered data and explore all other data sources to keep the UAFs in perspective. (NRDC, No. 39 at p. 6) The IOUs also supported use of UAFs, but stated that ideally they should be based on metered data. (IOU, No. 36 at p. 10) NEEP expressed its general support for DOE's approach, but cautioned that RECS data misrepresents refrigeration-only energy use because it includes the energy used for icemaking. NEEP recommended taking icemaking energy use in the RECS data into account when developing UAFs. (NEEP, No. 38 at p. 2) Similarly, NPCC supported DOE's effort to estimate in situ energy use, but stated that DOE's use of statistical regression may result in exaggerated differences between test and field energy use. It stated that UAFs should be based on metered energy use or a regression that permits isolation of icemaking energy use. (NPCC, No. 33 at p. 2)

For the reasons previously discussed, DOE believes that, in general, using RECS data in the estimation of field energy use of refrigeration products is valid. However, it acknowledges that the approach used in the preliminary analysis has shortcomings. Recognition of these shortcomings, combined with the urging of several interested parties that DOE should look for existing sets of metered field data, prompted DOE to develop a new approach for the NOPR to estimate energy use of refrigeration products in U.S. homes. This approach involved collecting field-metered electricity use data for residential refrigeration products.

DOE was able to obtain data from seven studies, including about 100 data points that DOE collected itself. A total of 1,967 data points were collected that included units from all representative product classes except compact freezers, and spanned a variety of collection years, unit ages, U.S. locations and household populations, including some units used in commercial settings (*e.g.,* offices and hotels). DOE made various adjustments to the raw data, including extrapolation to annual electricity consumption where necessary.

Test energy consumption was obtained for each unit. From identifying information about each unit, test energy consumption was estimated for each unit and the UAF was calculated as the ratio of metered energy use to test energy use. The data were pooled into four categories: primary refrigerators, secondary refrigerators, freezers and compact refrigerators. Although DOE considered including data for compact refrigerators in the final analysis, it decided not to include those data due to concerns over data quality and representativeness.

For each category, DOE performed weighted least-squares regressions on numerous variables of potential interest in order to construct a function that predicts the UAF based on household and climate variables. DOE selected for final evaluation a small number of variables for which the regression results had sufficient statistical significance, and that could be obtained or reasonably inferred from RECS variables. Within each of the three product categories modeled, DOE used the appropriate set of regression coefficients, along with values for the relevant variables specific to each household to generate UAF estimates for each RECS household. For compact refrigeration products, a UAF of 1 was used.

Using the UAF derived for each RECS household, DOE determined the field energy consumption in each household of a new refrigeration product at each considered efficiency level using the following equation:

$$FEC_{EL} = FEC_{RECS} \bullet (1 - R) = UAF_{RECS} \bullet TEC_{RECS} \bullet (1 - R)$$

Where:

FEC_{EL} = new refrigeration product's field energy consumption at a given efficiency level;

FEC_{RECS} = new refrigeration product's field energy consumption at baseline efficiency level;

R = reduction in energy consumption (expressed as fraction) due to efficiency improvements;

UAF_{RECS} = usage adjustment factor specific to RECS household;

TEC_{RECS} = maximum allowable test energy consumption for the new baseline refrigeration product.

In order to make the 2005 RECS sample more representative of current refrigeration products, DOE made two modifications. First, DOE modified the RECS weights for top- vs. bottom-mount refrigerators in order to reflect current information on the relationship between income and refrigerator door style (*i.e.,* top- or bottom-mount) provided by AHAM in 2010. Second, DOE examined recent data from three sources [33] to scale the average interior volume of standard-size refrigerator-freezers from the 2005 RECS data. The average scaled volumes for product classes 3 (refrigerator-freezer—automatic defrost with top-mounted freezer without through-the-door ice service), 5 (refrigerator-freezers—automatic defrost with bottom-mounted freezer without through-the-door ice service) and 7 (refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service) are now 18.3, 20.9 and 24.8 cubic feet, respectively (approximately 2, 16 and 18 percent higher, respectively, than in the preliminary analysis). As for other factors affecting household usage, the field metered data indicate no significant differences in UAF with respect to survey year after 1993. DOE requests comments on the weighting of the RECS sample using income relationships and volume scaling. (*See* Issue 15 under "Issues on Which DOE Seeks Comment" in section VII.E, below.)

For compact refrigerators, DOE used a UAF of 1 in the preliminary analysis. AHAM commented that it supports using UAF of 1 for compact refrigeration

[33] California Energy Commission, Appliances Database—Refrigeration, 1998–2009. *http://www.energy.ca.gov/appliances/database/excel_based_files/Refrigeration/* (Last accessed April 25, 2009); The NPD Group, Inc., The NPD Group/NPD Houseworld—POS, Refrigerators, January–December 2008, 2007–2008, Port Washington, NY; and Association of Home Appliance Manufacturers, data from 2005–2008, memoranda dated January 19, 2009 and March 26, 2010, Washington, DC.

products. (AHAM, No. 34 at p. 12) Because DOE has concerns about the reliability of the metered data for compact refrigerators, it continued to use a UAF of 1 for the NOPR analysis.

Table IV.12 presents a comparison of the UAFs calculated using the above approach with those calculated for the preliminary TSD. The average UAFs in the NOPR analysis are less than those used in the preliminary TSD, particularly for standard-size freezers. DOE requests comments on its approach for developing UAFs using field-metered data. (*See* Issue 16 under "Issues on Which DOE Seeks Comment" in section VII.E, below.)

TABLE IV.12—AVERAGE UNIT ADJUSTMENT FACTORS USED IN THE ENERGY USE ANALYSIS

Product class		Preliminary TSD	NOPR
Number	Description		
3	Refrigerator-freezer—automatic defrost with top-mounted freezer without through-the-door ice service.	1.23	0.93 (0.82 to 1.04) *
5	Refrigerator-freezers—automatic defrost with bottom-mounted freezer without through-the-door ice service.	1.08	0.92 (0.81 to 1.02) *
7	Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service.	1.44	0.94 (0.84 to 1.03) *
9	Upright freezers with automatic defrost	1.37	0.85
10	Chest freezers	1.48	0.89
11	Compact refrigerators and refrigerator-freezers with manual defrost	1.00	1.00
18	Compact chest freezers	1.00	1.00

* Averages are based on lifetime distribution and include conversion to 2nd refrigerators. Range indicates average UAF in year 1 (minimum) and year 20 (maximum).

Whirlpool stated that DOE used a flawed approach in backing out icemaker energy use by identifying products with TTD ice as ice-making products and counting other types as not having an ice maker. (Whirlpool, No. 31 at p. 3) In fact, DOE made no such adjustments in deriving UAF data in the preliminary analysis. However, DOE was able to obtain from the field-metered data an average value for TTD icemaking energy consumption, which was subsequently removed for the purpose of calculating average UAFs. There were no data available in the metered data or in the 2005 RECS data to indicate whether an automatic icemaker was present. The revised UAF distributions implicitly include an uncertainty due to the possible presence of non-TTD automatic icemaking.

A detailed description of DOE's energy use analysis for refrigeration products is given in chapter 7 of the NOPR TSD.

F. Life-Cycle Cost and Payback Period Analyses

DOE conducted LCC and PBP analyses to evaluate the economic impacts on individual consumers of potential energy conservation standards for refrigeration products. 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 costs, DOE discounts future operating costs to the time of purchase and sums them over the 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 level, DOE measures the PBP and the change in LCC relative to an estimate of the base-case appliance efficiency levels. The base-case estimate reflects the market in the absence of amended 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. For the preliminary analysis and the analysis for today's proposed rule, DOE developed household samples from the 2005 RECS. For each sampled household, DOE determined the energy consumption for the refrigeration product and the electricity price. By developing a representative sample of households, the analysis captured the variability in energy consumption and energy prices associated with the use of residential refrigeration products.

Inputs to the calculation of total installed cost include the cost of the product—which includes manufacturer selling prices, retailer markups, and sales taxes—and installation costs. Inputs to the calculation of operating costs include annual energy consumption, energy prices and price projections, repair and maintenance costs, product lifetimes, discount rates, and the year that proposed standards take effect. DOE determined the operating costs for each sampled household using that household's unique energy consumption and the household's energy price. DOE created distributions of values for some inputs, with probabilities attached to each value, to account for their uncertainty and variability. 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 household 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 spreadsheet model, and of all the inputs to the LCC and PBP analyses, are contained in TSD chapter 8 and its appendices.

Table IV.13 summarizes the approach and data DOE used to derive inputs to the LCC and PBP calculations. The table provides the data and approach DOE used for the preliminary TSD, as well as the changes made for today's NOPR. The subsections that follow discuss the initial inputs and the changes DOE made to them.

TABLE IV.13—SUMMARY OF INPUTS AND KEY ASSUMPTIONS IN THE LCC AND PBP ANALYSIS*

Inputs	Preliminary TSD	Changes for the proposed rule
Installed 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.
Operating Costs		
Annual Energy Use	Based on energy use given in 2005 RECS for refrigerators or freezers, adjusted using a 'usage adjustment factor' (UAF) that adjusts the energy use from its test energy consumption to reflect field conditions.	Based on a multiple linear regression of field-metered energy use data, adjusted using a UAF function based on 2005 RECS household characteristics.
Energy Prices	Electricity: Based on EIA's Form 861 data for 2006	Electricity: Updated using Form 861 data for 2007.
	Variability: Regional energy prices determined for 13 regions	Variability: No change.
Energy Price Trends	Forecasted using Annual Energy Outlook 2009 *AEO2009*	Forecasts updated using *AEO2010.*
Repair and Maintenance Costs	Not included	Used repair cost estimation method that estimates the rate of failure for selected components along with the incremental cost of repair or replacement compared to the baseline product.
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 SCF ** for 1989, 1992, 1995, 1998, 2001, 2004 and 2007.	No change.
Compliance Date of New Standard.	2014	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 NOPR TSD.
** Survey of Consumer Finances.

1. Product Cost

To calculate consumer product costs, DOE multiplied the manufacturer selling prices developed in the engineering analysis by the supply-chain markups described above (along with sales taxes). DOE used different markups for baseline products and higher-efficiency products, because DOE applies an incremental markup to the MSP increase associated with higher-efficiency products.

2. Installation Cost

Installation cost includes labor, overhead, and any miscellaneous materials and parts needed to install the equipment. DOE did not include installation cost for refrigeration products because it understands that this cost would be the same at all of the considered efficiency levels.

3. Annual Energy Consumption

For each sampled household, DOE determined the energy consumption for a refrigeration product at different efficiency levels using the approach described above in section IV.E.

4. Energy Prices

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

DOE estimated average residential electricity prices for each of the 13 geographic areas based on data from EIA Form 861, "Annual Electric Power Industry Database." DOE calculated an average annual regional residential electricity price by: (1) Estimating an average residential price for each utility (by dividing the residential revenues by residential sales); and (2) weighting each utility by the number of residential consumers served in that region (based on EIA Form 861). DOE calculated average commercial electricity prices in a similar manner. For the preliminary TSD, DOE used EIA data for 2006. The NOPR analysis used the data for 2007.

5. Energy Price Projections

To estimate energy prices in future years for the preliminary TSD, DOE multiplied the above average regional electricity prices by the forecast of annual average residential electricity price changes in the Reference Case from *AEO2009.*[34] *AEO2009* forecasted prices through 2030. For today's proposed rule, DOE updated its energy price forecasts using *AEO2010,* which has an end year of 2035.[35] To estimate the electricity price trend after 2035, DOE used the average annual rate of change in prices from 2020 to 2035. DOE intends to update its energy price forecasts for the final rule based on the latest available *AEO.*

[34] 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.

[35] U.S. Energy Information Administration. *Annual Energy Outlook 2010.* Washington, DC. April 2010.

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 operation of the equipment. In its preliminary analysis, DOE did not include repair and maintenance costs because it did not have information suggesting that these costs would change with higher efficiency levels. Commenting on this approach, Whirlpool stated that maintenance and repair costs could be at least double current levels if there is greater reliance on more complex technologies to meet new efficiency levels, as such technologies have a higher cost of replacement components and may require additional training of service technicians. (Whirlpool, No. 31 at p. 3) AHAM stated that higher efficiency products typically contain more components that may need repair and have a higher individual component cost. (AHAM, No. 34 at p. 13) In contrast, ACEEE supported DOE's finding that repair and maintenance costs do not vary with efficiency level. (ACEEE, No. 43 at p. 6)

For the NOPR, DOE developed a new repair cost estimation method that estimates the rate of failure for selected components (compressor, evaporator, condenser, evaporator fan, condenser fan, electronics and automatic icemaker). The estimated average annual repair cost for a given efficiency level can be expressed as the product of two elements: the average rate of repair of a component (expressed as annual probability of failure) times the incremental cost of repair or replacement compared to the baseline product.

DOE obtained repair rates for some components from a prior DOE rulemaking for commercial refrigeration equipment,[36] and used these rates to make estimates of repair rates for some other components. In addition, DOE obtained cumulative total annual repair rates for standard-size refrigerator-freezers for units up to five years old from *Consumer Reports* magazine. DOE used these data to adjust the repair rates estimated for specific components for each product class. DOE was not able to determine a clear trend in repair rate with age, so it used the average repair rate for all years for each product class. For product classes not covered by the *Consumer Reports* data, DOE used the average repair rate for standard-size refrigerator-freezers.

To estimate the total annual repair cost for the baseline products, DOE used retail repair costs by component from data reported by Best Buy Co., Inc. Detailed data on incremental MSP for components was available from the engineering analysis by product class and efficiency level. To convert these values to repair costs, DOE derived the cost to the contractor, and then scaled it to account for the contractor markup.

Nearly all residential refrigerators are sold with a one-year repair warranty. Based on this fact, DOE assumed there were no repair costs for consumers during the first year of operation and the annual average incremental repair cost as calculated above was imposed for all subsequent years of the lifetime of the product. Table IV.14 shows the annual average incremental repair cost by efficiency level for product classes 3 (refrigerator-freezer—automatic defrost with top-mounted freezer without through-the-door ice service), 5 (refrigerator-freezers—automatic defrost with bottom-mounted freezer without through-the-door ice service), and 7 (refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service). DOE requests comments on its derivation of repair costs. (*See* Issue 17 under "Issues on Which DOE Seeks Comment" in section VII.E, below.)

TABLE IV.14—ANNUAL AVERAGE INCREMENTAL REPAIR COST BY EFFICIENCY LEVEL FOR STANDARD-SIZE REFRIGERATOR-FREEZERS

Efficiency level (% less than baseline energy use)	Product class 3 ($)	Product class 5 ($)	Product class 7 ($)
Baseline			
1 (10)	$0.04	$0.22	$0.09
2 (15)	0.08	0.33	0.21
3 (20)	0.37	0.42	0.36
4 (25)	0.40	0.76	0.73
5 (30)	0.43	1.32	1.10
6 (33–36) *	0.67	1.76	1.10

* Max-tech level varies with product class.

7. Product Lifetime

Because the basis for lifetime estimates in the literature for refrigeration products is uncertain, DOE used other data sources to estimate the distribution of standard-size refrigerator and freezer lifetimes in the field for both the preliminary analysis and today's NOPR. By combining survey results from various years of RECS and the U.S. Census's *American Housing Survey*[37] with the known history of appliance shipments, DOE estimated the fraction of appliances of a given age still in operation. The survival function, which DOE assumed has the form of a cumulative Weibull distribution, provides an average and median appliance lifetime.

For compact refrigerators, DOE estimated an average lifetime of 5.6 years in the preliminary analysis using data on shipments and the stock-in-place (*i.e.,* the number of units in use). NRDC commented that the estimated lifetime for compact refrigerators is too low and that "the industry suggested" life of ten years is more accurate. (NRDC, No. 39 at p. 6) In contrast, AHAM and Whirlpool supported DOE's estimate. (AHAM, No. 34 at p. 13; Whirlpool, No. 31 at p. 3) DOE found that, given the data on historic shipments of compact refrigerators, using a longer lifetime would result in an equipment stock that is far larger than the stock given by 2005 RECS and EIA's 2003 Commercial Building Energy Consumption Survey. Since the estimate used in the preliminary analysis provides a reasonable match between shipments and the stock, DOE used the same lifetime distribution for the NOPR.

[36] Commercial Refrigeration Equipment Final Rule Technical Support Document. Available at: *http://www1.eere.energy.gov/buildings/appliance_standards/commercial/refrig_equip_final_rule_tsd.html.*

[37] U.S. Census Bureau, American Housing Survey. Available at: *http://www.census.gov/hhes/www/housing/ahs/ahs.html.*

See chapter 8 of the NOPR TSD for further details on the method and sources DOE used to develop product lifetimes.

8. Discount Rates

To establish discount rates for the LCC analysis, DOE identified all debt or asset classes that might be used to purchase refrigeration products, including household assets that might be affected indirectly. DOE used data from the Federal Reserve Board's "Survey of Consumer Finances" (SCF) for 1989, 1992, 1995, 1998, 2001, 2004, and 2007 to estimate the average percentages of the various debt and equity classes in the average U.S. household portfolios. DOE used SCF data and other sources to develop distributions of interest or return rates associated with each type of equity and debt. The average rate across all types of household debt and equity, weighted by the shares of each class, is 5.1 percent. While this value corresponds to the average discount rate, DOE assigned each sample household a specific discount rate drawn from the distributions.

DOE derived the discount rate for commercial-sector compact refrigeration products from the cost of capital of publicly-traded firms in the sectors that purchase those products (these include lodging and other commercial sectors). The firms typically finance equipment purchases through debt and/or equity capital. DOE estimated the cost of the firms' capital as the weighted average of the cost of equity financing and the cost of debt financing for recent years for which data were available (2001 through 2008). The estimated average discount rate for companies that purchase compact refrigeration products is 6.2 percent.

See chapter 8 in the NOPR TSD for further details on the development of discount rates for refrigeration products.

9. Compliance Date of Amended Standards

In the context of EPCA, the compliance date is the future date when parties subject to the requirements of a new standard must begin to comply. As described in DOE's semi-annual implementation report for energy conservation standards activities submitted to Congress, a final rule for the refrigeration products that are the subject of this rulemaking is scheduled to be completed by December 31, 2010. Compliance with amended standards for refrigeration products promulgated by DOE would be required three years after the final rule is published in the **Federal Register**. DOE calculated the LCC and PBP for refrigeration products as if consumers would purchase new products in the year compliance with the standard 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's LCC analysis considered the projected distribution of product efficiencies that consumers purchase under the base case (*i.e.,* the case without new energy efficiency standards). DOE refers to this distribution of product of efficiencies as a base-case efficiency distribution. DOE developed base-case efficiency distributions for each of the seven representative product classes. These distributions were developed from industry-supplied data for the year 2007 and were comprised of product efficiencies ranging from existing baseline levels (*i.e.,* meeting existing energy conservation standards) to levels meeting and exceeding ENERGY STAR levels. DOE then projected these distributions to the year that new standards are assumed to become effective (2014). To forecast the base-case efficiency distribution for each representative product class in the preliminary analysis, DOE accounted for change in the market shares of ENERGY STAR appliances based on historical trends.

In the preliminary analysis public meeting, ASAP and Whirlpool questioned DOE's forecast that, in 2014, ENERGY STAR products would reach a market share of 88 percent for bottom-mount refrigerator-freezers. (ASAP, No. 28 at p. 179–180; Whirlpool, No. 28 at p. 180) In their comments, AHAM, GE and Whirlpool expressed doubt with respect to DOE's forecast, and AHAM and GE noted that consumer payback diminishes at higher efficiency levels. (GE, No. 37 at p. 2; Whirlpool, No. 31 at p. 3; AHAM, No. 34 at p. 14)

Based on the comments and shipments data for 2008, DOE modified its approach for estimating base-case efficiency distributions for the NOPR analysis. DOE agrees that because the current ENERGY STAR efficiency level is higher than it was prior to the requirements established in 2008, the growth in market share may be slower. To address this issue, DOE adopted a projected market share of ENERGY STAR models in 2014 (under current requirements) that is equal to the average of ENERGY STAR market shares in 2007 (the last year under the old requirements) and 2008 (when current requirements took effect). With this approach, the ENERGY STAR market shares for product class 3 (refrigerator-freezer—automatic defrost with top-mounted freezer without through-the-door ice service) and product class 5 (refrigerator-freezers—automatic defrost with bottom-mounted freezer without through-the-door ice service) grow more slowly between 2008 and 2014 than they had under the old requirements before 2008. ENERGY STAR products reach a market share in 2014 of 8 percent for product class 3 and 68 percent for bottom-mount refrigerator-freezers. For standard-size freezers and compact products, DOE maintained the same approach for the NOPR as it used in the preliminary analysis.

For further information on DOE's estimate of base-case efficiency distributions, see chapter 8 of the NOPR TSD. DOE requests comments on its approach for estimating base-case efficiency distributions. (*See* Issue 18 under "Issues on Which DOE Seeks Comment" in section VII.E of this NOPR, below.)

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 increased total installed cost is not recovered in reduced operating expenses.

The inputs to the PBP calculation are the total installed cost of the equipment to the customer for each efficiency level and the 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.

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.

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

DOE's NIA assessed the national energy savings (NES) and the national NPV of total consumer costs and savings that would be expected to result from amended standards at specific efficiency levels. ("Consumer" in this context refers to consumers of the product being regulated.)

To make the analysis more accessible and transparent to all interested parties, DOE used an MS Excel spreadsheet model to calculate the energy savings and the national consumer costs and savings from each TSL. MS Excel is the most widely used spreadsheet calculation tool in the United States and there is general familiarity with its basic features. Thus, DOE's use of MS Excel as the basis for the spreadsheet models provides interested parties with access to the models within a familiar context. In addition, the TSD and other documentation that DOE provides during the rulemaking help explain the models and how to use them, and interested parties can review DOE's analyses by changing various input quantities within the spreadsheet.

DOE used the NIA spreadsheet to calculate the NES and NPV, based on the annual energy consumption and total installed cost data from the energy use characterization and the LCC analysis. DOE forecasted the energy savings, energy cost savings, product costs, and NPV of consumer benefits for each product class for products sold from 2014 through 2043. The forecasts provided annual and cumulative values for all four output parameters. In addition, DOE used its NIA spreadsheet to analyze scenarios that used inputs from the *AEO2010* Low Economic Growth and High Economic Growth cases. These cases have higher and lower energy price trends compared to the Reference case, as well as higher and lower housing starts, which result in higher and lower appliance shipments to new homes. NIA results based on these cases are presented in appendix 10–A of the NOPR TSD.

DOE evaluated the impacts of amended standards for refrigeration products 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 amended energy conservation standards. DOE compared these projections with projections characterizing the market for each product class if DOE were to adopt amended standards at specific energy efficiency levels (*i.e.,* the standards cases) for that class.

Table IV.15 summarizes the approach and data DOE used to derive the inputs to the NES and NPV analyses for the preliminary analysis and the changes to the analyses for the proposed rule. A discussion of these inputs and changes follows the table. See chapter 10 of the NOPR TSD for further details.

TABLE IV.15—APPROACH AND DATA USED FOR NATIONAL ENERGY SAVINGS AND CONSUMER NET PRESENT VALUE ANALYSES

Inputs	Preliminary TSD	Changes for the proposed rule
Shipments	Annual shipments from shipments model	No change in approach; used 2008 data to estimate the ratio of bottom-mount share to side-by-side share.
Compliance Date of Standard	2014	No change.
Base-Case Forecasted Efficiencies.	Used a "roll-up + ENERGY STAR" scenario to establish the distribution of efficiencies.	No change in basic approach; modified efficiency distributions based on new information.
Standards-Case Forecasted Efficiencies.	Used a "roll-up + ENERGY STAR" scenario to establish the distribution of efficiencies.	No change in basic approach; modified efficiency distributions based on new information.
Annual Energy Consumption per Unit.	Annual weighted-average values as a function of SWEUF.*	No change.
Total Installed Cost per Unit	Annual weighted-average values as a function of SWEUF.*	No change.
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.
Escalation of 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 DOE/EIA's NEMS	No change.
Discount Rate	Three and seven percent real	No change.
Present Year	Future expenses are discounted to 2010, when the final rule will be published.	No change.

* Shipments-Weighted Energy Use Factor

1. Shipments

The shipments portion of the NIA spreadsheet is a model that uses historical data as a basis for projecting future shipments of the products that are the subject of this rulemaking. In projecting shipments for refrigeration products, DOE accounted for installations in new homes and replacement of failed equipment. In addition, for standard-size refrigerator-freezers, DOE estimated purchases driven by the conversion of a first refrigerator to a second refrigerator. It also estimated purchases by existing households who enter the market as new owners for standard-size freezers.

In the preliminary analysis, DOE examined the historical trends in the market shares of different refrigerator-freezer configurations to disaggregate the total shipments of refrigerator-freezers into the three considered refrigerator-freezer product categories (top-mount, bottom-mount and side-by-side configurations). The market share of side-by-side refrigerator-freezer models has grown significantly during the past two decades. Bottom-freezer models historically had a small market share, but that share has also grown in recent years. However, DOE had insufficient data to forecast long-term growth of this product class, so DOE assumed that consumer behavior related to bottom-mount models in the future would mirror behavior regarding side-by-side models. DOE developed a model to forecast the combined bottom-mount and side-by-side market shares throughout the 30-year forecast period (beginning in 2014), and assumed that the ratio of bottom-mount share to side-by-side share would remain constant at the 2007 level (the last year for which DOE had disaggregated data).

AHAM commented that DOE's forecasted shares look realistic, but it suggested that DOE consider generating a separate forecast for bottom-mount refrigerator-freezers. (AHAM, No. 34 at p. 14) Whirlpool stated that DOE's approach is directionally correct, but in recent years the decline in top-mount sales and the rise in bottom-mount sales have been more pronounced. It also suggested that DOE should forecast bottom-mount sales separately and reassess the proportion of top-mount sales. (Whirlpool, No. 31 at p. 4)

As discussed above, DOE was not able to obtain sufficient information to separately forecast sales of bottom-mount refrigerator-freezers. Therefore, it retained the approach used for the preliminary analysis in conducting the NOPR analysis, but it used 2008 data to estimate the ratio of bottom-mount share to side-by-side share.

To estimate the effects on product shipments from increases in product price projected to accompany amended standards at higher efficiency levels, DOE applied a price elasticity parameter. It estimated this parameter with a regression analysis that used purchase price and efficiency data specific to residential refrigerators, clothes washers, and dishwashers over the period 1980–2002. The estimated "relative price elasticity" incorporates the impacts from purchase price, operating cost, and household income, and it also declines over time. DOE estimated shipments in each standards case using the relative price elasticity along with the change in the relative price between a standards case and the base case.

ACEEE commented that DOE should revisit its estimates of price elasticity to avoid overstating the impact of standards on future refrigerator sales. It noted that refrigerators are different from clothes washers and dishwashers because consumers have few, if any, alternatives for storing perishable foods. It recommended that DOE consider refrigerator shipments for new construction to be inelastic and that DOE should use a significantly lower price elasticity for replacement purchases. (ACEEE, No. 43 at p. 5) NPCC and the IOUs made similar comments. (NPCC, No. 33 at p. 3; IOUs, No. 36 at p. 12) Earthjustice commented that the price elasticity for refrigerators is less elastic than for other white goods (*i.e.,* large electrical home appliances that are typically finished in white enamel), and it should not be applied to new construction. (Earthjustice, No. 35 at p. 6)

In response, DOE believes that the price elasticity calculated using the full data set for refrigerators, clothes washers, and dishwashers is more robust than an elasticity calculated only for refrigerators because it is based on a larger data sample. Furthermore, the elasticity calculated only for refrigerators is not very different from the value derived from the combined appliance regression equation. DOE does not agree with the comment that there would be no sensitivity to product price of refrigerator shipments for new homes because there is some discretion regarding purchase of a second unit. Furthermore, since DOE derived its price elasticity using data for all shipments, it is appropriate to apply the parameter to total shipments (rather than total shipments excluding shipments to new homes). Based on the above considerations, DOE retained the approach used for the preliminary analysis in the NOPR analysis.

For details on the shipments analysis, see chapter 9 of the NOPR 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 standards) and each of the standards cases. To forecast the base-case efficiency distribution for each representative product class, DOE accounted for change in the market shares of ENERGY STAR appliances based on historical trends. For its determination of standards-case efficiency distributions, DOE used a "roll-up + ENERGY STAR" scenario to establish the distribution of efficiencies for the year in which compliance with amended standards is required (*i.e.,* 2014). DOE assumed that product efficiencies in the base case that did not meet the standard level under consideration would "roll up" to meet the new standard level in 2014. It further assumed that the ENERGY STAR program and related efforts would continue to promote efficient appliances after the introduction of amended standards in 2014, and that this would lead to increased market shares for products with an efficiency level above the standard level.

For the NOPR analysis, DOE used the same basic approach, but, as discussed below, it modified its base-case and standards-case efficiency distributions based on information obtained in discussion with ENERGY STAR program staff.

To project the efficiency distributions after 2014 for the base case, DOE first considered the potential for changes in ENERGY STAR qualification levels. DOE assumed that, in the absence of a new standard, the ENERGY STAR program would re-examine and possibly revise its qualification levels regardless of the market share in 2014. When setting a minimum product efficiency level for ENERGY STAR qualification, one important metric is that the average payback period compared to the current standard level should not exceed five years. Using the payback period calculation described in section IV.F, DOE applied this criterion to all product classes to evaluate the extent to which the current ENERGY STAR efficiency levels would be increased in the future.

DOE then estimated the market shares for ENERGY STAR products in 2021 based on past experience in the market for these products. As in the preliminary analysis, rather than make long-term projections based on limited information, DOE assumed there would be no further change in market shares between 2021 and the end of the forecast period. DOE recognizes that some change in shares is likely to occur in reality. However, since DOE used the same assumption in the standards cases, the accuracy of the assumption makes no difference to the analysis of energy savings.

For the standards cases (also referred to as candidate standard levels, or CSLs), DOE used the same approach as for the base case and assumed that in the case of amended standards, the ENERGY STAR program would re-evaluate its qualifying levels for all product classes using the five-year payback period criterion. For each CSL, DOE identified the maximum efficiency level with a payback of five years or less. If that level was below the current ENERGY STAR level, DOE maintained the current ENERGY STAR level. At higher CSLs, there is no efficiency level above the standard level with a payback period of less than 5 years. DOE assumed that the ENERGY STAR program would be suspended with standards at higher CSLs on a product-class specific basis. This result is projected to occur for all product classes at CSL 3 and above; for product classes 9 (upright freezers with automatic defrost) and 10 (chest freezers and all other freezers except compact freezers), it occurs at lower CSLs. The market share estimates for ENERGY STAR products in 2021 and beyond were based on a similar approach as for the base case.

For further details about the forecasted efficiency distributions, see chapter 10 of the NOPR TSD. DOE requests comments on its approach for forecasting base-case and standards-case efficiency distributions. (See Issue 19 under "Issues on Which DOE Seeks Comment" in section VII.E of this NOPR.)

3. Site-to-Source Energy Conversion

To estimate the national energy savings expected from appliance standards, DOE uses a multiplicative factor to convert site energy consumption (at the home or commercial building) into primary or source energy consumption (the energy required to 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 projected changes in generation sources (*i.e.,* the power plant types projected to provide electricity to the country). The factors that DOE developed are marginal values, which represent the response of the system to an incremental decrease in consumption associated with appliance standards.

In the preliminary analysis, DOE used annual site-to-source conversion factors based on the version of NEMS that corresponds to *AEO2009.* For today's NOPR, DOE updated its conversion factors based on *AEO2010,* which provides energy forecasts through 2035. For 2036–2043, DOE used conversion factors that remain constant at the 2035 values.

In response to a request from DOE's Office of Energy Efficiency and Renewable Energy (EERE), the National Research Council (NRC) appointed a committee on "Point-of-Use and Full-Fuel-Cycle Measurement Approaches to Energy Efficiency Standards" to conduct a study required by section 1802 of the Energy Policy Act of 2005 (Pub. L. 109–58 (August 8, 2005)). The fundamental task before the committee was to evaluate the methodology used for setting energy efficiency standards and to comment on whether site (point-of-use) or source (full-fuel-cycle) measures of energy savings would better support rulemaking efforts to achieve energy conservation goals. The NRC committee defined site (point-of-use) energy consumption as reflecting the use of electricity, natural gas, propane, and/or fuel oil by an appliance at the site where the appliance is operated. Full-fuel-cycle energy consumption was defined as including, in addition to site energy use, the following: energy consumed in the extraction, processing, and transport of primary fuels such as coal, oil, and natural gas; energy losses in thermal combustion in power generation plants; and energy losses in transmission and distribution to homes and commercial buildings.[38]

In evaluating the merits of using point-of-use and full-fuel-cycle measures, the NRC committee noted that DOE uses what the committee referred to as "extended site" energy consumption to assess the impact of energy use on the economy, energy security, and environmental quality. The extended site measure of energy consumption includes the 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 NRC committee concluded that extended site energy consumption understates the total energy consumed to make an appliance operational at the site. As a result, the NRC committee 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 NRC committee also recommended that DOE provide more comprehensive information to the public through labels and other means, such as an enhanced Web site. For those appliances that use multiple fuels (*e.g.,* water heaters), the NRC committee 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. The NRC committee also acknowledged the complexities inherent in developing a full-fuel-cycle measure of energy use and stated that a majority of the committee recommended a gradual transition from extended site to full-fuel-cycle measurement.

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

Based on two studies completed by the National Renewable Energy Laboratory (NREL) in 1999 and 2000, DOE estimated the ratio of the energy used upstream to the energy content of the coal or natural gas delivered to power plants. For coal, the NREL analysis considered typical mining practices and mine-to-plant transportation distances, and used data for the State of Illinois. Based on data in this report, the estimated multiplicative factor for coal is 1.08 (*i.e.,* it takes approximately 1.08 units of coal energy equivalent to provide 1 unit of coal to a power plant). A similar analysis of the energy consumed in upstream processes needed to produce and deliver natural gas to a power plant yielded a multiplicative factor of 1.19.[39]

While the above factors are indicative of the magnitude of the impacts of using full-fuel-cycle measures of energy use, there are two issues that warrant further study. The first is refinement of the estimates of the multiplicative factors, particularly to incorporate regional variation. The second is developing forecasts of the multiplicative factors over the time frames used in the rulemaking analyses, typically ten to fifty years. The existing NEMS forecast of power plant electricity generation by fuel type can be used to estimate the impact of a changing mix of fuels. However, NEMS provides no information on potential changes to the relative ease with which the different fuels can be extracted and processed, which shape the multiplicative factors.

[38] 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.

[39] For further information on the NREL studies, please see: Spath, Pamela L., Margaret K. Mann, and Dawn Kerr, Life Cycle Assessment of Coal-fired Power Production, NREL/TP–570–25119, June 1999; and Spath, Pamela L. and Margaret K. Mann, Life Cycle Assessment of a Natural Gas Combined-Cycle Power Generation System, NREL/TP–570–27715, September 2000.

DOE intends to further evaluate the viability of using full-fuel-cycle measures of energy consumption for assessment of national and environmental impacts of appliance standards.

4. Discount Rates

DOE multiplies monetary values in future years by the discount factor to determine the present value. For the preliminary analysis and today's NOPR, DOE estimated the NPV of appliance consumer benefits using both a 3-percent and a 7-percent real discount rate. DOE uses these discount rates in accordance with guidance provided by the Office of Management and Budget (OMB) to Federal agencies on the development of regulatory analysis (OMB Circular A–4 (Sept. 17, 2003), section E, "Identifying and Measuring Benefits and Costs").

5. Benefits From Effects of Standards on Energy Prices

Reduction in electricity consumption associated with amended standards for refrigeration products could reduce the electricity prices charged to consumers in all sectors of the economy and thereby reduce their electricity expenditures. In chapter 2 of the preliminary TSD, DOE explained that, because the power industry is a complex mix of fuel and equipment suppliers, electricity producers and distributors, it did not plan to estimate the value of potentially reduced electricity costs for all consumers associated with amended standards for refrigeration products.

Commenting on this decision, NRDC urged DOE to not ignore the benefits to consumers from reduced electricity rates and avoided new capacity construction due to amended standards for refrigeration products. (NRDC, No. 39 at pp. 5–6) Earthjustice, NEEP, and the IOUs stated that DOE should account for the economic value of avoided investments in electric utility capacity resulting from the standards under consideration. (Earthjustice, No. 35 at p. 6; NEEP, No. 38 at p. 2; IOUs, No. 36 at pp. 12–13) Similarly, NPCC stated that DOE should estimate the economic benefits of the reduced need for new electric power plants and infrastructure and include these in its utility impacts analysis. (NPCC, No. 33 at pp. 4–5)

For the NOPR, DOE incorporated the same approach that it did in the recently-promulgated final rule for residential heating products. 75 FR 20112 (April 16, 2010). As part of the utility impact analysis (described in section IV.K below), DOE used NEMS–BT to assess the impacts of the reduced need for new electric power plants and infrastructure projected to result from standards. In NEMS–BT, changes in power generation infrastructure affect utility revenue requirements, which in turn affect electricity prices. DOE estimated the impact on electricity prices associated with each considered TSL.

Although the aggregate benefits for all electricity users are potentially large, there may be negative effects on the actors involved in electricity supply. The electric power industry is a complex mix of power plant providers, fuel suppliers, electricity generators, and electricity distributors. While the distribution of electricity is regulated everywhere, the institutional structure of the power sector varies, and has changed over time. For these reasons, an assessment of impacts on the actors involved in electricity supply from reduction in electricity demand associated with energy conservation standards is beyond the scope of this rulemaking.

In considering the potential benefits to electricity users, DOE takes under advisement the guidance provided by OMB on the development of regulatory analysis. Specifically, at page 38, Circular A–4 instructs that transfers should be excluded from the estimates of the benefits and costs of a regulation. Because there is uncertainty about the extent to which the calculated impacts from reduced electricity prices are a transfer from the actors involved in electricity supply to electricity consumers, DOE has concluded that, at present, it should not give a heavy weight to this factor in its consideration of the economic justification of standards on refrigeration products. DOE is continuing to investigate the extent to which electricity price changes projected to result from standards represent a net gain to society.

H. Consumer Subgroup Analysis

In analyzing the potential impact of new or amended standards on consumers, DOE evaluates the impact on identifiable sub-groups of consumers that may be disproportionately affected by a national standard. DOE evaluates impacts on particular sub-groups of consumers primarily by analyzing the LCC impacts and PBP for those particular consumers from alternative standard levels. For the NOPR, DOE analyzed the impacts of the considered standard levels on low-income consumers and senior citizens. DOE did not estimate impacts for compact refrigeration products because the household sample sizes were not large enough to yield meaningful results.

Chapter 2 of the preliminary TSD notes that did not plan to analyze renters as a sub-group. NRDC disagreed with DOE's view that renters do not warrant a sub-group analysis, as they may be more positively affected by higher standards than the population of all consumers. (NRDC, No. 39 at pp. 4–5) NRDC provided no supporting data for its assertion. DOE notes that, in most cases, renters pay the electricity bill but do not own the refrigerator in their home. To some extent, the higher cost of a more-efficient refrigerator-freezer incurred by the building owner would likely be passed on to the renter through increased rent. Because DOE is not aware of information that would allow it to reliably assess the extent to which such "pass-through" would occur, it is not able to quantitatively analyze the impacts of alternative standard levels on renters. To the extent that "pass-through" of the incremental cost of of a more-efficient refrigerator-freezer does not occur, DOE acknowledges that renters would likely experience more favorable LCC impacts than non-renters.

Chapter 11 in the NOPR describes the consumer sub-group analysis.

I. Manufacturer Impact Analysis

The following sections address the various steps taken to analyze the impacts of standards on manufacturers. These steps include conducting a series of analyses, interviewing manufacturers, and evaluating the comments received from interested parties up to this point during the course of this rulemaking.

1. Overview

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

The MIA is both a quantitative and qualitative analysis. The quantitative part of the MIA relies on the Government Regulatory Impact Model (GRIM), an industry cash-flow model customized for the residential refrigeration products covered in this rulemaking. *See* section IV.I.2, below, for details on the GRIM analysis. The qualitative part of the MIA addresses factors such as product characteristics, characteristics of particular firms, and market trends. The qualitative discussion also includes an assessment of the impacts of standards on manufacturer subgroups. The complete MIA is discussed in chapter 12 of the NOPR TSD. DOE conducted the MIA in the three phases described below.

a. Phase 1: Industry Profile

In Phase 1 of the MIA, DOE prepared a profile of the residential refrigeration industry based on the market and technology assessment prepared for this rulemaking. Before initiating the detailed impact studies, DOE collected information on the present and past structure and market characteristics of each industry. This information included market share data, product shipments, manufacturer markups, and the cost structure for various manufacturers. The industry profile includes: (1) Further detail on the overall market and product characteristics; (2) estimated manufacturer market shares; (3) financial parameters such as net plant, property, and equipment; selling, general and administrative (SG&A) expenses; cost of goods sold, *etc.;* and (4) trends in the number of firms, market, and product characteristics. The industry profile included a top-down cost analysis of residential refrigeration manufacturers that DOE used to derive preliminary financial inputs for the GRIM (*e.g.,* revenues, depreciation, SG&A, and research and development (R&D) expenses). DOE also used public sources of information to further calibrate its initial characterization of each industry, including Security and Exchange Commission 10–K filings (available at *http://www.sec.gov*), Standard & Poor's stock reports (available at *http://www2.standardandpoors.com*), and corporate annual reports. DOE supplemented this public information with data released by privately held companies.

b. Phase 2: Industry Cash-Flow Analysis

Phase 2 focused on the financial impacts of potential amended energy conservation standards on the industry as a whole. More stringent energy conservation standards can affect manufacturer cash flows 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/or possible changes in sales volumes. To quantify these impacts, DOE used the GRIM to perform a cash-flow analysis for residential refrigerators, freezers, and refrigerator-freezers. In performing these analyses, DOE used the financial values derived during Phase 1 and the shipment scenarios used in the NIA.

c. Phase 3: Subgroup Impact Analysis

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

DOE reports the MIA impacts of amended energy conservation standards by grouping together the impacts on manufacturers of certain product classes. DOE presents the industry impacts by the major product types (*i.e.,* standard size refrigerator-freezers, standard size freezers, compact refrigerators and freezers, and built-in refrigeration products). These product groupings represent markets that are served by the same manufacturers. By segmenting the results into these product types, DOE is able to discuss how these subgroups of manufacturers will be impacted by amended energy conservation standards.

DOE also investigated whether small business manufacturers should be analyzed as a manufacturer subgroup. During its research, DOE identified only one company which manufactures products covered by this rulemaking and qualifies as a small business under the applicable Small Business Administration (SBA) definition. DOE did not analyze a separate subgroup of small business manufacturer for this NOPR because this rulemaking will not have a significant economic impact on a substantial number of small entities. See section VI.B of today's NOPR, below, for more information on this determination.

A second potential subgroup would be manufacturers of built-in refrigeration products. However, because DOE is establishing separate product classes for built-in products, DOE is already presenting separate results and impacts for this potential manufacturer subgroup. The impacts on the manufacturers of these niche products are therefore already characterized in the broader MIA and do not require an explicit subgroup analysis.

2. GRIM Analysis

DOE uses the GRIM to quantify the changes in cash flow that result in a higher or lower industry value. The GRIM analysis is a standard, annual cash-flow analysis that incorporates manufacturer costs, manufacturer selling prices, shipments, and industry financial information as inputs, and models changes in costs, distribution of shipments, investments, and manufacturer margins that would result from amended energy conservation standards. The GRIM spreadsheet uses the inputs to arrive at a series of annual cash flows, beginning with the base year of the analysis, 2010 (which accounts for the investments needed to bring products into compliance by 2014), and continuing to 2043. DOE calculated INPVs by summing the stream of annual discounted cash flows during this period. For residential refrigeration products, DOE uses a real discount rate of 7.2 percent for all products.

DOE used the GRIM to calculate cash flows using standard accounting principles and to compare changes in INPV between a base case and various TSLs (the standards cases). The difference in INPV between the base and standards cases represents the financial impact of the amended standard on manufacturers. DOE collected this information from a number of sources, including publicly available data and interviews with a number of manufacturers (described in the next section). Additional details about the GRIM can be found in chapter 12 of the NOPR TSD.

In conducting its analysis, DOE treated certain product classes of residential refrigeration products separately. For example, DOE created specialized interview guides for different groups of product classes: one for standard-size products, one for compact products, and one for all products. Additionally, DOE grouped product classes made by the same manufacturers; this allowed DOE to better understand the impacts on manufacturers of these product classes.

Similarly, in this notice, DOE presents the MIA results for standard-size refrigerator-freezers, standard-size freezers, compact refrigerators and freezers, and built-in refrigeration products separately. Each of the four groups of product classes and results is based on a unique set of considered TSLs. DOE describes the TSLs in section V.A of today's NOPR, below. Because the combinations of efficiency levels that compose a TSL can make it more difficult to discuss the required efficiencies for each product class, DOE presents the MIA results in section V.B.2 of today's NOPR, below and chapter 12 of the NOPR TSD by groups of manufacturers that make the covered products. DOE presents the MIA results for standard-size refrigerator-freezers, standard-size freezers, compact refrigerators and freezers, and built-in refrigeration products separately.

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 MPCs 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.

DOE used the MPCs calculated in the engineering analysis for the residential refrigeration products, as described in section IV.C, above, and further detailed in chapter 5, section 5.9, of the NOPR TSD.

To calculate baseline MPCs, DOE followed a three step process. First, DOE derived each of the baseline products' retail price from the NPD market data described in section IV.F.1, above. Next, DOE discounted these baseline retail prices by the sales tax and retail markup to arrive at the baseline MSPs. Next, DOE discounted the baseline MSPs by the manufacturer markup to arrive at the average baseline MPCs. For all non-built-in product classes, DOE used a 1.26 manufacturer markup to calculate baseline MPCs and MSPs. (DOE received comments on the manufacturer markup and DOE describes the methodology used to calculate this figure in section IV.I.3.d, below.) Because built-in product classes are high-end products that are made in much lower production volumes, DOE used a different cost structure for these products than for the other product classes. DOE used information submitted during manufacturer interviews to estimate that a typical baseline manufacturer markup for built-in products is 1.40. To calculate baseline MPCs for the built-in product classes, DOE discounted the NPD baseline retail prices by the 1.40 manufacturer markup and a distributor markup to account for products sold through that distribution chain.

DOE also used the information from its tear-down analysis to verify the accuracy of the markup information and cost data for the units it tore down. In addition, DOE used the tear-down cost data 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.

ii. Base-Case Shipments Forecast

The GRIM estimates manufacturer revenues based on total unit shipment forecasts and the distribution of these values by efficiency level. Changes in the efficiency mix at each standard level affect manufacturer finances. For this analysis, the GRIM uses the NIA shipments forecasts from 2010 to 2043, the end of the analysis period. In the shipments analysis, DOE also estimated the distribution of efficiencies in the base case for all product classes. *See* section IV.G.1, above, for additional details.

iii. Product and Capital Conversion Costs

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

DOE based its estimates of the product conversion costs that would be required to meet each TSL on information obtained from manufacturer interviews, the design pathways analyzed in the engineering analysis, and market information about the number of platform and product families for each manufacturer. DOE assigned estimates for the total product development required for each design option based on the necessary engineering resources required to implement each design option across a product platform. DOE multiplied the estimate by the number of platforms and product families for each manufacturer. DOE also assumed that VIP use and/or wall thickness increases would require more significant changes to existing platforms than other design options that amount to component swaps. For wall thickness increases, DOE used product development efforts that were analogous to designing a new platform. For VIPs, which are not yet common on large-scale production lines for most products in the industry, DOE assumed more substantial product development costs than required for component swaps. However, DOE also assumed that manufacturers' recent experience with the technology would indicate that less effort would be required for incorporating VIPs than for designing completely new products. Finally, DOE estimated industry product conversion costs by extrapolating the interviewed manufacturers' product conversion costs for each product class to account for the market share of companies that were not interviewed. DOE's estimates of the product conversion costs for all of the refrigeration products addressed in this rulemaking can be found in section V.B.2, below, of today's NOPR and in chapter 12 of the NOPR TSD. Chapter 12 of the NOPR TSD also contains more detail on the assumptions DOE used to calculate the product conversion costs for each design option and other details about the product conversion costs.

As discussed above, to calculate industry cash flow impacts DOE also estimated the capital conversion costs manufacturers would incur to comply with potential amended energy conservation standards. During interviews, DOE asked manufacturers to estimate the capital conversion costs required to expand the production of higher-efficiency products or to quantify the required tooling and plant changes if product lines meeting the potential required efficiency level do not currently exist. As with product conversion costs, DOE based its capital conversion cost estimates on these interviews and assumptions from the engineering analysis. DOE assumed that most component changes, while requiring moderate product conversion costs, would not require changes to existing production lines and equipment, and therefore not require additional capital expenditures because one-for-one component swaps would not require changes to existing production equipment.

However, DOE calculated and included in its analysis the capital conversion costs required for design options that involved VIPs, wall thickness increases, and changes to heat exchangers. For changes to heat exchangers, DOE estimated the tooling investment required for the fabrication equipment and the consequent slight changes to the internal dimensions of the existing products. These tooling changes would likely include purchasing new dies or plastic molds for a small change in internal dimensions or shelving. For VIPs and wall thickness increases, DOE estimated the cost of the equipment required to manufacture new product lines because DOE assumed that these design changes would be extremely disruptive to current operations. Because the changes required to implement these design options would greatly change existing products, DOE expects that the capital conversion costs would be closer to purchasing new production equipment. DOE also used the assumptions from the engineering analysis regarding the incremental depreciation costs for adding additional VIPs and manufacturer market shares to calculate incremental equipment necessary for adding more VIPs.

DOE's estimates of the capital conversion costs for all of the residential refrigeration products can be found in section V.B.2, below, of today's NOPR and in chapter 12 of the NOPR TSD.

b. GRIM Scenarios

i. Residential Refrigeration Shipment Forecasts

The GRIM used the shipments developed in the NIA for standard-size refrigerator-freezers, standard-size freezers, compact refrigerators and freezers, and built-in refrigeration products. To determine efficiency distributions for the standards case, DOE used a "roll-up + market shift" scenario for 2014, the year that revised standards are assumed to become effective, through 2043. 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 2014. DOE further assumed that revised standards would result in a market shift such that market shares of products with efficiency better than the standard would gradually increase because the ENERGY STAR program would continue to promote efficient appliances after revised standards are introduced in 2014. See section IV.G.1 of this NOPR, above, and chapter 10 of the NOPR TSD for more information on the residential refrigeration standards-case shipment scenarios.

ii. 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 two standards-case markup scenarios to represent the uncertainty regarding the potential impacts on prices and profitability for manufacturers following the implementation of amended energy conservation standards: (1) A flat markup scenario, and (2) a preservation of operation profit scenario. These scenarios lead to different markups values, which, when applied to the inputted MPCs, result in varying revenue and cash flow impacts.

The flat markup scenario assumes that the cost of goods sold for each product is marked up by a flat percentage to cover standard SG&A expenses, R&D expenses, and profit. The flat markup scenario uses the baseline manufacturer markup (discussed in chapter 6 of the TSD) for all products in both the base case and the standards case. To derive this percentage, DOE evaluated publicly available financial information for manufacturers of white goods. DOE also requested feedback on this value during manufacturer interviews. This scenario represents the upper bound of industry profitability in the standards case because manufacturers are able to fully pass through additional costs due to standards to their customers.

DOE also modeled a lower bound profitability scenario. During interviews, multiple manufacturers stated that higher production costs could severely harm profitability. Because of the highly competitive market, several manufacturers suggested that the additional costs required at higher efficiencies could not be fully passed through to customers. In particular, several manufacturers noted their customer base is composed of a limited number of retailers that have substantial buying power. They also noted that the average costs of refrigeration products within product categories have been fairly constant or fallen even as new products and additional features have been added. Finally, manufacturers noted that their retail customers price products at fixed (or "sticky") price points with step-increases to premium price points reflecting different bundles of features.

Because of the market dynamics among manufacturers and retailers, and because of the pressure to keep the current price points fixed for a given bundle of features, DOE also modeled the preservation of operating profit markup scenario. In this scenario, the manufacturer markups are lowered such that, in the standards case, manufacturers are only able to maintain the base-case total operating profit in absolute dollars, despite higher product costs and investment. DOE implemented this scenario in GRIM by lowering the manufacturer markups at each TSL to yield approximately the same earnings before interest and taxes in the standards case in the year after the compliance date of the amended standards as in the base case. This scenario represents the lower bound of industry profitability following amended energy conservation standards because higher production costs and the investments required to comply with the amended energy conservation standard do not yield additional operating profit.

3. Discussion of Comments

During the December 2009 public meeting, interested parties commented on the assumptions and results of the preliminary analysis. Oral and written comments discussed several topics, including pending legislation resulting in a phase-down of HFCs, manufacturer tax credits, the cumulative regulatory burden on manufacturers, and standards-driven investments. DOE addresses these comments below.

a. Potential Regulation of HFCs

Several manufacturers expressed concern about the impact of a potential phase-down of HFCs, a possible scenario in light of pending climate legislation contained in the bill proposing enactment of the American Clean Energy and Security Act of 2009 (H.R. 2454). GE stated that if DOE did not recognize the trend toward HFC limits in its analysis, the department would risk creating a disincentive for manufacturers to employ low-GWP foams and refrigerants. GE noted the industry's concern about HFC limits reflects not only the pending climate legislation but also regulation from the EPA as well as the Montreal Protocol.

As such, GE argued DOE should evaluate the impact of the potential phase-down on the industry from a technical and economic perspective. (GE, No. 37 at p. 2; GE, Public Meeting Transcript, No. 28 at p. 47–48) AHAM reiterated that the phase-down of HFCs would have a substantial cost impact on the industry. (AHAM, Public Meeting Transcript, No. 28 at p. 18) Sub Zero added that the capital investment of the potential switch to hydrocarbons (*i.e.,* non-HFCs) should be considered in DOE's analysis. (Sub Zero, Public Meeting Transcript, No. 28 at p. 50).

DOE acknowledges that an HFC phase-out or similar legislation requiring a refrigerant or blowing agent change could necessitate substantial changes for residential refrigeration products. DOE has monitored legislation and rulemakings from UL, EPA, and Congress to understand what HFC limitations might go into effect in the near term and what changes are being proposed for use of alternatives. EPA has proposed allowing use of isobutane refrigerant in residential refrigeration products up to a charge limit of 57 grams. 75 FR 25803 (May 10, 2010). DOE has included this refrigerant as a design option where appropriate and is prepared to evaluate the impact of HFC phase-out legislation, if it is enacted.

b. Manufacturer Tax Credits

ACEEE stated that manufacturer tax credits in the pending climate legislation for higher efficiency products should be taken into account in DOE's analysis. (ACEEE, Public Meeting Transcript, No. 28 at p. 209) NEEP also stated that manufacturer tax credits and market pull programs reduce transition costs for manufacturers as they help build the demand and manufacturing capabilities at the higher end efficiencies. (NEEP, No. 38 at pp. 2–3)

DOE agrees that manufacturer tax credits help offset the costs of developing higher efficiency products. DOE includes the benefit of tax credits earned by the industry in 2010 under the provisions of the Energy Improvement and Extension Act of 2008 (EIEA 2008), Pub. L. 110–343, Div. B, Sec. 305 (October 3, 2008), in the GRIM calculations. Using publicly available information and recent SEC filings, DOE estimated manufacturers' market shares and shipment projections in 2010 and calculated the Federal production tax credits based on shipments of 30-percent efficiency level units—those units which qualified for the tax credit in 2010. DOE's analysis suggests that manufacturers will collect approximately $37 million in Federal production tax credits in 2010 from the provisions of EIEA 2008. In the GRIM, DOE accounts for the Federal production tax credit as a direct cash benefit in the base and standards cases that directly increases INPV. Because 2010 is the base year to which industry cash flows are discounted, any Federal production tax credits received prior to 2010 fall outside of the analysis period. These tax credits are consequently not considered in the INPV analysis. However, any tax benefit received in 2010 falls within the analysis period and, hence, increases industry value (potentially mitigating the impacts on manufacturers due to energy conservation standards). The estimated $37 million benefit to manufacturers does not significantly impact the INPV calculated by DOE.

DOE believes that ACEEE, in its comments related to pending legislation, was referring to the tax credits that would impact manufacturers of residential refrigerators in the American Clean Energy and Security Act of 2009 that passed the House of Representatives on June 26, 2009. That bill (H.R. 2454) contained provisions that provide bonus payments for the production of superefficient best-in-class products for years 2011–2013. The impacts of these tax credit provisions under H.R. 2454 are not quantified in the GRIM, as the legislation is still pending. It would be highly speculative to try to predict the passage of such legislation, much less the details of its provisions, all of which are highly uncertain. Appendix 12–C of the NOPR TSD discusses in detail the tax credits currently available to residential refrigeration product manufacturers and their impacts.

DOE research suggests that Federal production tax credits and other market pull programs such as ENERGY STAR have helped spur the development and market acceptance of more advanced technologies in residential refrigeration products. However, such tax credits and other market pull programs would not substantially defray the capital conversion costs required if all products were required to employ a given technology. Much higher production volumes would be required under a national standard and would require manufacturers to upgrade each of their production lines, rather than selectively improve the products that could reach the qualifying level most economically.

Furthermore, the actual design pathway manufacturers may take to achieve the proposed efficiency levels on a national scale could vary from those pathways manufacturers have taken to produce the much smaller subset of tax-credit qualifying products today. For example, if manufacturers no longer received a production credit for products under a national standard, any of the additional costs that could not be passed to consumers could cause manufacturers to consider more capital intense design pathways that would result in lower per unit costs. Therefore, the tax credits have helped to alleviate a portion of the product conversion costs required by amended energy conservation standards by providing manufacturers with experience implementing more efficient technology. DOE has taken this experience using advanced technology into account in its methodology for calculating product conversion costs. However, the production tax credits have not driven wholesale adoption of the new technology or caused manufacturers to make substantial changes to their production facilities to use these technologies on a wide scale.

c. Standards-Induced Versus Normal Capital Conversion Costs

ASAP noted that not all capital investments that manufacturers would make to comply with potential amended standards should be directly attributed to the standards, since a certain amount of investment in plants and equipment is a necessary cost of doing business. ASAP urged DOE to be careful to disaggregate incremental impacts due to the standards in the MIA. (ASAP, Public Meeting Transcript, No. 28 at pp. 209–11)

In its analysis, DOE separates capital conversion costs that are directly attributable to standards from normal capital expenditures. The equipment with remaining useful life that is not repurposed is counted as stranded assets (*i.e.,* net plant, property, and equipment that have not been fully depreciated that can no longer be used in the production of standards-compliant products). DOE estimates that capital conversion costs at today's proposed level are $895 million out of a net PPE of $1,529 million. Typical capital expenditures in the base year are $252 million. DOE also notes that the promulgation of a standard that would require VIPs or wall thickness increases could be extremely disruptive to existing facilities. These types of capital costs would not be attributed to ongoing capital expenses (to replace worn equipment and tooling for new products, for example). These plant modification and equipment changes would be attributable to a potential amended energy conservation standard. A discussion of DOE's methodology in developing capital and product conversion costs for residential refrigeration manufacturers is located in section IV.I.2.a, above, of today's NOPR and in chapter 12 of the NOPR TSD.

d. Manufacturer Markups

AHAM stated that DOE did not show any empirical support for the manufacturer markup used in the preliminary TSD and requested that DOE provide more information with respect to how the manufacturer markup was determined. (AHAM, No. 34 at p. 14) GE and Sub Zero also requested that DOE qualify how it determined its markups, including the manufacturer markups. (GE, No. 37 at p. 2–3; Sub Zero, No. 40 at p. 9; Sub Zero, Public Meeting Transcript, No. 28 at p. 112)

In developing the baseline manufacturer markup of 1.26 used in DOE's analysis, DOE began by researching the annual 10–K reports filed with the Securities and Exchange Commission by residential white goods manufacturers to determine an industry-wide market-share weighted markup. This baseline manufacturer markup was used for the 2009 final rule for cooking products and the 2010 commercial clothes washers final rule. 74 FR 16040 (April 8, 2009); 75 FR 1122 (January 8, 2010). Because all publicly traded companies that manufacture residential refrigeration equipment also manufacture a number of other appliances, and because the 1.26 baseline manufacturer markup had already been vetted during the rulemakings for these other products and equipment, DOE used the same baseline manufacturer markup as an initial estimate for residential refrigeration products. A description of the methodology used to calculate this baseline manufacturer markup can be found in the NOPR and NOPR TSD for these rulemakings. *See* 73 FR 62034 (October 17, 2008) and the related TSD, available at *http://www1.eere.energy.gov/buildings/appliance_standards/commercial/clothes_washers.html.* DOE requested manufacturer feedback on the accuracy of this estimate and other financial assumptions during DOE's confidential manufacturer impact analysis interviews.

Finally, as discussed above in section IV.I.2.b, above, in the standards case, DOE modeled manufacturers' concerns about potential profitability impacts due to amended energy conservation standards in its preservation of operating profit markup scenario. DOE continues to welcome feedback on any of the assumptions it used for its baseline manufacturer markups and its markup scenarios.

4. Manufacturer Interviews

DOE interviewed manufacturers representing more than 95 percent of standard-size refrigerator-freezer sales, approximately 95 percent of standard-size freezer sales, about 75 percent of compact refrigerator and freezer sales, and more than 95 percent of built-in refrigeration products. These interviews were in addition to those DOE conducted as part of the engineering analysis. DOE contacted companies from its database of manufacturers, which provided a representative sample of each industry. DOE used these interviews to tailor the GRIM to incorporate unique financial characteristics for the residential refrigeration industry. All interviews provided information that DOE used to evaluate the impacts of potential amended energy conservation standards on manufacturer cash flows, manufacturing capacities, and employment levels. Before each telephone interview or site visit, DOE provided company representatives with an interview guide that included the topics for which DOE sought input. The MIA interview topics included: (1) Key issues to this rulemaking; (2) a company overview and organizational characteristics; (3) engineering analysis and life cycle cost analysis follow-up; (4) manufacturer markups and profitability; (5) shipment projections; (6) financial parameters; (7) conversion costs; (8) cumulative regulatory burden; (9) possible impacts from potential HFC regulations; (10) direct employment impact assessment; (11) exports, foreign competition, and outsourcing; (12) consolidation; and (13) impacts on small business. Appendix 12–A of the NOPR TSD contains the three interview guides DOE used to conduct the MIA interviews.

In the manufacturer interviews, DOE asked manufacturers to describe their major concerns about this rulemaking. The following sections describe the most significant issues identified by manufacturers. These summaries are provided in aggregate to protect manufacturer confidentiality. DOE also includes additional concerns in chapter 12 of the NOPR TSD.

a. Potential for Significant Changes to Manufacturing Facilities

A number of manufacturers indicated that conversion costs would be exponentially greater if the adopted standards require significant rather than incremental increases in efficiency. While DOE does not analyze design options that would lower consumer utility, manufacturers indicated that for some product classes they would consider wall thickness increases if they resulted in lower per unit costs. However, manufacturers also indicated that wall thickness increases in response to more stringent energy standards would be extremely capital intensive. Changing the wall thickness of refrigeration products would require extensive investments to completely replace injection molding equipment, interior fabrication feeder lines and equipment, and foaming fixtures on every production line. Such substantial changes would require many times the investment required for incremental efficiency improvements. For example, the design and implementation of a new heat exchanger design would only require new fabrication tooling for the component and slight adjustments to production line tooling but would leave most of the existing production equipment intact. Smaller manufacturers were generally concerned that conversion costs would disproportionately impact their operations since comparable product and capital conversion costs would be spread over a smaller shipment volume.

Additionally, several manufacturers stated that new standards could increase the total steady state invested capital necessary to maintain current production levels. As an example, many plants leverage economies of scale by utilizing a shared front end of production (cabinet and door bending, for example) to serve multiple product lines. These economies would be forfeited if amended standards disproportionately affected one product class utilizing the shared front end. As such, manufacturing plants could have relatively lower capital intensity following standards.

b. VIPs

Manufacturers were also concerned about potential issues with a standard that effectively required the widespread adoption of VIPs. In particular, the material costs of VIPs would add significant costs to the products, especially at the retail level. Manufacturers were concerned that using this design option in product classes that historically have been low-cost options could have unintended consequences such as inducing consumers to prolong the life of the products or switch to less profitable products. Manufacturers were also concerned about the additional labor that is required to install VIPs. Additional production steps would be required with VIPs, which involve greater care in handling to prevent damaging the components. While less of a concern on lower volume products, the additional production steps on high-speed production lines would add tremendous complexity. The additional production steps and slower line rates would lengthen the production lines and require additional equipment.

Manufacturers were also concerned about the ability of VIP suppliers to ramp up production to meet necessary demand from more stringent standards.

Finally, manufacturers indicated that their experience with VIPs has revealed a range of efficiency improvements—all of which point to lower benefits than the theoretical potential of VIPs. They also expressed concern about the degradation of the panels over the lifetime of their products. Because of the range of efficiency improvements in practice, some manufacturers indicated they could elect to employ other design pathways that would eliminate these potential problems with the technology.

c. Impact on U.S. Production and Jobs

Manufacturers generally agreed that potential standards that would require substantial capital conversion costs would lower U.S. production and employment. Depending on the level of these expenditures, some manufacturers stated that new investments would not be made in the U.S., given the lower labor costs overseas. Margins are already thin for certain product classes, and manufacturers believed that higher standards could further reduce profitability. The lower labor costs available overseas could offset some of the impact on profitability, especially for their lower margin product lines. Some manufacturers stated they could also choose to source or drop altogether certain product lines they currently manufacture if they did not believe they could recoup the capital investments required to meet amended energy conservation standards on those lines. Any decision to drop or source more product lines would also lead to less domestic production and fewer domestic jobs.

d. Impacts to Product Utility

Several manufacturers expressed concern that more stringent energy standards could impact the utility of their products. Most residential kitchens have standardized size openings for refrigerators, which would force any wall thickness growth inward and decrease internal volume. While this scenario was not analyzed as a design option for all products, manufacturers indicated some in the industry could elect to use thicker walls to meet new standards for full size refrigerator-freezers. Finally, several manufacturers indicated that other product features currently available may have to be removed in order to both meet new standard levels and maintain product prices that would be acceptable to consumers. Examples of these features that industry cited included ice and water dispensers, glass doors, soda can dispensers, crisper compartments, anti-sweat features, and food preservation capabilities.

Manufacturers also expressed concern that the energy savings from more stringent energy conservation standards would not be great enough to justify passing through the added costs to consumers. Currently, manufacturers bundle higher efficiency with other desirable features to justify higher prices for those ENERGY STAR models. According to manufacturers, if amended standards cause prices to rise even higher, the lower operating costs would not justify higher prices, since the savings as a percentage of the purchase price would be very low. Therefore, the increased cost of meeting more stringent efficiency requirements may cause manufacturers to reduce the number of other features bundled with these products in order to retain a reasonable price point, causing consumer utility to decline.

The value of future ENERGY STAR levels is also a concern for manufacturers. Many retailers and other distribution channels require ENERGY STAR products. Since the features bundled with ENERGY STAR products are the greatest justification for the added costs, manufacturers were concerned that a higher ENERGY STAR level after potentially stricter standards would offer less value to consumers. Consumers would save less energy relative to the added efficiency costs or would have a product with fewer features.

Manufacturers also stated that the financial burden of developing products to meet amended energy conservation standards has an opportunity cost due to limited capital and R&D dollars. Investments incurred to meet amended standards reflect foregone investments in innovation and the development of new features that consumers value and on which manufacturers earn a premium.

e. Technical Difficulties Associated With Higher Efficiency Levels

Many manufacturers expressed concerns about the technical difficulties involved in achieving new standards that are significantly more stringent than current levels. Manufacturers were concerned there might not be adequate supplies of particular components. In particular they were concerned about supplies of high efficiency compressors and VIPs, for all product classes, and especially at higher efficiency levels that would increase the demand for these components many times over current levels. Manufacturers also stated that there are fewer low-cost technology improvements available than there were during past rulemakings. Compact units, in general, pose an additional challenge because there are fewer low-capacity compressors with sufficiently high EER ratings. Specifically, compact freezers were cited as a product class in which it would be especially difficult to make significant energy improvements. Current standards for compact freezers are already more stringent relative to capacity than are standards for compact refrigerators.

f. Changes in Consumer Behavior

Several manufacturers noted that higher consumer prices resulting from amended energy conservation standards could result in product switching between lines of standard-size refrigerator-freezers. Currently, top-mount refrigerator-freezers are inexpensive commodity products, on which manufacturers said they make little to no profit margin. Instead, manufacturers earn a profit on more expensive and more feature-loaded side-mount and bottom-mount refrigerator-freezers. Manufacturers are concerned that if amended energy conservation standards cause retail prices to increase across product classes, many consumers will no longer be willing to pay the premium for side-mount and bottom-mount refrigerator-freezers and will switch to buying the less expensive and less profitable top-mount refrigerator-freezers.

Similarly, a number of manufacturers expressed concern that higher retail prices could alter consumers' decisions to repair or replace their standard-size refrigerator-freezers. Many consumers who in the base case would buy a new refrigerator when their current unit fails would instead opt to repair their existing unit in the potential standards case due to the higher cost of purchasing a new unit. This decision would result in lower shipments for manufacturers and would leave less efficient units in the existing stock.

g. Separate Product Classes for Built-Ins

Most manufacturers expressed their support for separate product classes for built-in refrigerators and freezers. Manufacturers stated that built-in units are inherently less efficient than their free-standing counterparts for several reasons, including more limited air flow. Because of such limitations, the incremental costs of improving efficiency are higher at every efficiency level. Built-in manufacturers also believed that their components costs per unit were higher than for conventional products due to less bulk purchasing power. Built-in manufacturers also argued that their products offer distinct utility (*i.e.,* the ability to build products into the kitchen cabinetry), justifying the need for separate product classes for built-ins. Without separate product classes for built-ins, depending on the stringency of new standards, some or all built-in models could disappear from the market because of the designs' inability to satisfy the proposed standards for free-standing equivalent models. Built-in manufacturers also suggested that an average correction based on conventional free-standing products could be an appropriate means of accounting for the inherently lower efficiency of built-in products.

h. Test Procedure Concerns

Many manufacturers expressed concerns over the test procedures for refrigerators and freezers. Several stated that icemaking energy use, which represents a large portion of unit energy consumption, should be included in the amended test procedure to reward more efficient icemakers. However, manufacturers acknowledged that testing icemaker energy use is difficult. All manufacturers wanted to ensure that tests for icemaking energy are repeatable and could be implemented correctly. Manufacturers also did not want a test for icemaking energy use to result in the elimination of TTD units.

J. Employment Impact Analysis

DOE considers employment impacts in the domestic economy as one factor in selecting a proposed standard. Employment impacts consist of direct and indirect impacts. Direct employment impacts are any changes in the number of employees of manufacturers of the appliance products 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 refrigeration products. 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 standards to be redirected to other forms of economic activity. DOE also expects these shifts in spending and economic activity to affect the demand for labor in the short term, as explained below.

One method for assessing the possible effects on the demand for labor of such shifts in economic activity is to compare sectoral employment statistics developed by the Labor Department's Bureau of Labor Statistics (BLS).[40] The BLS regularly publishes its estimates of the number of jobs per million dollars of economic activity in different sectors of the economy, as well as the jobs created elsewhere in the economy by this same economic activity. Data from BLS indicate that expenditures in the utility sector generally create fewer jobs (both directly and indirectly) than expenditures in other sectors of the economy. There are many reasons for these differences, including wage differences and the fact that the utility sector is more capital intensive and less labor intensive than other sectors.[41]

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

For the standards considered in today's NOPR, DOE estimated indirect national employment impacts using an input/output model of the U.S. economy called Impact of Sector Energy Technologies (ImSET). ImSET is a spreadsheet model of the U.S. economy that focuses on 187 sectors most relevant to industrial, commercial, and residential building energy use.[42] ImSET is a special purpose version of the "U.S. Benchmark National Input-Output" (I–O) model, 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 refrigeration products.

For more details on the employment impact analysis, see TSD chapter 13.

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 standards. For this analysis, DOE used the NEMS–BT model to generate forecasts of electricity consumption, electricity generation by plant type, and electric generating capacity by plant type, that would result from each TSL. DOE obtained the energy savings inputs associated with efficiency improvements to considered products from the NIA. DOE conducts the utility impact analysis as a scenario that departs from the latest *AEO2010* Reference case. In other words, the estimated impacts of a proposed standard are the differences between values forecasted by NEMS–BT and the values in the *AEO2010* Reference case.

As part of the utility impact analysis, DOE 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 requirements, which in turn affect electricity prices. DOE estimated the change in electricity prices projected to result over time from each TSL.

[40] 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.*

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

[42] J. M. Roop, M. J. Scott, and R. W. Schultz, *ImSET 3.1: Impact of Sector Energy Technologies,* PNNL–18412, Pacific Northwest National Laboratory, 2009. Available at: *http://www.pnl.gov/main/publications/external/technical_reports/PNNL-18412.pdf.*

Chapter 14 of the TSD accompanying this notice describes the utility impact analysis.

L. Environmental Analysis

Pursuant to the National Environmental Policy Act of 1969 and the requirements of 42 U.S.C. 6295(o)(2)(B)(i)(VI) and 6316(a), DOE has prepared a draft environmental assessment (EA) of the impacts of the potential standards for refrigeration products in today's proposed rule, which it has included as chapter 15 of the NOPR 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 refrigeration product energy use is reduced by the amount of energy saved (by fuel type) due to each TSL. The inputs of national energy savings come from the NIA spreadsheet model, and the output is the forecasted physical emissions. NEMS–BT tracks CO_2 emissions using a detailed module that provides results with broad coverage of all sectors and inclusion of interactive effects. The net benefit of the standards in today's proposed rule is the difference between the forecasted emissions estimated by NEMS–BT at each TSL and the *AEO2010* Reference Case. For the final rule, DOE intends to revise the emissions analysis using the most current AEO.

DOE has preliminarily determined that sulfur dioxide (SO_2) emissions from affected Electric Generating Units (EGUs) are subject to nationwide and regional emissions cap and trading programs that create uncertainty about the standards' impact on SO_2 emissions. Title IV of the Clean Air Act sets an annual emissions cap on SO_2 for all affected EGUs. SO_2 emissions from 28 eastern States and the District of Columbia (DC) are also limited under the Clean Air Interstate Rule (CAIR). Published in the **Federal Register** on May 12, 2005, CAIR creates an allowance-based trading program that will gradually replace the Title IV program in those States and DC. 70 FR 25162. (The recent legal history surrounding CAIR is discussed below.) The attainment of the emissions caps is flexible among EGUs and is enforced through the use of emissions allowances and tradable permits. Under existing EPA regulations, any excess SO_2 emission allowances resulting from the lower electricity demand caused by the imposition of an efficiency standard could be used to permit offsetting increases in SO_2 emissions by any regulated EGU. However, if the standard resulted in a permanent increase in the quantity of unused emission allowances, there would be an overall reduction in SO_2 emissions from the standards. While there remains some uncertainty about the ultimate effects of efficiency standards on SO_2 emissions covered by the existing cap and trade system, the NEMS–BT modeling system that DOE uses to forecast emissions reductions currently indicates that no physical reductions in power sector emissions would occur for SO_2.

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

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

Similar to emissions of SO_2 and NO_X, future emissions of Hg would have been subject to emissions caps. The Clean Air Mercury Rule (CAMR) would have permanently capped emissions of mercury for new and existing coal-fired plants in all States beginning in 2010. 70 FR 28606 (May 18, 2005). However, the CAMR was vacated by the DC Circuit in its decision in *New Jersey* v. *Environmental Protection Agency.* 517 F 3d 574 (DC Cir. 2008) Thus, DOE was able to use the NEMS–BT model, which reflects the fact that CAMR was vacated and does not incorporate CAMR emission caps, to estimate the changes in Hg emissions resulting from the proposed rule. However, DOE continues to review the impact of rules that reduce energy consumption on Hg emissions, and may revise its assessment of Hg emission reductions in future rulemakings.

Commenting on the preliminary analysis, Whirlpool stated that analysis of CO_2 emissions is only complete if the changes in CO_2 emissions resulting from manufacturing and transporting the higher efficiency products are also included. (Whirlpool, No. 31 at p. 5) AHAM made a similar point. (AHAM, No. 34 at p. 15) 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 "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.

M. Monetizing Carbon Dioxide and Other Emissions Impacts

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

For today's NOPR, DOE is relying on a set of values for the social cost of carbon (SCC) that were developed by an interagency process. A summary of the basis for these new values is provided below, and a more detailed description of the methodologies used is provided in appendix 15–A of the NOPR TSD.

1. Social Cost of Carbon

Under Executive Order 12866, 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 social monetized 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.

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.16.

TABLE IV.16—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

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 social cost of carbon 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 [43] points out that any assessment will suffer from uncertainty, speculation, and lack of information about (1) Future emissions of greenhouse gases, (2) the effects of past and future emissions on the climate system, (3) the impact of changes in climate on the physical and biological environment, and (4) the translation of these environmental impacts into economic damages. As a result, any effort to quantify and monetize the harms associated with climate change will raise serious questions of science, economics, and ethics and should be viewed as provisional.

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

For such policies, the benefits from reduced (or costs from increased) emissions in any future year can be estimated by multiplying the change in emissions in that year by the SCC value appropriate for that year. The net present value of the benefits can then be calculated by multiplying each of these future benefits by an appropriate discount factor and summing across all affected years. This approach assumes that the marginal damages from increased emissions are constant for small departures from the baseline emissions path, an approximation that is reasonable for policies that have effects on emissions that are small relative to cumulative global carbon dioxide emissions. For policies that have a large (non-marginal) impact on global cumulative emissions, there is a separate question of whether the SCC is an appropriate tool for calculating the benefits of reduced emissions. 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 were $4.7, $21.4, $35.1, and $64.9 per metric ton in 2007 dollars. These values were adjusted to 2009$ using the standard GDP deflator value for 2008 and 2009. For emissions (or 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, 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,

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

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 per year. It also included a sensitivity analysis at $80 per ton of CO_2. A domestic SCC value is meant to reflect the value of damages in the United States resulting from a unit change in carbon dioxide emissions, while a global SCC value is meant to reflect the value of damages worldwide.

A 2008 regulation proposed by DOT assumed a domestic SCC value of $7 per ton CO_2 (in 2006 dollars) for 2011 emission reductions (with a range of $0 − $14 for sensitivity analysis), also increasing at 2.4 percent per year. A regulation finalized by DOE in October of 2008 used a domestic SCC range of $0 to $20 per ton CO_2 for 2007 emission reductions (in 2007 dollars). In addition, EPA's 2008 Advance Notice of Proposed Rulemaking for Greenhouse Gases identified what it described as "very preliminary" SCC estimates subject to revision. EPA's global mean values were $68 and $40 per ton CO_2 for discount rates of approximately 2 percent and 3 percent, respectively (in 2006 dollars for 2007 emissions).

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

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

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

c. 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. Specifically, the group considered public comments and further explored the technical literature in relevant fields.

It is important to recognize that a number of key uncertainties remain, and that current SCC estimates should be treated as provisional and revisable since they will evolve with improved scientific and economic understanding. The interagency group also recognizes that the existing models are imperfect and incomplete. The National 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 will periodically review and reconsider estimates of the SCC used for cost-benefit analyses to reflect increasing knowledge of the science and economics of climate impacts, as well as improvements in modeling. In this context, statements recognizing the limitations of the analysis and calling for further research take on exceptional significance. The interagency group offers the new SCC values with all due humility about the uncertainties embedded in them and with a sincere promise to continue work to improve them.

In summary, in considering the potential global benefits resulting from reduced CO_2 emissions, DOE used the most recent values identified by the interagency process, adjusted to 2009$ using the standard GDP deflator values for 2008 and 2009. For each of the four cases specified, the values used for emissions in 2010 were $4.9, $22.1, $36.3, and $67.1 per metric ton avoided (expressed in 2009$). To monetize the CO_2 emissions reductions expected to result from amended standards for refrigeration products in 2014–2043, DOE used the values identified in Table A1 of the "Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866," which is reprinted in appendix 15–A of the NOPR TSD for the full range of annual SCC estimates from 2010 to 2050. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the four cases using the discount rates that had been used to obtain the SCC values in each case.

2. Valuation of Other Emissions Reductions

As previously stated, DOE's analysis assumed the presence of nationwide emission caps on SO_2 and caps on NO_X emissions in the 28 States covered by the CAIR. In the presence of these caps, the NEMS–BT modeling system that DOE used to forecast emissions reduction indicated that no physical reductions in power sector emissions would occur for SO_2, but that the standards could put slight downward pressure on the prices of emissions allowances in cap-and-trade markets. Estimating this effect is very difficult because such factors as credit banking can change the trajectory of prices. From its modeling to date, DOE is unable to estimate a benefit from SO_2 emissions reductions at this time. *See* the environmental assessment, chapter 15 in the NOPR TSD for further details.

DOE also investigated the potential monetary benefit of reduced NO_X emissions from the TSLs it considered. As noted above, new or amended energy conservation standards would reduce NO_X emissions in those 22 States that are not affected by the CAIR, in addition to the reduction in site NO_X emissions nationwide. DOE estimated the monetized value of NO_X emissions reductions resulting from each of the TSLs considered for today's NOPR based on environmental damage estimates from the available 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\$).[44] In accordance with U.S. Office of Management and Budget (OMB) guidance,[45] 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.

DOE is aware of multiple agency efforts to determine the appropriate range of values to use 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 in its rulemakings.

N. Demand Response

This section discusses comments received regarding demand response or smart grid controls. These are controls that can react to signals from utilities or other external organizations and adapt the product operation. This capability might be used to allow utilities to reduce energy use during peak demand hours by reducing the power input of many connected appliances.

DOE received comments from LG urging consideration of smart grid controls for refrigeration products when setting standards. LG commented that the investment required to meet new energy standards may displace the investment to develop and implement smart grid refrigeration products, thus limiting the potential to meet DOE's goals for establishment of a smart grid. (LG, No. 41 at p. 5) DOE received some additional information regarding smart grid issues during NOPR phase interviews with manufacturers. This information did not clearly indicate that smart grid controls could provide significant benefits when used in refrigeration products that are comparable to the benefits associated with energy use reductions that are proposed in this notice. Some of the potential benefits, such as the initiation of defrost only during off-peak periods could be implemented without the use of smart grid controls. Because of the uncertain value of the smart grid benefits, DOE did not consider the possible offset of smart grid development investment when selecting proposed standard levels.

The U.S. Navy (USN) commented that DOE should consider implementing a credit or other form of encouragement for demand response technologies in the energy conservation standard or other standards, or in voluntary programs such as ENERGY STAR. (USN, No. FDMS Draft 0022.1 at p. 2) IOU commented that DOE should include as part of any standard a requirement that refrigeration products include a demand response feature. (IOU, No. 36 at p. 13) IOU asked for a response to this comment and requested that the response indicate whether States would be allowed to implement demand response requirements if DOE does not do so. (*Id.*)

The requirement to include demand response capability in a product constitutes a design requirement that a product include such a feature. EPCA allows establishment of design requirements, but only for certain products. EPCA defines "energy conservation standard" as:

> (A) a performance standard which prescribes a minimum level of energy efficiency or a maximum quantity of energy use, or, in the case of showerheads, faucets, water closets, and urinals, water use, for a covered product, determined in accordance with test procedures prescribed under section 6293 of this title; or
>
> (B) a design requirement for the products specified in paragraphs (6), (7), (8), (10), (15), (16), (17), and (19) of section 6292(a) of this title * * *

42 U.S.C. 6291(6)

Refrigeration products do not belong to the group of products for which DOE can set design requirements (such as demand response capability) under 6291(6)(B). Based on this limitation and the available facts, it is DOE's tentative view that a demand response requirement cannot be included as part of today's NOPR.

DOE next considered whether a credit may be allowed for demand response features. DOE understands that such features, when applied to refrigeration products, could be used to reduce energy costs by shifting portions of the energy use associated with defrost or icemaking to times when the electricity cost is lower, but that they would not contribute significantly to reduction of energy use. EPCA does not allow establishment of energy conservation standards if, "the establishment of such standard will not result in significant conservation of energy" (42 U.S.C. 6295(o)(3)(B)). Hence, DOE cannot consider implementing a credit in the energy conservation standards for refrigeration products to encourage use of this technology.

DOE and other agencies are not prohibited from developing voluntary programs to encourage use of demand response technology. However, such programs are not the subject matter of this notice.

EPCA's requirement on preemption on or after the compliance date for Federal energy conservation standards for a given product states that "no State regulation concerning the energy efficiency, energy use, or water use of such covered product shall be effective with respect to such product * * *" (42 U.S.C. 6297(c)). EPCA provides a number of exceptions to this requirement, but none of these apply to refrigeration products. DOE interprets "regulation concerning energy use" to be equivalent to "energy conservation standard". The title of section 6297(c), "General rule of preemption for energy conservation standards when Federal standard becomes effective for product," further clarifies that this section addresses energy conservation standards, which would mean, in this instance, a performance-based standard. Based on the limited facts made available to DOE, a design requirement would not likely meet this requirement. Preemption under these conditions would not likely apply.

V. Analytical Results

The following section addresses the results from DOE's analyses with respect to potential energy efficiency standards for the various product classes examined as part of this rulemaking. Issues discussed include the trial standard levels examined by DOE, the projected impacts of each of these levels if adopted as energy efficiency standards for refrigeration products, and the standards levels that DOE is tentatively proposing in today's NOPR. Additional details regarding the analyses conducted by the agency are contained in the publicly available NOPR TSD supporting this notice.

A. Trial Standard Levels

DOE analyzed the benefits and burdens of a number of TSLs for the refrigeration products that are the subject of today's proposed rule. A description of each TSL DOE analyzed is provided below. DOE attempted to limit the number of TSLs considered for the NOPR by excluding efficiency levels that do not exhibit significantly different economic and/or engineering characteristics from the efficiency levels

[44] Refer to the OMB, Office of Information and Regulatory Affairs, "2006 Report to Congress on the Costs and Benefits of Federal Regulations and Unfunded Mandates on State, Local, and Tribal Entities," Washington, DC, for additional information.

[45] OMB, Circular A–4: Regulatory Analysis (Sept. 17, 2003).

already selected as a TSL. While DOE only presents the results for those efficiency levels in TSL combinations in today's NOPR, DOE presents the results for all efficiency levels that it analyzed in the NOPR TSD.

Table V.1 presents the TSLs and the corresponding product class efficiencies for standard-size refrigerator-freezers. TSL 1 consists of those efficiency levels that meet current ENERGY STAR criteria. TSL 2 consists of the highest efficiency levels for which the consumer NPV is positive, using a 7-percent discount rate. TSL 3 consists of the highest efficiency levels for which the consumer NPV is positive, using a 3-percent discount rate, as well as the levels recommended in the Joint Comments. TSL 4 consists of those efficiency levels that yield energy use 30 percent below the baseline products. TSL 5 consists of the max-tech efficiency levels.

TABLE V.1—TRIAL STANDARD LEVELS FOR STANDARD-SIZE REFRIGERATOR-FREEZERS

Trial standard level	Top-mount refrigerator-freezers	Bottom-mount refrigerator-freezers	Side-by-side refrigerator-freezers
	Product classes 1, 1A, 2, 3, 3A, 3I and 6	Product classes 5, 5A, and 5I	Product classes 4, 4I, and 7
	Efficiency Level (% less than baseline energy use)		
1	3 (20)	3 (20)	3 (20)
2	3(20)	3 (20)	4 (25)
3	4 (25) *	3 (20)	4 (25)
4	5 (30)	5 (30)	5 (30)
5	6 (36)	6 (36)	6 (33)

* Level for product classes 1, 1A, and 2 is 20%.

Table V.2 presents the TSLs and the corresponding product class efficiencies for standard-size freezers. TSL 1 consists of those efficiency levels that yield energy use 20 percent below the baseline products. TSL 2 consists of the levels recommended in the Joint Comments. TSL 3 consists of incrementally higher efficiency levels than the preceding TSL. TSL 4 consists of the efficiency levels for which the consumer NPV is positive, using a 7-percent discount rate. TSL 5 consists of the max-tech efficiency levels, which are also the efficiency levels for which the consumer NPV is positive, using a 3-percent discount rate.

TABLE V.2—TRIAL STANDARD LEVELS FOR STANDARD-SIZE FREEZERS

Trial standard level	Upright freezers		Chest freezers
	Product class 9	Product class 8	Product classes 10 and 10A
	Efficiency Level (% less than baseline energy use)		
1	3 (20)	3 (20)	3 (20)
2	5 (30)	4 (25)	*4 (25)
3	6 (35)	5 (30)	5 (30)
4	7 (40)	6 (35)	6 (35)
5	8 (44)	7 (41)	7 (41)

* Level for product class 10A is 30%.

Table V.3 presents the TSLs and the corresponding product class efficiencies for compact refrigeration products. TSL 1 consists of efficiency levels that meet current ENERGY STAR criteria for some compact refrigerators (product classes 11, 11A, 12 and 13A), and efficiency levels that are 10 percent below the baseline energy use for other compact refrigerators (product classes 13, 14, and 15) and compact freezers (product classes 16, 17, and 18). TSL 2 consists of the levels recommended in the Joint Comments. TSL 3 consists of the highest efficiency levels for which the consumer NPV is positive, using both a 3-percent and a 7-percent discount rate. TSL 4 consists of incrementally higher efficiency levels than TSL 3. TSL 5 consists of the max-tech efficiency levels.

TABLE V.3—TRIAL STANDARD LEVELS FOR COMPACT REFRIGERATION PRODUCTS

Trial standard level	Compact refrigerators and refrigerator-freezers		Compact freezers
	Product classes 11, 11A, 12, and 13A	Product classes 13, 14, and 15	Product classes 16, 17, 18
	Efficiency Level (% less than baseline energy use)		
1	3 (20)	1 (10)	1 (10)
2	4 (25)	*2 (15)	1 (10)
3	5 (30)	2 (15)	2 (15)
4	7 (40)	4 (25)	4 (25)

TABLE V.3—TRIAL STANDARD LEVELS FOR COMPACT REFRIGERATION PRODUCTS—Continued

Trial standard level	Compact refrigerators and refrigerator-freezers		Compact freezers
	Product classes 11, 11A, 12, and 13A	Product classes 13, 14, and 15	Product classes 16, 17, 18
5	10 (59)	7 (42)	7 (42)

* Level for product class 14 is 20%.

Table V.4 presents the TSLs and the corresponding product class efficiencies for built-in refrigeration products. TSL 1 consists of the efficiency levels that are 10 percent better than the current standard. TSL 2 consists of the highest efficiency levels for which the consumer NPV is positive, using both a 3-percent and a 7-percent discount rate. TSL 3 consists of the levels recommended in the Joint Comments. TSL 4 consists of incrementally higher efficiency levels than TSL 3. TSL 5 consists of the max-tech efficiency levels.

TABLE V.4—TRIAL STANDARD LEVELS FOR BUILT-IN REFRIGERATION PRODUCTS

Trial standard level	Built-in all-refrigerators	Built-in bottom-mount refrigerator-freezers	Built-in side-by-side refrigerator-freezers	Built-in upright freezers
	Product class 3A–BI	Product classes 5–BI and 5I–BI	Product classes 4–BI, 4I–BI and 7–BI	Product class 9–BI
	Efficiency Level (% less than baseline energy use)			
1	1 (10)	1 (10)	1 (10)	1 (10)
2	2 (15)	2 (15)	1 (10)	3 (20)
3	3 (20)	2 (15)	3 (20)	4 (25)
4	4 (25)	4 (25)	3 (20)	4 (25)
5	5 (29)	5 (27)	4 (22)	5 (27)

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 representative product class, DOE's analysis provided several outputs for each TSL, which are reported in Table V.5 through Table V.15. 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), 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 a given TSL. The results for each TSL are relative to the energy efficiency distribution in the base case (no amended standards). DOE based the LCC and PBP analyses on energy consumption under conditions of actual product use, whereas it based the rebuttable presumption PBPs on energy consumption under conditions prescribed by the DOE test procedure, as required by EPCA. (42 U.S.C. 6295(o)(2)(B)(iii))

TABLE V.5—PRODUCT CLASS 3, TOP-MOUNT REFRIGERATOR-FREEZERS: LCC AND PBP RESULTS

Trial standard level	Efficiency level (% less than baseline energy use)	Life-cycle cost 2009$			Life-cycle cost savings				Payback period (years)
		Installed cost	Discounted operating cost	LCC	Average savings 2009$	% of households that experience			Median
						Net cost	No impact	Net benefit	
	Baseline	$543	$750	$1,293					
	1 (10)	555	696	1,251	$42	1.7%	21.6%	76.8%	2.7
	2 (15)	563	668	1,231	62	2.3	17.4	80.3	3.0
1, 2	3 (20)	624	640	1,264	29	42.3	8.1	49.6	9.2
3	4 (25)	667	605	1,272	22	54.9	0.0	45.1	10.9
4	5 (30)	759	571	1,330	−37	73.8	0.0	26.2	15.4
5	6 (36)	892	535	1,427	−133	85.4	0.0	14.6	20.5

TABLE V.6—PRODUCT CLASS 5, BOTTOM-MOUNT REFRIGERATOR-FREEZERS: LCC AND PBP RESULTS

Trial standard level	Efficiency level (% less than baseline energy use)	Life-cycle cost 2009$			Life-cycle cost savings				Payback period (years)
		Installed cost	Discounted operating cost	LCC	Average savings 2009$	% of households that experience			Median
						Net cost	No impact	Net benefit	
	Baseline ...	$945	$917	$1,862					
	1 (10)	947	908	1,856	$8	0.2	86.9	12.9	2.5
	2 (15)	949	904	1,853	12	0.3	86.9	12.9	2.7
1, 2, 3	3 (20)	955	892	1,847	19	4.5	67.8	27.7	4.9
	4 (25)	1,020	853	1,873	−8	75.0	0.0	25.0	17.5
4	5 (30)	1,127	817	1,945	−79	88.2	0.0	11.8	24.8
5	6 (36)	1,276	770	2,046	−180	93.3	0.0	6.7	29.0

TABLE V.7—PRODUCT CLASS 7, SIDE-BY-SIDE REFRIGERATOR-FREEZERS WITH THROUGH-THE-DOOR ICE SERVICE: LCC AND PBP RESULTS

Trial standard level	Efficiency level (% less than baseline energy use)	Life-cycle cost 2009$			Life-cycle cost savings				Payback period (years)
		Installed cost	Discounted operating cost	LCC	Average savings 2009$	% of households that experience			Median
						Net cost	No impact	Net benefit	
	Baseline ...	$1,152	$1,178	$2,330					
	1 (10)	1,155	1,156	2,310	$20	0.1	78.1	21.8	1.5
	2 (15)	1,160	1,132	2,292	40	0.5	51.7	47.8	2.4
1	3 (20)	1,179	1,100	2,279	53	7.3	36.9	55.8	4.8
2, 3	4 (25)	1,244	1,051	2,295	37	50.8	0.0	49.2	10.9
4	5 (30)	1,385	1,002	2,387	−55	77.7	0.0	22.3	18.6
5	6 (33)	1,496	970	2,466	−134	86.2	0.0	13.9	22.6

TABLE V.8—PRODUCT CLASS 9, UPRIGHT FREEZERS: LCC AND PBP RESULTS

Trial standard level	Efficiency level (% less than baseline energy use)	Life-cycle cost 2009$			Life-cycle cost savings				Payback period (years)
		Installed cost	Discounted operating cost	LCC	Average savings 2009$	% of households that experience			Median
						Net cost	No impact	Net benefit	
	Baseline ...	$560	$969	$1,529					
	1 (10)	571	897	1,468	$62	1.7	19.9	78.5	2.3
	2 (15)	592	852	1,445	85	9.7	1.7	88.6	4.3
1	3 (20)	611	807	1,418	111	11.7	0.6	87.8	4.8
	4 (25)	640	760	1,401	128	16.2	0.4	83.4	5.8
2	5 (30)	667	714	1,381	148	18.7	0.2	81.1	6.2
3	6 (35)	727	673	1,399	130	30.8	0.0	69.2	8.4
4	7 (40)	810	632	1,442	87	45.0	0.0	55.0	11.0
5	8 (44)	994	599	1,593	−63	70.2	0.0	29.8	17.4

TABLE V.9—PRODUCT CLASS 10, CHEST FREEZER: LCC AND PBP RESULTS

Trial standard level	Efficiency level (% less than baseline energy use)	Life-cycle cost 2009$			Life-cycle cost savings				Payback period (years)
		Installed cost	Discounted operating cost	LCC	Average savings 2009$	% of households that experience			Median
						Net cost	No impact	Net benefit	
	Baseline ...	$407	$578	$985					
	1 (10)	414	533	946	$38	0.0	16.2	83.8	2.1
	2 (15)	424	506	930	55	0.7	1.2	98.1	3.4
1	3 (20)	436	479	915	70	1.6	0.2	98.2	4.2
2	4 (25)	483	451	935	50	25.8	0.2	74.0	8.7
3	5 (30)	504	424	928	56	28.3	0.2	71.5	9.1
4	6 (35)	565	404	968	17	53.5	0.0	46.5	13.1
5	7 (41)	687	369	1,055	−71	79.0	0.0	21.0	19.3

TABLE V.10—PRODUCT CLASS 11, COMPACT REFRIGERATORS: LCC AND PBP RESULTS

Trial standard level	Efficiency level (% less than baseline energy use)	Life-cycle cost 2009$			Life-cycle cost savings				Payback period (years)
		Installed cost	Discounted operating cost	LCC	Average savings 2009$	% of households that experience			
						Net cost	No impact	Net benefit	Median
	Baseline	$146	$165	$311					
	1 (10)	151	150	301	$10	11.9	1.6	86.5	2.0
	2 (15)	156	142	297	13	17.0	1.4	81.6	2.3
1	3 (20)	162	134	296	15	24.4	1.4	74.2	2.8
2	4 (25)	174	126	300	10	43.3	1.0	55.7	3.9
3	5 (30)	184	118	302	8	50.6	0.9	48.5	4.4
	6 (35)	212	111	324	−13	77.2	0.0	22.8	6.7
4	7 (40)	221	103	324	−13	76.1	0.0	23.9	6.5
	8 (45)	255	97	351	−41	87.4	0.0	12.6	8.6
	9 (50)	274	88	362	−51	88.8	0.0	11.2	9.0
5	10 (59)	341	75	416	−105	93.8	0.0	6.2	11.6

TABLE V.11—PRODUCT CLASS 18, COMPACT FREEZERS: LCC AND PBP RESULTS

Trial standard level	Efficiency level (% less than baseline energy use)	Life-cycle cost 2009$			Life-cycle cost savings				Payback period (years)
		Installed cost	Discounted operating cost	LCC	Average savings 2009$	% of households that experience			Median
						Net cost	No impact	Net benefit	
	Baseline	$202	$200	$402					
1, 2	1 (10)	209	182	391	$11	9.9	4.7	85.4	2.5
3	2 (15)	223	172	395	7	40.6	0.0	59.4	4.6
	3 (20)	268	163	430	−29	91.1	0.0	8.9	10.9
4	4 (25)	279	153	432	−30	88.5	0.0	11.5	10.0
	5 (30)	312	146	458	−57	94.6	0.0	5.4	12.6
	6 (35)	320	137	457	−55	92.7	0.0	7.3	11.5
5	7 (42)	399	124	523	−121	97.8	0.0	2.3	15.9

TABLE V.12—PRODUCT CLASS 3A–BI, BUILT-IN ALL-REFRIGERATORS: LCC AND PBP RESULTS

Trial standard level	Efficiency level (% less than baseline energy use)	Life-cycle cost 2009$			Life-cycle cost savings				Payback period (years)
		Installed cost	Discounted operating cost	LCC	Average savings 2009$	% of households that experience			
						Net cost	No impact	Net benefit	Median
	Baseline	$4,676	$776	$5,451					
1	1 (10)	4,683	721	5,404	$47	0.3	22.6	77.2	1.6
2	2 (15)	4,696	693	5,388	63	2.6	18.4	79.0	3.0
3	3 (20)	4,826	660	5,486	−34	69.1	9.1	21.9	15.9
4	4 (25)	5,017	629	5,646	−195	94.5	0.0	5.5	29.7
5	5 (29)	5,162	607	5,769	−318	97.2	0.0	2.8	36.7

TABLE V.13—PRODUCT CLASS 5–BI, BUILT-IN BOTTOM-MOUNT REFRIGERATOR-FREEZERS: LCC AND PBP RESULTS

Trial standard level	Efficiency level (% less than baseline energy use)	Life-cycle cost 2009$			Life-cycle cost savings				Payback period (years)
		Installed cost	Discounted operating cost	LCC	Average savings 2009$	% of Households that experience			
						Net cost	No impact	Net benefit	Median
	Baseline	$5,386	$908	$6,294					
1	1 (10)	5,390	899	6,289	$7	1.2	87.1	11.7	4.4
2, 3	2 (15)	5,401	906	6,307	0	8.2	87.0	4.8	12.9
	3 (20)	5,435	892	6,328	−21	29.3	67.5	3.3	26.2
4	4 (25)	5,607	864	6,471	−164	99.0	0.0	1.1	62.8
5	5 (27)	5,706	845	6,551	−244	99.3	0.0	0.7	61.8

TABLE V.14—PRODUCT CLASS 7–BI, BUILT-IN SIDE-BY-SIDE REFRIGERATOR-FREEZERS WITH THROUGH-THE-DOOR ICE SERVICE: LCC AND PBP RESULTS

Trial standard level	Efficiency level (% less than baseline energy use)	Life-cycle cost 2009$			Life-cycle cost savings				Payback period (years)
		Installed cost	Discounted operating cost	LCC	Average savings 2009$	% of Households that experience			
						Net cost	No impact	Net benefit	Median
	Baseline	$7,887	$1,293	$9,180					
1, 2	1 (10)	7,902	1,276	9,178	$7	8.0	78.5	13.5	8.7
	2 (15)	7,947	1,261	9,208	−18	39.8	52.4	7.8	21.0
3, 4	3 (20)	8,078	1,228	9,306	−116	60.2	37.2	2.5	36.7
5	4 (22)	8,197	1,211	9,409	−219	98.8	0.0	1.2	60.0

TABLE V.15—PRODUCT CLASS 9–BI, BUILT-IN UPRIGHT FREEZERS: LCC AND PBP RESULTS

Trial standard level	Efficiency level (% less than baseline energy use)	Life-cycle cost 2009$			Life-cycle cost savings				Payback period (years)
		Installed cost	Discounted operating cost	LCC	Average savings 2009$	% of Households that experience			
						Net cost	No impact	Net benefit	Median
	Baseline	$4,383	$947	$5,330					
1	1 (10)	4,400	876	5,276	$54	4.3	19.9	75.8	3.4
	2 (15)	4,415	834	5,249	82	8.6	1.7	89.7	4.3
2	3 (20)	4,509	797	5,306	24	53.1	0.6	46.3	12.8
3, 4	4 (25)	4,657	752	5,409	−78	78.2	0.5	21.3	21.1
5	5 (27)	4,770	730	5,500	−169	87.1	0.3	12.6	26.8

b. Consumer Subgroup Analysis

As described in section IV.H, DOE determined the impact of the considered TSLs on low-income households and senior-only households. DOE did not estimate impacts for compact refrigeration products because the household sample sizes were not large enough to yield meaningful results.

Table V.16 through Table V.18 compare the average LCC savings at each efficiency level for the two consumer subgroups with the average LCC savings for the entire sample for each representative product class. In general, the average LCC savings for low-income households and senior-only households at the considered efficiency levels are not substantially different from the average for all households. Chapter 11 of the NOPR TSD presents the complete LCC and PBP results for the two subgroups.

TABLE V.16—STANDARD-SIZE REFRIGERATOR-FREEZERS: COMPARISON OF AVERAGE LCC SAVINGS FOR CONSUMER SUBGROUPS AND ALL HOUSEHOLDS

Efficiency level (% less than baseline energy use)	Top-mount refrigerator-freezers			Bottom-mount refrigerator-freezers			Side-by-side refrigerator-freezers		
	Product class 3			Product class 5			Product class 7		
	Senior	Low-income	All	Senior	Low-income	All	Senior	Low-income	All
1 (10)	$40	$44	$42	$53	$9	$8	$20	$21	$20
2 (15)	58	65	61	77	13	12	40	41	40
3 (20)	22	32	28	90	20	19	53	55	53
4 (25)	12	25	20	62	−7	−8	37	36	37
5 (30)	−49	−33	−38	−2	−78	−79	−55	−59	−55
6 (36/36/33)	−149	−129	−135	−29	−180	−180	−134	−140	−134

TABLE V.17—STANDARD-SIZE FREEZERS: COMPARISON OF AVERAGE LCC SAVINGS FOR CONSUMER SUBGROUPS AND ALL HOUSEHOLDS

Efficiency level (% less than baseline energy use)	Upright freezers			Chest freezers		
	Product class 9			Product class 10		
	Senior	Low-income	All	Senior	Low-income	All
1 (10)	$62	$58	$61	$38	$37	$38
2 (15)	85	79	83	55	53	55
3 (20)	111	102	109	70	68	70
4 (25)	128	117	126	50	47	50
5 (30)	148	134	146	56	53	56
6 (35)	130	113	127	17	12	17
7 (40/41)	87	68	84	−71	−76	−71
8 (44)	−63	−85	−71			

TABLE V.18—BUILT-IN REFRIGERATION PRODUCTS: COMPARISON OF AVERAGE LCC SAVINGS FOR CONSUMER SUBGROUPS AND ALL HOUSEHOLDS

Efficiency level (% less than baseline energy use)	Built-in all refrigerators			Built-in bottom-mount refrigerator-freezers			Built-in side-by-side refrigerator-freezers			Built-in upright freezers		
	Product class 3A–BI			Product class 5–BI			Product class 7–BI			Product class 9–BI		
	Senior	Low-income	All	Senior	Low-income	All	Senior	Low-income	All	Senior	Low-income	All
1 (10)	$44	$49	$47	$6	$7	$7	$7	$6	$7	$54	$50	$54
2 (15)	58	65	63	−3	−1	0	−18	−24	−18	82	74	82
3 (20)	−47	−37	−34	−26	−24	−21	−116	−135	−116	24	13	24
4 (25)	−211	−198	−195	−173	−167	−164	−219	−239	−219	−78	−93	−78
5 (29/27/22/27)	−337	−321	−318	−255	−247	−244	....	....	....	−169	−185	−169

c. Rebuttable Presumption Payback

As discussed in section III.D.2, EPCA provides a rebuttable presumption that an energy conservation standard is economically justified if the increased purchase cost for a product that meets the standard is less than three times the value of the first-year energy savings resulting from the standard. In calculating a rebuttable presumption payback period for the considered standard levels, DOE used discrete values rather than distributions for input values, and, as required by EPCA, based the energy use calculation on the DOE test procedures for refrigeration products. As a result, DOE calculated a single rebuttable presumption payback value, and not a distribution of payback periods, for each efficiency level. Tables V.19 through V.22 present the average rebuttable presumption payback periods for those efficiency levels where the increased purchase cost for a product that meets a standard at that level is less than three times the value of the first-year energy savings resulting from the standard.

TABLE V.19—STANDARD-SIZE REFRIGERATOR-FREEZERS: EFFICIENCY LEVELS WITH REBUTTABLE PAYBACK PERIOD LESS THAN THREE YEARS

Product class 3: Top-mount refrigerator-freezer		Product class 5: Bottom-mount refrigerator-freezer		Product class 7: Side-by-side refrigerator-freezer with TTD*	
Efficiency level (% less than baseline energy use)	PBP years	Efficiency level (% less than baseline energy use)	PBP years	Efficiency level (% less than baseline energy use)	PBP years
1 (10)	2.4	1 (10)	2.1	1 (10)	1.4
2 (15)	2.6	2 (15)	2.4	2 (15)	1.7
	....	....	....	3 (20)	2.9

* Through-the-door ice service.

TABLE V.20—STANDARD-SIZE FREEZERS: EFFICIENCY LEVELS WITH REBUTTABLE PAYBACK PERIOD LESS THAN THREE YEARS

Product class 9: upright freezer		Product class 10: chest freezer	
Efficiency level (% less than baseline energy use)	PBP years	Efficiency level (% less than baseline energy use)	PBP years
1 (10)	1.9	1 (10)	1.8
	....	2 (15)	2.7

TABLE V.21—COMPACT REFRIGERATION PRODUCTS: EFFICIENCY LEVELS WITH REBUTTABLE PAYBACK PERIOD LESS THAN THREE YEARS

Product class 11: compact refrigerator		Product class 18: compact freezer	
Efficiency level (% less than baseline energy use)	PBP years	Efficiency level (% less than baseline energy use)	PBP years
1 (10)	1.8	1 (10)	2.0
2 (15)	2.1	....	....
3 (20)	2.7	....	....

TABLE V.22—BUILT-IN REFRIGERATION PRODUCTS: EFFICIENCY LEVELS WITH REBUTTABLE PAYBACK PERIOD LESS THAN THREE YEARS

Product class 3A–BI: built-in all-refrigerator		Product class 5–BI: built-in bottom-mount refrigerator-freezer		Product class 7–BI: built-in side-by-side refrigerator-freezer with TTD *		Product class 9–BI: built-in upright freezer	
Efficiency level (% less than baseline energy use)	PBP years	Efficiency level (% less than baseline energy use)	PBP years	Efficiency level (% less than baseline energy use)	PBP years	Efficiency level (% less than baseline energy use)	PBP years
1 (10)	1.5	1 (10)	....	1 (10)	....	1 (10)	2.7
2 (15)	2.6	....	....	....	....	....	....

* Through-the-door ice service.

While DOE examined the rebuttable-presumption criterion, it considered whether the standard levels considered for today's rule are economically justified through a more detailed analysis of the economic impacts of these levels pursuant to 42 U.S.C. 6295(o)(2)(B)(i). The results of this analysis serve as the basis for DOE to definitively evaluate the economic justification for a potential standard level (thereby supporting or rebutting the results of any preliminary determination of economic justification).

2. Economic Impacts on Manufacturers

DOE performed an MIA to estimate the impact of amended energy conservation standards on manufacturers of residential refrigeration products. The section below describes the expected impacts on manufacturers at each potential TSL.

a. Cash-Flow Analysis Results

The tables below depict the financial impacts on manufacturers (represented by changes in INPV) and the conversion costs DOE estimates manufacturers would incur at each TSL. DOE shows four sets of results, corresponding to the four sets of TSLs considered in this rulemaking. Each set of TSLs reflect the impacts on manufacturers of a certain group of product classes.

The INPV results refer to the difference in industry value between the base case and the standards case, which DOE calculated by summing the discounted industry cash flows from the base year (2010) through the end of the analysis period. The discussion also notes the difference in cash flow between the base case and the standards case in the year before the compliance date of potential amended energy conservation standards. This figure provides a proxy for the magnitude of the required conversion costs, relative to the cash flow generated by the industry in the base case. In its discussion of the MIA results, DOE frequently references the common technology options that achieve the efficiencies required by a given TSL in the relevant representative product classes. To find to a complete description of technology options and the required efficiencies at each TSL, see section IV.B.2 of today's NOPR and appendix 5–A of the TSD.

Each set of results below shows two tables of INPV impacts: The first table reflects the lower (less severe) bound of impacts and the second represents the upper bound. To evaluate this range of cash-flow impacts on the residential refrigeration products industry, DOE modeled two different scenarios using different markup assumptions. These assumptions correspond to the bounds of a range of market responses that DOE anticipates could occur in the standards case. Each scenario results in a unique set of cash flows and corresponding industry value at each TSL.

To assess the lower (less severe) end of the range of potential impacts, DOE modeled the flat markup scenario. The flat markup scenario assumes that in the standards case manufacturers would be able to pass the higher production costs required for more efficient products on to their customers. Specifically, the industry would be able to maintain its average base-case gross margin, as a percentage of revenue, despite higher product costs. In general, the larger the product price increases, the less likely manufacturers are to achieve the cash flow from operations calculated in this scenario because the less likely it is that manufacturers would be able to fully markup these larger cost increases.

Through its discussions with manufacturers, DOE found that overall profit is driven more by bundles of product features, such as stainless steel exteriors, ice dispensers, and digital displays, than by energy efficiency characteristics. In other words, more efficient products command higher prices, but these prices are driven by the many other features that are also bundled with efficiency. However, the overall profit margin percentage does widely vary even if the dollar profit per unit increases for products with these additional features. Manufacturers are skeptical that customers would accept higher prices for increased energy efficiency because it does not command higher margins in the current market. Under such a scenario, it follows that the large retailers that compose the relatively concentrated customer base of the industry would not accept manufacturers fully passing through the additional cost of improved efficiency because consumers would be wary of higher prices without additional features. Therefore, to assess the higher (more severe) end of the range of potential impacts, DOE modeled the preservation of operating profit markup scenario in which higher energy conservation standards result in lower manufacturer markups. This scenario models manufacturers' concerns that the higher costs of more efficient technology would harm profitability if the full cost increases cannot be passed on. The scenario represents the upper end of the range of potential impacts on manufacturers because no additional operating profit is earned on the investments required to meet the proposed amended energy conservation standards, while higher production costs erode profit margins and result in lower cash flows from operations.

DOE used the main NIA shipment scenario for both the lower- and higher-bound MIA scenarios that were used to characterize the potential INPV impacts. The shipment forecast is an important driver of the INPV results below. The main NIA shipment scenario includes a price elasticity effect, meaning higher prices in the standards case result in lower shipments. Lower shipments also reduce industry revenue, and, in turn, INPV.

i. Cash-Flow Analysis Results for Standard-Size Refrigerator-Freezers

TABLE V.23—MANUFACTURER IMPACT ANALYSIS FOR STANDARD-SIZE REFRIGERATOR-FREEZERS—FLAT MARKUP SCENARIO

	Units	Base case	Trial standard level				
			1	2	3	4	5
INPV	(2009$ millions)	3,173	3,088	2,997	2,886	2,530	2,344
Change in INPV	(2009$ millions)		(84.8)	(175.9)	(287.5)	(643.0)	(828.9)
	(%)		−2.7%	−5.5%	−9.1%	−20.3%	−26.1%
Product Conversion Costs	(2009$ millions)		153	197	229	348	406
Capital Conversion Costs	(2009$ millions)		229	393	620	1,405	2,013
Total Conversion Costs.	(2009$ millions)		382	590	848	1,753	2,419

TABLE V.24—MANUFACTURER IMPACT ANALYSIS FOR STANDARD-SIZE REFRIGERATOR-FREEZERS—PRESERVATION OF OPERATING PROFIT MARKUP SCENARIO

	Units	Base case	Trial standard level				
			1	2	3	4	5
INPV	(2009$ millions)	3,173	2,871	2,713	2,511	1,676	1,018
Change in INPV	(2009$ millions)		(301.7)	(459.8)	(662.1)	(1,496.8)	(2,154.7)
	(%)		−9.5%	−14.5%	−20.9%	−47.2%	−67.9%
Product Conversion Costs	(2009$ millions)		153	197	229	348	406
Capital Conversion Costs	(2009$ millions)		229	393	620	1,405	2,013
Total Conversion Costs.	(2009$ millions)		382	590	848	1,753	2,419

TSL 1 represents the current ENERGY STAR level for standard-size refrigerator-freezers or a 20 percent reduction in measured energy consumption over the current energy conservation standards for the analyzed product class 3 (automatic defrost with top-mounted freezer without through-the-door ice service), product class 5 (automatic defrost with bottom-mounted freezer without through-the-door ice service), and product class 7 (automatic defrost with side-mounted freezer with through-the-door ice service). At TSL 1, DOE estimates impacts on INPV to range −$84.8 million to -$301.7 million, or a change in INPV of −2.7 percent to −9.5 percent. At this proposed level, industry free cash flow is estimated to decrease by approximately 64.8 percent to $71.3 million, compared to the base-case value of $202.6 million in the year leading up to the proposed energy conservation standards.

The INPV impacts at TSL 1 are relatively minor, in part because the vast majority of manufacturers produce ENERGY STAR units in significant volumes, particularly for product class 5 and 7. Approximately 42 percent of product class 7 shipments and 47 percent of product class 5 shipments currently meet this TSL. By contrast, the vast majority of product class 3 shipments are baseline units. Additionally, most of the design options DOE analyzed at this proposed level are one-for-one component swaps, including more efficient compressors and brushless DC condenser and evaporator fan motors, which require only modest changes to the manufacturing process at TSL 1. As such, DOE estimated total product conversion costs of $153 million and capital conversion costs of $229 million.

While substantial on a nominal basis, the total conversion costs are relatively low compared to the industry value of $3.2 billion. The total conversion costs at TSL 1 are mostly driven by the design options that manufacturers could use to improve the efficiency of the smaller-sized units of the product classes analyzed. For example, the analyzed design options for the 22 cubic foot product class 7 unit included a VIP in the freezer door, while the 26 cubic foot product class 7 unit only analyzed less costly component swaps. VIP implementation would require significant capital and product conversion costs because additional production steps are required to hold and bind each panel in its location before the product is foamed. Each additional step requires more equipment to lengthen production lines and, because of lower throughput, more production lines for each manufacturer to maintain similar shipment volumes. Some manufacturers have experience with VIPs, but DOE expects substantial engineering and testing resources would be required for their use in new platforms and/or at higher production volumes.

Similarly, the 16 cubic foot product class 3 unit uses a variable speed compressor as a design option. While not a capital intensive solution, variable speed compressors would require substantial engineering time to integrate the complex component, especially if electronic control systems would also be required. Because these changes are more complex than the other analyzed design options, more than three-quarters of the conversion costs for TSL 1 are attributable to the use of the VIPs and variable speed compressors in the smaller-volume product class 7 and product class 3 units, respectively.

The flat markup scenario shows slightly negative impacts at TSL 1, indicating that the outlays for conversion costs marginally outweigh any additional profit earned on incrementally higher variable costs. On a shipment-weighted basis, the average MPC for standard-size refrigerator-freezers increases by 10 percent at TSL 1. These small component cost changes are not significant enough to fully recoup these investments even if manufacturers earn additional profit on these costs, as the flat markup scenario assumes. Hence, there is a slight negative impact, even in the upper-bound scenario, at TSL 1.

The efficiency requirements for product class 3 and product class 5 refrigerator-freezers are the same at TSL 2 as TSL 1. However, the efficiency requirements for product class 7 increase to a 25 percent reduction in measured energy consumption from current energy conservation standards. DOE estimates the INPV impacts at TSL 2 range from −$175.9 million to −$459.8 million, or a change in INPV of −5.5 percent to −14.5 percent. At this proposed level, the industry cash flow is estimated to decrease by approximately 102.8 percent to −$5.7 million, compared to the base-case value of $202.6 million in the year leading up to the proposed energy conservation standard.

The additional impacts at TSL 2 relative to TSL 1 result from the further improvements manufacturers must make to product class 7 refrigerator-freezers to achieve a 25 percent energy reduction, as very few shipments of product class 7 currently exceed the ENERGY STAR level. Specifically, for the 22-cubic foot product, the design options DOE analyzed include a variable speed compressor and a VIP in the freezer cabinet, instead of the door as in TSL 1. For the 26-cubic foot product class 7 unit, the design options analyzed include a VIP in the freezer door in addition to additional component swaps and the component swaps needed to meet TSL 1. Total conversion costs increase by $208 million compared to TSL 1, which is largely driven by the initial use of VIPs in the 26-cubic foot product class 7 unit. Besides these specific changes to side-by-side units, at TSL 2 most production lines of standard-size refrigerator-freezers do not use of VIPs or other very costly components, mitigating some of the disruption to current facilities. Consequently, the INPV impacts, while greater than at TSL 1, are still relatively moderate compared to the value of the industry.

At TSL 2, the INPV in the flat markup is lower than at TSL 1, which means the additional conversion costs to add more VIPs leaves manufacturers worse off even if they can earn additional profit on these costly components. In the preservation of operating profit markup scenario, the industry earns no additional profit on this greater investment, lowering cash flow from operations in the standards case and resulting in greater INPV impacts.

The efficiency requirements for product class 5 and product class 7 refrigerator-freezers are the same at TSL 3 as TSL 2. However, the efficiency requirements for product class 3 increase to a 25 percent reduction in measured energy consumption from current energy conservation standards. TSL 3 represents a 25 percent reduction in measured energy consumption over the current energy conservation standards both product class 3 and product class 7. In addition, TSL 3 represents a 20 percent reduction in measured energy consumption for the unanalyzed product classes 1, 1A, and 2. DOE estimates the INPV impacts at TSL 3 to range from −$287.5 million to −$662.1 million, or a change in INPV of −9.1 percent to −20.9 percent. At this proposed level, the industry cash flow is estimated to decrease by approximately 151.6 percent to −$104.5 million, compared to the base-case value of $202.6 million in the year leading up to the standards.

The additional negative impacts on industry cash flow result from the changes to product class 3 refrigerator-freezers to reach a 25 percent reduction in energy use (side-by-side products met this proposed level at TSL 2). Specifically, the design options DOE analyzes at TSL 3 for 16 cubic foot top-mount refrigerator-freezers include the use of VIPs for the first time (in the freezer cabinet), in addition to the component swaps discussed above. In total, DOE estimates product conversion costs of $229 million and capital conversion costs of $620 million at TSL 3. The high cost to purchase new production equipment and the large engineering effort to manufacture new platforms for these smaller-sized product class 3 units drive the vast majority of this additional $258 million in conversion costs that DOE estimates manufacturers would incur at TSL 3. Because the smaller size top-mounts account for a large percentage of total shipments, the production equipment necessary to implement new platforms for these products is costly.

While production of units meeting TSL 3 is fairly limited, several manufacturers have introduced products that meet this proposed level in response to Federal production tax credits. This experience mitigates some of the product conversion costs by giving manufacturers some experience with the newer technologies. However, the more severe impacts at TSL 3, relative to TSL 2, are due to the incremental outlays for conversion costs to make the changes described above. In particular, any experience with VIPs on some products does not lower the substantial capital conversion necessary to purchase production equipment necessary to manufacture products that are substantially different from existing products.

As mentioned above, the preservation of operating profit markup scenario assumes no additional profit is earned on the higher production costs, which lower profit margins as a percentage of revenue and leads to worse impacts on INPV. In the flat markup scenario, the impact of the investments is mitigated by the assumption that manufacturers can earn a similar profit margin as a percentage of revenues on their higher variable costs. At TSL 3 MPCs increase by an average of 16 percent over the base case, leading to additional per-unit profit in this scenario. However, the magnitude of the conversion investments still leads to negative INPV impacts even if additional profit is earned on the incremental manufacturing costs. The lower industry shipments driven by the relative price elasticity assumption account for approximately 19 percent of the impact in the flat markup scenario.

TSL 4 represents a 30 percent reduction in measured energy consumption over the current energy conservation standards for product class 3, product class 5, and product class 7. DOE estimates the INPV impacts at TSL 4 to range from −$643.0 million to −$1,496.8 million, or a change in INPV of −20.3 percent to −47.2 percent. At this proposed level, the industry cash flow is estimated to decrease by approximately a factor of 3.2 to −$449.6 million, compared to the base-case value of $202.6 million in the year leading up to the proposed energy conservation standards.

At TSL 4, significant changes to the manufacturing process are necessary for all refrigerator-freezers. A 30 percent reduction in energy consumption is the max available top-mount on the market; the maximum available side-by-side and bottom-mount only slightly exceed a 30 percent reduction. The design options DOE analyzed for all standard-size products—with the exception of the 25 cubic foot product class 5 unit—use multiple VIPs in the fresh food compartment, freezer doors, and cabinets to reach 30 percent efficiency level. The design options also include the use of variable speed compressors for all units analyzed except the 21 cubic foot product class 3 unit. These product changes substantially increase the variable costs across nearly all platforms at this TSL.

While products that meet the efficiency requirements of TSL 4 are not in widespread production, several manufacturers produce units at these efficiencies due to tax credit incentives. However, at TSL 4 most manufacturers expect to completely redesign existing production lines if the proposed energy conservation standards were set at levels that necessitated these changes across most or all of their products. Manufacturers would need to purchase injection molding equipment, cabinet bending equipment, and other equipment for interior tooling as they would need to create new molds for these production lines. These changes drive DOE's estimate of the large product and capital conversion costs at TSL 4 ($348 million and $1,405 million, respectively). The significant incremental investment relative to TSL 3 results, in large part, from the design option of adding VIPs to the 21 cubic foot analyzed product class 3 unit. This top-mounted refrigerator-freezer represents a substantial portion of the market and manufacturers would have to completely redesign these platforms.

As a result of the large investment necessary to meet this proposed level, some manufacturers could move production to Mexico or other lower-labor-costs countries to achieve cost savings for labor expenditures. (More information on employment impacts is provided in section V.B.2.b.) In addition to the large capital conversion costs, the shipment-weighted average MPC increases by approximately 36 percent at TSL 4 compared to the base case. However, the magnitude of the conversion costs at TSL 4 are so large that even if manufacturers can reap additional profit from these higher product costs (as in the flat markup scenario), they would still be substantially impacted, as shown by the negative INPV results in the flat markup scenario. Additionally, the 36 percent increase in MPC drives shipments lower due to the price elasticity. Lower industry volume due to the decline in shipments accounts for approximately one-quarter of the change in industry value in the flat markup scenario. The large, negative impact on INPV is even greater under the preservation of operating profit markup scenario due to the inability to pass on the higher costs of expensive design options such as variable speed compressors and VIPs.

TSL 5 represents max tech for all standard-size refrigerator-freezers. The max-tech level corresponds to reductions in measured energy consumption of 36 percent, 36 percent, and 33 percent over the current energy conservation standards for product class 3, product class 5, and product class 7, respectively. DOE estimates the INPV impacts at TSL 5 to range from −$828.9 million to −$2,154.7 million, or a change in INPV of −26.1 percent to −67.9 percent. At this proposed level, the industry cash flow is estimated to decrease by a factor of approximately 4.5 to −$707.8 million, compared to the base-case value of $202.6 million in the year leading up to the proposed energy conservation standards.

No products that meet TSL 5 are currently offered on the U.S. market. At TSL 5, the changes required to meet this proposed level are similar to those at TSL 4, as complete redesigns of all platforms would be required.TSL 5 requires much more extensive use of VIPs, however. The higher conversion costs at TSL 5 are primarily due to the use of VIPs in additional locations in the door, cabinet and freezer, whereas at TSL 4 some of the analyzed design options of the larger-sized units included limited or no VIP use. This would require manufacturers to further lengthen assembly lines and even modify or move their entire facilities, driving the $2,419 million conversion cost estimate at this proposed level. As with TSL 4, at TSL 5 some manufacturers could elect to move production out of the U.S. to offset some of the addition product costs. At TSL 5, DOE estimates MPCs increase by approximately 58 percent compared to the base case. Similar to TSL 4, this substantially reduces shipments due to the price elasticity effect and exacerbates the industry impacts in both markup scenarios.

As with other TSLs, the impact on INPV is mitigated under the flat markup scenario because manufacturers are able to fully pass on the large increase in MPC to consumers, thereby increasing manufacturers' gross profit in absolute terms. However, even assuming manufacturers could earn the same gross margin percentage per unit on those higher costs, the capital and product conversion costs cause negative INPV impacts, as shown by the 26.15 percent decline in INPV in the flat markup scenario. This large impact even in the lower bound scenario demonstrates that the large conversion costs to redesign all existing platforms results in substantial harm even if manufacturers earn a historical margin on these additional costs. Due to the extremely large cost increases at the max-tech level, it is more unlikely at TSL 5 that manufacturers could fully pass through the increase production costs. If margins are impacted, TSL 5 would result in a substantial INPV loss under this scenario.

ii. Cash-Flow Analysis Results for Standard-Size Freezers

TABLE V.25—MANUFACTURER IMPACT ANALYSIS FOR STANDARD-SIZE FREEZERS—FLAT MARKUP SCENARIO

	Units	Base case	Trial standard level				
			1	2	3	4	5
INPV	(2009$ millions)	403	378	292	308	344	300
Change in INPV	(2009$ millions)		(24.9)	(110.6)	(94.5)	(59.0)	(102.4)
	(%)		−6.2%	−27.5%	−23.5%	−14.6%	−25.4%
Product Conversion Costs	(2009$ millions)		22	51	55	63	70
Capital Conversion Costs	(2009$ millions)		50	175	182	183	320
Total Conversion Costs.	(2009$ millions)		72	226	237	247	390

TABLE V.26—MANUFACTURER IMPACT ANALYSIS FOR STANDARD-SIZE FREEZERS—PRESERVATION OF OPERATING PROFIT MARKUP SCENARIO

	Units	Base case	Trial standard level				
			1	2	3	4	5
INPV	(2009$ millions)	403	345	217	202	184	37
Change in INPV	(2009$ millions)		(57.3)	(186.0)	(201.1)	(218.9)	(365.1)

TABLE V.26—MANUFACTURER IMPACT ANALYSIS FOR STANDARD-SIZE FREEZERS—PRESERVATION OF OPERATING PROFIT MARKUP SCENARIO—Continued

	Units	Base case	Trial standard level				
			1	2	3	4	5
	(%)	....	−14.2%	−46.2%	−49.9%	−54.4%	−90.7%
Product Conversion Costs	(2009$ millions)	....	22	51	55	63	70
Capital Conversion Costs	(2009$ millions)	....	50	175	182	183	320
Total Conversion Costs.	(2009$ millions)	....	72	226	237	247	390

TSL 1 represents a 20 percent reduction in measured energy use over the current energy conservation standards for the analyzed product class 9 (upright freezers with automatic defrost) and product class 10 (chest freezers and all other freezers except compact freezers). DOE estimates the INPV impacts at TSL 1 to range from −$24.9 million to −$57.3 million, or a change in INPV of −6.2 percent to −14.2 percent. At this proposed level, the industry cash flow is estimated to decrease by approximately 100.4 percent to −$0.1 million, compared to the base-case value of $25.7 million in the year leading up to the proposed energy conservation standards.

While products meeting TSL 1 are only currently produced in limited volumes, the changes in the manufacturing process would not require completely new platforms to meet the energy requirements at this TSL. For most standard-size freezer platforms, the design options DOE analyzed include the use of brushless DC evaporator fan motors and compressors with higher EERs. However, the design options to meet this efficiency level also include increasing door insulation thickness for all analyzed products except the 20 cubic foot product class 10 unit. Increasing door insulation thickness drives the majority of the conversion cost outlay DOE estimates manufacturers would incur at TSL 1. To increase door insulation thickness, manufacturers would need to purchase new equipment tooling equipment for their door assembly. DOE estimates that these changes would result in product conversion costs of $22 million and capital conversion costs of $50 million at TSL 1. However, the conversion costs are somewhat mitigated at TSL 1 because the design options analyzed would not change the production equipment for the cabinet.

At TSL 1, variable costs increase by approximately 10 percent relative to base case MPCs. The flat markup scenario shows less severe impacts because it assumes manufacturers can pass on these substantially higher product costs and maintain gross margin percentages. Additionally, the reduction in shipments due to the price elasticity has only a marginally negative effect at this proposed level. The relatively large conversion costs decrease industry value under both markup scenarios and account for a substantial portion of the INPV impacts especially if manufacturers are not able to earn any additional profit on the higher production costs (the preservation of operating profit scenario).

TSL 2 represents a 30 percent reduction in measured energy consumption over the current energy conservation standards for product class 9 and 25 percent for product class 10. TSL 2 also represents a 25 percent reduction in measured energy consumption for the unanalyzed product class 8 (upright freezers with manual defrost) and a 30 percent reduction for the analyzed product class 10A (chest freezers with automatic defrost). DOE estimates the INPV impacts at TSL 2 to range from −$110.6 million to −186.0 million, or a change in INPV of −27.5 percent to −46.2 percent. At this proposed level, the industry cash flow is estimated to decrease by approximately a factor of 3.2 to −$57.5 million, compared to the base-case value of $25.7 million in the year leading up to the proposed energy conservation standards.

The vast majority of the standard-size freezer market does not currently meet the efficiency requirements at TSL 2. DOE's design options assume that, in addition to the component swaps noted above, manufacturers would increase the insulation thickness of both the door and cabinet. As a result, product redesigns are expected across most platforms, which could substantially disrupting current manufacturing processes. These changes account for the majority of DOE's estimates for total product conversion costs of $51 million and capital conversion costs of $175 million, an increase over TSL 1 of $29 million and $125 million, respectively. The magnitude of the investments, relative to the industry value, results in severe INPV impacts. Even if manufacturers are able to pass on the estimated 24 percent increase in product costs onto their customers, the large product and capital conversion costs resulting from increased insulation thickness decrease INPV. If manufacturers are not able to pass on these costs, as shown by the preservation of operating profit scenario, INPV impacts are projected to be severe.

TSL 3 represents a 35 percent reduction in measured energy use over the current energy conservation standards for product class 9 and a 30 percent reduction for product class 10. DOE estimates the INPV impacts at TSL 3 to range from −$94.5 million to −$201.1 million, or a change in INPV of −23.5 percent to −49.9 percent. At this proposed level, the industry cash flow is estimated to decrease by a factor of approximately 3.4 to −$61.3 million, compared to the base-case value of $25.7 million in the year leading up to the proposed energy conservation standards.

The efficiency requirements at TSL 3 are more stringent than the max available products in the market for product class 9 and product class 10. The impacts at TSL 3 are similar to those at TSL 2 because the design options analyzed by DOE already required platform redesigns at TSL 2. However, the additional design options analyzed at TSL 3 also include a variable speed compressor in the 14-cubic foot product class 9 unit and VIPs in the bottom wall of the 20-cubic foot product class 10 unit. These design options substantially increase the variable costs associated with these products but do not greatly change the product and capital conversion costs. The average MPC of a standard-size freezer shipped at TSL 3 is estimated to be approximately 34 percent more expensive than in the base case, leading to a 9 percent decline in shipments due to the price elasticity assumption in 2014 alone.

The impacts at TSL 3 under the flat markup scenario become less severe than at TSL 2 because the scenario assumes manufacturers can fully pass on the added cost to consumers, while investments do not significantly increase from TSL 2 to TSL 3. However, under the preservation of operating profit markup scenario, manufacturers do not receive any extra profit on units of higher cost, resulting in worse INPV impacts at TSL 3 than at TSL 2.

TSL 4 represents a 40 percent reduction in measured energy use over the current energy conservation standards for product class 9 and a 35 percent reduction for product class 10. DOE estimates the INPV impacts at TSL 4 to range from −$59.0 million to −$218.9 million, or a change in INPV of −14.6 percent to −54.4 percent. At this proposed level, the industry cash flow is estimated to decrease by a factor of approximately 3.5 to −$64.0 million, compared to the base-case value of $25.7 million in the year leading up to the proposed energy conservation standards.

At TSL 4, the design options DOE analyzed include the addition of a variable speed compressor for the 20-cubic foot product class 9 unit, the 15-cubic foot product class 10 unit, and the 20-cubic foot product class 10 unit. For the 14 cubic foot product class 9 unit, the design options analyzed were even thicker wall cabinet insulation and the implementation of VIPs.

The relative impacts at TSL 4 are also caused by the incremental MPCs compared to the conversion costs to implement these design options. Outlays for conversion costs increase only slightly at TSL 4 (by 4 percent, compared to TSL 3) while variable costs increase substantially (by approximately 50 percent compared to the baseline) due to the addition of variable speed compressors and VIPs. Because manufacturers earn incrementally more profit on each unit at TSL 4 compared to TSL 3 in the flat markup scenario—without substantial changes to conversion costs—further declines in industry value, though still substantial, are mitigated in this scenario. However, manufacturers expressed skepticism that such large cost increases could be passed on. This view is reflected by the severely negative results in the preservation of operating profit scenario.

TSL 5 represents max tech for the standard-size freezer product classes. This TSL reflects a 44 percent reduction in measured energy use for product class 9 and a 41 percent reduction for product class 10. DOE estimates the INPV impacts at TSL 5 to range from −$102.4 million to −$365.1 million, or a change in INPV of −25.4 percent to −90.7 percent. At this proposed level, the industry cash flow is estimated to decrease by a factor of approximately 5.7 to −$120.3 million, compared to the base-case value of $25.7 million in the year leading up to the proposed energy conservation standards.

To achieve the max-tech level at TSL 5, DOE analyzed design options that include the widespread implementation of multiple VIPs on all standard-size freezers, in addition to the use of more efficient components and thicker insulation already necessary to achieve the efficiency requirements at TSL 4. DOE estimated that TSL 5 would require product and capital conversion costs of $70 million and $320 million, respectively. These large conversion costs result from the changes associated with multiple VIP implementation and wall thickness increases. In addition, DOE estimates that product costs would almost double base-case MPCs, driven by the use of variable speed compressors and VIPs in the doors and cabinet of all product lines. As a result, INPV decreases substantially from TSL 4 to TSL 5.

iii. Cash-Flow Analysis Results for Compact Refrigeration Products

TABLE V.27—MANUFACTURER IMPACT ANALYSIS FOR COMPACT REFRIGERATION PRODUCTS—FLAT MARKUP SCENARIO

	Units	Base case	Trial standard level				
			1	2	3	4	5
INPV	(2009$ millions)	200	185	169	143	170	67
Change in INPV	(2009$ millions)		(14.3)	(30.8)	(56.8)	(29.6)	(133.0)
	(%)		−7.2%	−15.4%	−28.4%	−14.8%	−66.6%
Product Conversion Costs	(2009$ millions)		15	35	41	48	67
Capital Conversion Costs	(2009$ millions)		24	46	76	71	220
Total Conversion Costs.	(2009$ millions)		39	80	118	119	287

TABLE V.28—MANUFACTURER IMPACT ANALYSIS FOR COMPACT REFRIGERATION PRODUCTS—PRESERVATION OF OPERATING PROFIT MARKUP SCENARIO

	Units	Base Case	Trial Standard Level				
			1	2	3	4	5
INPV	(2009$ millions)	200	168	133	101	85	(96)
Change in INPV	(2009$ millions)		(32.1)	(66.7)	(99.2)	(114.4)	(295.6)
	(%)		−16.1%	−33.4%	−49.6%	−57.3%	−148.0%
Product Conversion Costs	(2009$ millions)		15	35	41	48	67
Capital Conversion Costs	(2009$ millions)		24	46	76	71	220
Total Conversion Costs.	(2009$ millions)		39	80	118	119	287

TSL 1 represents a 20 percent reduction in measured energy use over the current energy conservation standards for product class 11 (compact refrigerators and refrigerator-freezers with manual defrost) and a 10 percent reduction for product class 18 (compact chest freezers). DOE estimates the INPV impacts at TSL 1 to range from −$14.3 million to −$32.1 million, or a change in INPV of −7.2 percent to −16.1 percent. At this proposed level, industry cash flow is estimated to decrease by approximately 112.9 percent to −$1.5 million, compared to the base-case value of $11.9 million in the year leading up to the proposed energy conservation standards. A small percentage of product class 18 shipments currently meet this TSL, but most product class 11 shipments are baseline units.

The design options analyzed by DOE at TSL 1 assumed that more significant changes in the manufacturing process would be required for product class 11, while product class 18 would only require increased compressor efficiency. For product class 11, DOE analyzed several design options that represent component changes, such as a more efficient compressor and increased heat exchanger area, which do not have a significant impact on consumer prices or conversion costs. However, DOE also analyzed increasing door insulation thickness for product class 11, which drives the bulk of the estimated $15 million and $24 million outlays for product conversion and capital conversion costs, respectively. As described for standard-size refrigerator-freezers and standard-size freezers, increasing insulation thickness requires manufacturers to invest in injection molding equipment and other equipment for interior tooling to manufacturer products with different door dimensions. The overall impacts at TSL 1 are relatively moderate because the conversion costs are still small compared to the industry value of $200 million.

The higher production costs at TSL 1 do not have a substantial impact on INPV at TSL 1. The MPC of compact refrigeration products on a shipment-weighted basis increases 11 percent over the base case at TSL 1. The combined INPV impacts are greater under the preservation of operating profit scenario since manufacturers cannot pass on any of the added cost to consumers under that scenario, resulting in lower cash flows from operations. However, because production costs do not greatly increase at TSL 1, the impacts on INPV are relatively low under this scenario as well.

TSL 2 represents a 25 percent reduction in measured energy use over the current energy conservation standards for product class 11 and a 10 percent reduction for product class 18. TSL 2 also represents a 15 percent reduction in measured energy consumption for the analyzed product classes 13 and 15, and a 20 percent reduction for the unanalyzed product class 14. DOE estimates the INPV impacts at TSL 2 to range from −$30.8 million to −$66.7 million, or a change in INPV of −15.4 percent to −33.4 percent. At this proposed level, the industry cash flow is estimated to decrease by approximately 230.1 percent to −$15.4 million, compared to the base-case value of $11.9 million in the year leading up to the proposed energy conservation standards.

At TSL 2, further changes are required for product class 11. In addition to component swaps, the design options analyzed by DOE also include thicker cabinet insulation. As discussed for TSL 1, increasing insulation thickness significantly impacts product and capital conversion costs, but much more so when adding insulation to the cabinet (as opposed to the door). To increase the insulation thickness of the cabinet, manufacturers must replace virtually all stamping equipment which greatly increases the capital conversion costs. Additionally, DOE analyzed the use of isobutane refrigerant as a design option for the 4-cubic foot product class 11 unit. At TSL 2, a substantial portion of the investment to reach TSL 2 would likely go towards training service technicians to handle the explosive refrigerant. As a result of thicker cabinet insulation and conversion to isobutane, product conversion and capital conversion costs roughly double at TSL 2 (to $35 million for product conversion costs and $46 million for capital conversion costs). The shipment-weighted MPC increased 22 percent at TSL 2 compared to baseline costs, which also contributed to the more severe impacts projected under the preservation of operation profit scenario if manufacturers do not earn additional profit on these higher costs.

TSL 3 represents a 30 percent reduction in measured energy use over the current energy conservation standards for product class 11 and a 15 percent reduction for product class 18. DOE estimates the INPV impacts at TSL 3 to range from −$56.8 million to −$99.2 million, or a change in INPV of −28.4 percent to −49.6 percent. At this proposed level, the industry cash flow is estimated to decrease by a factor of approximately 3.5 to −$29.4 million, compared to the base-case value of $11.9 million in the year leading up to the proposed energy conservation standards.

At TSL 3, the design options analyzed for both product class 18 units include thicker door insulation, which further increases the capital conversion costs over TSL 1 and TSL 2, where this was not analyzed as a design option. The additional impacts at TSL 3 are also due to more stringent requirements for product class 11. A 30 percent reduction for product class 11 is greater than the most efficient units on the market today. For both analyzed sizes of product class 11, DOE analyzed the design option of thicker insulation in the cabinet for both units analyzed. The net effect is a large increase in conversion costs due to the much higher cost of the equipment necessary to manufacture the cabinet. At TSL 3, DOE estimated total product conversion costs of $41 million and capital conversion costs of $76 million, a 46 percent total increase in conversion costs over TSL 2. The effect of the design changes at TSL 3 on shipment-weighted unit cost is a 27 percent increase over the baseline MPC. The magnitude of the investments relative to the industry value leads to significant impacts, although they are moderated somewhat in the flat markup because manufacturers earn additional profit on the investments.

TSL 4 represents a 40 percent reduction in measured energy use over the current energy conservation standards for product class 11 and a 25 percent reduction for product class 18. DOE estimates the INPV impacts at TSL 4 to range from −$29.6 million to −$114.4 million, or a change in INPV of −14.8 percent to −57.3 percent. At this proposed level, the industry cash flow is estimated to decrease by approximately 344.1 percent to −$29.0 million, compared to the base-case value of $11.9 million in the year leading up to the proposed energy conservation standards.

The design options analyzed at TSL 4 would also severely disrupt current manufacturing processes. For the 1.7-cubic foot product class 11 unit, DOE analyzed a variable speed compressor and isobutane refrigerant as design options. For the 4 cubic foot product class 11 unit and the 7-cubic foot product class 18 unit, DOE analyzed thicker insulation in the cabinets. For 3.4-cubic foot product class 18 unit, DOE analyzed both an increase to cabinet insulation thickness and VIPs in the bottom wall as design options. Although increasing insulation thickness, converting to isobutane, and implementing VIPs all would necessitate large conversion costs, capital conversion costs decrease slightly from TSL 3 to TSL 4 because of the removal of all previous design options in the 1.7-cubic foot unit. In other words, the design options analyzed for this unit cause less substantial changes to existing production equipment, but would also require a large investment by manufacturers to train service technicians to deal with the explosive refrigerant. Because this would require a large outlay for product conversion costs, total conversion costs are roughly the same at TSL 3 and TSL 4. The addition of a variable speed compressor in the smaller product class 11 unit analyzed also has a substantial impact on unit price because of its high component cost. At TSL 4, the shipment-weighted MPC is 60 percent higher than the baseline MPC. These cost increases are projected to cause a 16 percent decrease in shipments at TSL 4 in 2014 alone. Over time, the decline in shipments is a big contributor to the negative impacts on INPV in both markup scenarios.

The large conversion costs and higher prices leading to lower shipments cause a decrease in INPV from TSL 3 to TSL 4 under the preservation of operating profit markup scenario (since this scenario assumes higher production costs are not passed on to consumers). However, under the flat markup scenario, manufacturers are able to earn additional profit on the new high-cost components such as variable speed compressors, resulting in an increase in INPV from TSL 3 to TSL 4.

TSL 5 represents max tech for both product classes 11 and 18. The max-tech level corresponds to a 59 percent and 42 percent reduction in measured energy use for product class 11 and product class 18, respectively. DOE estimates the INPV impacts at TSL 5 to range from −$133.0 million to −$295.6 million, or a change in INPV of −66.6 percent to −148.0 percent. At this proposed level, the industry cash flow is estimated to decrease approximately nine-fold to −$95.7 million, compared to the base-case value of $11.9 million in the year leading up to the proposed energy conservation standards.

The design options DOE analyzed include the use of VIPs for all analyzed product class 11 and 18 units to reach max-tech efficiency levels. Additionally, the design options analyzed for some products also included other costly changes. For the 1.7-cubic foot product class 11 unit, the design options analyzed included multiple VIPs, a larger heat exchanger, and thicker insulation. The design options analyzed for the 4-cubic foot product class 11 unit also included a variable speed compressor and thicker insulation. For product class 18, DOE assumed that manufacturers would remove the design options necessary to meet TSLs 1 through 4 and add a variable speed compressor and thicker insulation for both analyzed products. These significant changes greatly increase the investment required to manufacture standards-compliant products. DOE estimated that product conversion costs would be $67 million at TSL 5, an increase of almost 40 percent over TSL 4. DOE also estimated that capital conversion costs would be $220 million, a more than three-fold increase over TSL 4. This drastic increase in conversion costs demonstrates the significant investments required by implementing widespread use of VIPs and increasing wall thickness.

At TSL 5, the shipment-weighted MPC increases by over 150 percent over the baseline due to the high material costs of VIPs and variable speed compressors. These large jumps cause shipments to decrease by 42 percent due to the price elasticity in 2014 alone. As a result of lower industry shipments and extremely high conversion costs, INPV decreases substantially from TSL 4 to TSL 5 and becomes negative under the preservation of operating profit scenario, which indicates the industry loses more than its base-case value in the standards case under this scenario.

iv. Cash-Flow Analysis Results for Built-In Refrigeration Products

TABLE V.29—MANUFACTURER IMPACT ANALYSIS FOR BUILT-IN REFRIGERATION PRODUCTS—FLAT MARKUP SCENARIO

	Units	Base case	Trial standard level				
			1	2	3	4	5
INPV	(2009$ millions)	658	607	604	593	579	574
Change in INPV	(2009$ millions)		(51.7)	(54.7)	(65.8)	(79.7)	(84.9)
	(%)		−7.9%	−8.3%	−10.0%	−12.1%	−12.9%
Product Conversion Costs	(2009$ millions)		41	51	65	75	87
Capital Conversion Costs	(2009$ millions)		40	38	55	74	84
Total Conversion Costs.	(2009$ millions)		81	89	119	149	171

TABLE V.30—MANUFACTURER IMPACT ANALYSIS FOR BUILT-IN REFRIGERATION PRODUCTS—PRESERVATION OF OPERATING PROFIT MARKUP SCENARIO

	Units	Base case	Trial standard level				
			1	2	3	4	5
INPV	(2009$ millions)	658	606	601	578	555	538
Change in INPV	(2009$ millions)		(52.9)	(57.0)	(80.5)	(103.0)	(120.3)
	(%)		−8.0%	−8.7%	−12.2%	−15.6%	−18.3%
Product Conversion Costs	(2009$ millions)		41	51	65	75	87
Capital Conversion Costs	(2009$ millions)		40	38	55	74	84
Total Conversion Costs.	(2009$ millions)		81	89	119	149	171

TSL 1 represents a 10 percent reduction in measured energy use over the current energy conservation standards for product class 3A–BI (built-in all-refrigerators—automatic defrost), product class 5–BI (built-in refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker), product class 7–BI (built-in refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service), and product class 9–BI (built-in upright freezers with automatic defrost without an automatic icemaker). DOE estimates the INPV impacts at TSL 1 to range from −$51.7 million to −$52.9 million, or a change in INPV of −7.9 percent to −8.0 percent. At this proposed level, the industry cash flow is estimated to decrease by approximately 63.9 percent to $15.0 million, compared to the base-case value of $41.5 million in the year leading up to the proposed energy conservation standards.

At TSL 1, the design options that DOE analyzes result in moderate changes in the manufacturing process for built-in refrigeration products. For product classes 3A–BI and 9–BI, the design options that DOE analyzed to reach TSL 1 included the use of more efficient components that do not require significant changes to the manufacturing process. However, for product class 5–BI and product class 7–BI, the design options DOE analyzed also include the use of VIPs in the freezer door. While these components add to the overall costs of production, the added costs represent a small percentage of the total cost of a built-in refrigeration product. These cost deltas are low compared to the overall cost of the products and result in small impacts even if no additional profit is earned on the incremental MPCs. The estimated product conversion costs for all built-in refrigeration products at TSL 1 are $41 million and the estimated capital conversion costs are $40 million. The implementation of VIPs represents a substantial part of the conversion costs, but several built-in refrigeration manufacturers have products that use similar technology, which helps to mitigate some of the product conversion costs that would be required to design products from the ground up.

TSL 2 represents a 15 percent reduction in measured energy use for product class 3A–BI and product class 5–BI. For product classes 7–BI and 9–BI, TSL 2 represents a reduction of 10 percent and 20 percent, respectively. DOE estimates the INPV impacts at TSL 2 to range from −$54.7 million to −$57.0 million, or a change in INPV of −8.3 percent to −8.7 percent. At this proposed level, the industry cash flow is estimated to decrease by approximately 68.0 percent to $13.3 million, compared to the base-case value of $41.5 million in the year leading up to the proposed energy conservation standards.

The efficiency requirements for product class 7–BI refrigerator-freezers do not change from TSL 1 to TSL 2, but the efficiency requirements for all other analyzed built-in product classes increase. The design options that DOE analyzes at TSL 2 for product classes 3A–BI and 7–BI still only include component swaps to reach a 15 percent efficiency improvement. Product class 5–BI uses a variable speed compressor in the freezer with a brushless DC condenser fan motor, but no longer use the VIPs used to reach TSL 1. The design options analyzed for product class 9–BI include a brushless DC evaporator and condenser fan motor, a larger condenser, a variable speed compressor, and a VIP in the upper door. Because product class 5–BI no longer uses VIPs and fewer changes to existing products are necessary, the overall impact is a slight decrease in capital conversion costs from $40 million at TSL 1 to $38 million at TSL 2. Product conversion costs increase to $51 million at TSL 2 because additional engineering time would be required to implement the additional component changes. However, because the complexity of the changes to the products and production facilities are similar at TSL 1 and TSL 2, there is only a small decrease in INPV from TSL 1 to TSL 2.

TSL 3 represents a 20 percent reduction in measured energy use for product class 3A–BI and product class 7–BI. For product classes 5–BI and 9–BI, TSL 2 represents a reduction of 15 percent and 25 percent, respectively. DOE estimates the INPV impacts at TSL 3 to range from −$65.8 million to −$80.5 million, or a change in INPV of −10.0 percent to −12.2 percent. At this proposed level, the industry cash flow is estimated to decrease by approximately 93.0 percent to $2.9 million, compared to the base-case value of $41.5 million in the year leading up to the proposed energy conservation standards.

The efficiency requirements for product class 5–BI do not change from TSL 2 to TSL 3. However, the design options for all other built-in refrigeration products at TSL 3 include the implementation of VIPs. The widespread implementation of VIPs increases product and capital conversion costs, which are estimated to be $65 million and $55 million at TSL 3, respectively. Substantial changes to existing production facilities would be required to manufacture products that meet the required efficiencies at TSL 3. Most of the capital conversion costs involve purchasing new production equipment and would result in high stranded assets. The extensive changes that manufacturers would be required to make to existing facilities and the projected erosion of profitability if the additional production cost of implementing VIPs does not yield additional profit result in a projected decrease in INPV from TSL 3 to TSL 4. However, the industry value is high relative to the required capital conversion costs and the cost of the additional VIP panels is relatively small compared to the overall cost of the products, which helps to mitigate some of the negative impacts caused by these changes.

TSL 4 represents a 25 percent reduction in measured energy use over the current energy conservation standards for the following product classes: 3A–BI, 5–BI, and 9–BI. For product class 7–BI, TSL 4 represents a 20 percent reduction in measured energy use from current energy conservation standards. DOE estimates the INPV impacts at TSL 4 to range from −$79.7 million to −$103.0 million, or a change in INPV of −12.1 percent to −15.6 percent. At this proposed level, the industry cash flow is estimated to decrease by approximately 117.8 percent to −$7.4 million, compared to the base-case value of $41.5 million in the year leading up to the proposed energy conservation standards.

The efficiency requirements for product class 7–BI do not change from TSL 3 to TSL 4. The design options for the other built-in refrigeration products all include the addition of more VIPs to reach TSL 4. The design options analyzed for product classes 3A–BI and 5–BI also include using a variable speed compressor. The complexity of implementing multiple component swaps and the additional production equipment necessary to use additional VIPs increases both the product and capital conversion costs. These costs are estimated to be $75 million and $74 million at TSL 4, respectively, and result in a decrease in INPV from TSL 3 to TSL 4.

TSL 5 represents max tech for the four built-in product classes. This proposed level represents a reduction in measured energy use of 29 percent, 27 percent, 22 percent, and 27 percent, respectively, for product classes 3A–BI, 5–BI, 7–BI, and 9–BI. DOE estimates the INPV impacts at TSL 5 to range from −$84.9 million to −$120.3 million, or a change in INPV of −12.9 percent to −18.3 percent. At this proposed level, the industry cash flow is estimated to decrease by approximately 135.1 percent to −$14.6 million, compared to the base-case value of $41.5 million in the year leading up to the proposed energy conservation standards.

The design options analyzed by DOE include the widespread use of VIPs to achieve the max-tech efficiency levels at TSL 5. Additionally, product class 3A–BI uses multiple variable speed compressors. Since the implementation of VIPs is both research and capital intensive, product and capital conversion costs increase to $87 million and $84 million, respectively. The complexity of implementing multiple component swaps and the additional production equipment necessary to use additional VIPs increases both the product and capital costs.

b. Impacts on Employment

DOE quantitatively assessed the impacts of potential amended energy conservation standards on employment. DOE used the GRIM to estimate the domestic labor expenditures and number of domestic production workers in the base case and at each TSL from 2010 to 2043. DOE used statistical data from the most recent U.S. Census Bureau's 2007 Economic Census, 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 involved with the manufacture of the product are a function of the labor intensity of the product, the sales volume, and an assumption that wages remain fixed in real terms over time.

In each GRIM, DOE used the labor content of each product and the manufacturing production costs from the engineering analysis to estimate the annual labor expenditures in the residential refrigeration product 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 workers up to the line-supervisor level who are directly involved in fabricating and assembling a product within an Original Equipment Manufacturer (OEM) 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, a worker on a wine cooler line would not be included with the estimate of the number of residential refrigeration workers.

The employment impacts shown in Table V.31 through Table V.34 represent the potential production employment that could result following amended energy conservation standards. The upper end of the results in these tables estimates the maximum change in the number of production workers after amended energy conservation standards must be met. The upper end of the results assumes manufacturers would continue to produce the same scope of covered products in the same production facilities. The upper end of the range also assumes that domestic production 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.31 through Table V.34 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. While the results present a range of employment impacts following the compliance date of amended energy conservation standards, the discussion below also includes a qualitative discussion of the likelihood of negative employment impacts at the various TSLs. Finally, the employment impacts shown are independent of the employment impacts from the broader U.S. economy, which are documented in chapter 13, Employment Impact Analysis, of the NOPR TSD.

i. Standard-Size Refrigerator-Freezer Employment Impacts

Using the GRIM, DOE estimates that in the absence of amended energy conservation standards, there would be 8,517 domestic production workers involved in manufacturing standard-size refrigerator-freezers in 2014. Using 2007 Census Bureau data and interviews with manufacturers, DOE estimates that approximately 42 percent of standard-size refrigerator-freezers sold in the United States are manufactured domestically. Table V.31 shows the range of the impacts of potential amended energy conservation standards on U.S. production workers in the standard-size refrigerator-freezer market.

TABLE V.31—POTENTIAL CHANGES IN THE TOTAL NUMBER OF DOMESTIC STANDARD-SIZE REFRIGERATOR-FREEZER PRODUCTION WORKERS IN 2014

	Trial standard level					
	Base case	1	2	3	4	5
Total Number of Domestic Production Workers in 2014 (without changes in production locations)	8,517	8,300	8,258	8,309	8,236	8,088
Potential Changes in Domestic Production Workers in 2014 *	....	(217)–(8,517)	(259)–(8,517)	(208)–(8,517)	(281)–(8,517)	(429)–(8,517)

* DOE presents a range of potential employment impacts. Numbers in parentheses indicate negative numbers.

All examined TSLs show relatively minor impacts on domestic employment levels at the lower end of the range. Most of the design options used in the engineering analysis involve the swapping of components in baseline units with more efficient parts for top-mounted, side-by-side, and bottom-mounted refrigerator-freezers. These component swaps for these design options add primarily material costs and do not greatly impact the labor content of the baseline products. The relatively small decreases in domestic production employment for the lower end of the range of the employment impacts arise from higher product prices lowering shipments the year the standard becomes effective. At these higher TSLs, the effects of lower shipments more than offset the additional product labor that is required to manufacture products that use VIP panels.

During interviews, manufacturers indicated that their domestic employment levels could be impacted under two scenarios: (1) The widespread adoption of VIPs or (2) significant capital conversion costs that would force them to consider non-domestic manufacturing locations once the compliance date for the amended energy conservation standards arrive. The widespread adoption of VIPs would increase the labor content of today's products. The labor content of products with VIPs increases because of the extra handling steps that would be required to ensure that VIPs are not damaged during production. Because of the competitive nature of the industry, manufacturers believed the extra labor costs could force them to move their remaining domestic production to Mexico to take advantage of the cheaper labor.

Manufacturers also indicated that large conversion costs would likely force them to consider investing in lower-labor-cost countries. For most product categories, there is a range of efficiency levels that can be met with relatively low-cost components (as analyzed in the engineering analysis). Beyond these levels, manufacturers would need to decide to follow the MPC design options analyzed in the engineering analysis for each product category. Manufacturers indicated the analyzed design options that use multiple VIPs would involve significant capital conversion costs and add very large material costs to their products that would likely result in the relocation of their production facilities abroad. However, manufacturers indicated they would face even larger capital conversion costs at lower efficiencies if they redesigned their products with thicker walls. While not analyzed as a design option for standard-size refrigerator-freezers, increasing wall thickness would likely result in moving domestic production outside of the U.S. at lower efficiency levels.

ii. Standard-Size Freezer Employment Impacts

Using the GRIM, DOE estimates that, in the absence of amended energy conservation standards, there would be 1,904 standard-size freezer production workers in the U.S. in 2014. Using the 2007 Census data and interviews with manufacturers, DOE estimates that approximately 80 percent of standard-size freezers sold in the United States are manufactured domestically. Table V.32 shows the impacts of amended energy conservation standards on U.S. production workers in the standard-size freezer market.

TABLE V.32—POTENTIAL CHANGES IN THE TOTAL NUMBER OF DOMESTIC STANDARD-SIZE FREEZER PRODUCTION WORKERS IN 2014

	Trial standard level					
	Base case	1	2	3	4	5
Total Number of Domestic Production Workers in 2014 (without changes in production locations)	1,904	1,850	1,781	1,734	1,634	1,508
Potential Changes in Domestic Production Workers in 2014 *		(54)–(1,904)	(123)–(1,904)	(170)–(1,904)	(270)–(1,904)	(396)–(1,904)

* DOE presents a range of potential employment impacts. Numbers in parentheses indicate negative numbers.

Similar to standard-size refrigerator-freezers, there are relatively small decreases in employment at the lower end of the range of employment impacts. These slight declines are caused by higher prices that drive lower shipments once manufacturers must meet the amended energy conservation standard. Standard-size freezer manufacturers also indicated that domestic production could be shifted abroad with any efficiency level that required large capital conversion costs. At TSL 1, DOE does not expect substantial changes to domestic employment in the standard-size freezer market if manufacturers use the design options listed in the engineering analysis to reach the efficiency requirements at this TSL.

However, at TSL 2 through TSL 5, manufacturers indicated that there could be domestic employment impacts depending on the design pathway used to reach the required efficiencies. At TSL 2 and above, the engineering analysis assumes that manufacturers would have to use wall thickness changes to reach the required efficiencies. Manufacturers indicated that because these products are typically low-end, they would likely follow the design pathways in the engineering analysis and increase the wall insulation thickness to reach higher efficiencies in order to avoid having to pass large price increases on to consumers. While this would result in extremely large conversion costs and would more likely lead to manufacturers moving production abroad, manufacturers believed this strategy would help to maintain sales volumes.

iii. Compact Refrigeration Product Employment Impacts

DOE's research suggests that a limited percentage of compact refrigerators and refrigerator-freezers are made domestically (see Table V.33). The overwhelming majority of products are imported. Manufacturers with domestic manufacturing facilities tend to source or import their compact products. The small employment numbers are mostly from remaining domestic production of compact chest freezers. As a result, amended energy conservation standards for compact refrigerators or refrigerator-freezers are unlikely to noticeably alter domestic employment levels.

TABLE V.33—POTENTIAL CHANGES IN THE TOTAL NUMBER OF DOMESTIC COMPACT REFRIGERATION PRODUCT PRODUCTION WORKERS IN 2014

	Trial standard level					
	Base case	1	2	3	4	5
Total Number of Domestic Production Workers in 2014 (without changes in production locations)	31	30	29	29	28	46

TABLE V.33—POTENTIAL CHANGES IN THE TOTAL NUMBER OF DOMESTIC COMPACT REFRIGERATION PRODUCT PRODUCTION WORKERS IN 2014—Continued

	Trial standard level					
	Base case	1	2	3	4	5
Potential Changes in Domestic Production Workers in 2014*	....	(1)–(31)	(2)–(31)	(2)–(31)	(3)–(31)	15–(31)

*DOE presents a range of potential employment impacts. Numbers in parentheses indicate negative numbers.

iv. Built-In Refrigeration Product Employment Impacts

Using the GRIM, DOE estimates that, in the absence of amended energy conservation standards, there would be 1,320 U.S. workers manufacturing built-in refrigeration products in 2014. Using the 2007 Census data and interviews with manufacturers, DOE estimates that approximately 94 percent of the built-in refrigeration products sold in the United States are manufactured domestically. Table V.34 shows the impacts of amended energy conservation standards on U.S. production workers in the built-in refrigeration market.

TABLE V.34—POTENTIAL CHANGES IN THE TOTAL NUMBER OF DOMESTIC BUILT-IN REFRIGERATION PRODUCT PRODUCTION WORKERS IN 2014

	Trial standard level					
	Base case	1	2	3	4	5
Total Number of Domestic Production Workers in 2014 (without changes in production locations)	1,320	1,320	1,319	1,327	1,331	1,357
Potential Changes in Domestic Production Workers in 2014*	....	0–(1,320)	(1)–(1,320)	7–(1,320)	11–(1,320)	37–(1,320)

*DOE presents a range of potential employment impacts. Numbers in parentheses indicate negative numbers.

Employment in the built-in refrigeration market follows a pattern similar to that seen in the market for standard-size refrigerator-freezers and standard-size freezers at lower TSLs. At TSL 1 and TSL 2, higher prices result in fewer shipments, and a consequent reduction in labor expenditures that more than offsets the additional labor required to manufacture products with VIPs. However, at TSL 3 and above, the use of additional VIPs in built-in refrigeration products requires enough additional labor to cause a slight increase in the number of domestic production workers. Because built-in products are high-end products with far fewer shipments, it is less likely that manufacturers would choose to move all production facilities in response to amended energy conservation standards. The higher margins and profit earned in this market also make it more likely that manufacturers could earn a return on the investments required to reach the amended energy conservation standards and invest in existing facilities rather than move production abroad.

c. Impacts on Manufacturing Capacity

Manufacturers indicated that design changes involving thicker walls or multiple VIP panels would require substantial changes to their current manufacturing process. While these technologies would require the purchase of millions of dollars of production equipment, most manufacturers indicated they would likely be able to make the required changes in between the announcement of the final rule and compliance date of an amended energy conservation standard. For most product classes, the design changes and investments required by the proposed rule are similar in magnitude to the introduction of a new product line. Manufacturers have experience with the design options involving VIPs, but not at the scale that would be required if the proposed rule's provisions are adopted. The primary capacity concern of manufacturers is the ability of their suppliers, particularly manufacturers of VIPs and more efficient compressors, to ramp up production in time to meet the amended energy conservation standard. DOE analyzed VIP supply issues in section IV.B.1.c. Issues associated with supply of compressors are discussed in section IV.B.1, above.

d. Impacts on Sub-Group of Manufacturers

As discussed in section IV.I.1.c, using average cost assumptions to develop an industry cash-flow estimate is inadequate for assessing differential impacts among manufacturer subgroups. Small manufacturers, niche equipment manufacturers, and manufacturers that exhibit a cost structure substantially different from the industry average could be affected disproportionately. For this rulemaking, DOE used the results of the industry characterization to identify any subgroups of refrigerator manufacturers that exhibit similar characteristics different from the industry as a whole. The only such subgroup DOE identified was built-in manufacturers.

However, as discussed previously, DOE is proposing to establish separate product classes for built-in products and is presenting separate analytical results for those products classes. Therefore, the MIA results DOE presents for those product classes already allow DOE to examine the MIA impacts on this potential manufacturer subgroup. Section V.B.2 presents a more detailed discussion of the results for built-in product classes.

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 energy conservation standards, other regulations can significantly affect manufacturers' financial health. 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 with which manufacturers of these refrigeration products must comply and which take effect within three years of the anticipated effective date of the amended standards. The following section briefly addresses comments DOE received with respect to cumulative regulatory burden and summarizes other key related concerns manufacturers raised during interviews.

Sub Zero stated that the cumulative regulatory burden is a serious concern for appliance manufacturers. Sub Zero recommended that DOE include the cost and burden of these upcoming requirements when assessing manufacturers' capacity to meet proposed new standards. (Sub Zero, No. 40 at p. 9)

DOE notes that it routinely assesses the cumulative regulatory burden on manufacturers in its analysis and the results of this assessment are discussed in this section of today's NOPR and in chapter 12 of the NOPR TSD. The cumulative regulatory burden section of the TSD shows that manufacturers of residential refrigeration products also have significant market shares of other products will be affected by either ongoing or pending rulemakings that will establish amended energy conservation standards. These parallel rulemakings will likely require manufacturers to comply with amended standards within three years of the anticipated compliance date for residential refrigeration products.

Part of this assessment included investigating and tracking what manufacturers expressed during interviews as one of the most critical potential elements of regulatory burden—the near-term possibility of changes to HFC availability. As stated in section IV.B.1.b, DOE is prepared to address this issue by evaluating the efficiency improvement and trial standard levels for products using alternative foam insulation materials, if legislation or some other legal requirements banning HFCs should be enacted or otherwise effective. A further complication that DOE tracked was the use of isobutane refrigerant as a design option. Isobutane could be used as an alternative refrigerant to the HFC-based refrigerants currently used by the industry. The current limit for an isobutane charge appears to be sufficient as a design option only for smaller products (see the discussion in section IV.B.1.a).

Several manufacturers also expressed concern during interviews about the overall volume of DOE energy conservation standards with which they must comply. Most refrigerator manufacturers also make a full range of appliances and share engineering and other resources with these other internal manufacturing divisions for different appliances (including certification testing for regulatory compliance). Many of these other appliances, such as kitchen ranges and ovens, clothes washers, clothes dryers, and microwave ovens, are also subject to recently amended or soon-to-be amended Federal energy conservation standards. Some of the test procedures for these other products are also currently being amended through ongoing rulemakings that would, if adopted, incorporate standby and off mode energy consumption measurements.[46] Manufacturers were concerned that the other products facing amended or new energy conservation standards would compete for the same engineering and financial resources, especially if the proposed refrigeration product standards would cause manufacturers to build new production lines instead of repurposing existing ones.

While DOE acknowledges that rulemakings for other covered products could affect the resources available to residential refrigeration manufacturers, DOE has not included manufacturers' conversion costs related to complying with other rulemakings as a cash outflow in the GRIM. This method is consistent with how DOE treats revenue generated from sales of those products. However, DOE addresses the residential refrigeration manufacturers' conversion costs related to complying with other DOE rulemakings that have compliance dates falling within three years of the anticipated compliance date of this rulemaking in chapter 12 of the NOPR TSD. DOE has quantified these other conversion costs where applicable and considered those costs in its decision to propose the levels presented in today's rulemaking.

[46] The schedule for all DOE rulemakings can be found at *http://www1.eere.energy.gov/buildings/appliance_standards/schedule_setting.html.*

Manufacturers also expressed concern about the increasing stringency of international energy efficiency standards and materials requirements. Specifically, changing energy standards in Canada and elsewhere abroad also increase the regulatory burden on manufacturers by duplicating testing requirements. Many manufacturers would prefer more global standardization and harmonization of standards and testing. Variations among testing requirements often require that manufacturers refit or redesign test facilities so that tests tailored for specific testing requirements can be performed. The resources expended on these refits or redesigns could have been used for new product development. Examples of European standards that create additional compliance costs for manufacturers that compete in Europe include the Restriction on the use of Hazardous Substances (RoHS), Waste Electrical and Electronic Equipment (WEEE), and the Registration, Evaluation, Authorization, and restriction of Chemicals (REACH).

DOE discusses these and other requirements, and includes the full details of the cumulative regulatory burden, in chapter 12 of the NOPR TSD.

3. National Impact Analysis

a. Significance of Energy Savings

To estimate the national energy savings attributable to potential standards for refrigeration products, DOE compared the energy consumption of these products under the base case to their anticipated energy consumption under each TSL. Tables V.35 through V.38 present DOE's forecasts of the national energy savings for each TSL, which were calculated using the approach described in section IV.G. Chapter 10 of the NOPR TSD presents tables that also show the magnitude of the energy savings if the savings are discounted at rates of seven and three 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.35—STANDARD-SIZE REFRIGERATOR-FREEZERS: CUMULATIVE NATIONAL ENERGY SAVINGS IN QUADS

Trial standard level	Top-mount refrigerator-freezers	Bottom-mount refrigerator-freezers	Side-by-side refrigerator-freezers
	Product classes 1, 1A, 2, 3, 3A, 3I and 6	Product classes 5, 5A, and 5I	Product classes 4, 4I, and 7
1	1.62	0.09	0.54
2	1.62	0.09	0.88
3	2.07	0.09	0.88
4	2.49	0.45	1.20
5	2.90	0.65	1.39

TABLE V.36—STANDARD-SIZE FREEZERS: CUMULATIVE NATIONAL ENERGY SAVINGS IN QUADS

Trial standard level	Upright freezers	Chest freezers
	Product classes 8 and 9	Product classes 10 and 10A
1	0.43	0.28
2	0.66	0.36
3	0.77	0.43
4	0.86	0.49
5	0.89	0.56

TABLE V.37—COMPACT REFRIGERATION PRODUCTS: CUMULATIVE NATIONAL ENERGY SAVINGS IN QUADS

Trial standard level	Compact refrigerators	Compact freezers
	Product classes 11, 11A, 12, 13, 13A, 14, and 15	Product classes 16, 17, 18
1	0.27	0.03
2	0.34	0.03
3	0.39	0.04
4	0.47	0.07
5	0.50	0.09

TABLE V.38—BUILT-IN REFRIGERATION PRODUCTS: CUMULATIVE NATIONAL ENERGY SAVINGS IN QUADS

Trial standard level	Built-in all refrigerators	Built-in bottom-mount refrigerator-freezers	Built-in side-by-side refrigerator-freezers	Built-in upright freezers
	Product class 3A–BI	Product classes 5–BI and 5I–BI	Product classes 4–BI, 4I–BI and 7–BI	Product class 9–BI
1	0.00	0.00	0.01	0.00
2	0.01	0.00	0.01	0.01
3	0.01	0.00	0.03	0.01
4	0.01	0.01	0.03	0.01
5	0.01	0.02	0.04	0.01

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 refrigeration products. In accordance with the OMB's guidelines on regulatory analysis (OMB Circular A–4, section E, September 17, 2003), 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 on private capital in the U.S. economy, and reflects the returns on 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 on 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. It can be approximated by the real rate of return on long-term government debt (*i.e.,* yield on Treasury notes minus annual rate of change in the Consumer Price Index), which has averaged about 3 percent on a pre-tax basis for the last 30 years.

Tables V.39 through V.46 show the consumer NPV results for each TSL DOE considered for refrigeration products, using both a 7-percent and a 3-percent discount rate. In each case, the impacts cover the lifetime of products purchased in 2014–2043. See chapter 10 of the NOPR TSD for more detailed NPV results.

TABLE V.39—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR STANDARD-SIZE REFRIGERATOR-FREEZERS, 3-PERCENT DISCOUNT RATE

Trial standard level	Top-mount refrigerator-freezers	Bottom-mount refrigerator-freezers	Side-by-side refrigerator-freezers
	Product class 1, 1A, 2, 3, 3A, 3I and 6	Product classes 5, 5A, and 5I	Product classes 4, 4I, and 7
	billion 2009 dollars		
1	6.68	0.79	4.37
2	6.68	0.79	3.62
3	6.00	0.79	3.62
4	(1.95)	(3.22)	(2.35)
5	(14.63)	(7.32)	(7.38)

TABLE V.40—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR STANDARD-SIZE REFRIGERATOR-FREEZERS, 7-PERCENT DISCOUNT RATE

Trial standard level	Top-mount refrigerator-freezers	Bottom-mount refrigerator-freezers	Side-by-side refrigerator-freezers
	Product classes 1, 1A, 2, 3, 3A, 3I and 6	Product classes 5, 5A, and 5I	Product classes 4, 4I, and 7
	billion 2009 dollars		
1	0.85	0.27	1.42
2	0.85	0.27	0.46
3	(0.32)	0.27	0.46
4	(5.36)	(2.43)	(3.26)
5	(12.86)	(4.95)	(6.26)

TABLE V.41—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR STANDARD-SIZE FREEZERS, 3-PERCENT DISCOUNT RATE

Trial standard level	Upright freezers	Chest freezers
	Product classes 8 and 9	Product classes 10 and 10A
	billion 2009 dollars	
1	3.91	2.74
2	5.42	2.37
3	5.13	2.75
4	4.20	1.82
5	0.67	(0.16)

TABLE V.42—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR STANDARD-SIZE FREEZERS, 7-PERCENT DISCOUNT RATE

Trial standard level	Upright freezers	Chest freezers
	Product classes 8 and 9	Product classes 10 and 10A
	billion 2009 dollars	
1	1.25	0.90
2	1.57	0.54
3	1.22	0.59
4	0.55	0.00
5	(1.42)	(1.21)

TABLE V.43—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR COMPACT REFRIGERATION PRODUCTS, 3-PERCENT DISCOUNT RATE

Trial standard level	Compact refrigerators	Compact freezers
	Product classes 11, 11A, 12, 13, 13A, 14, and 15	Product classes 16, 17, 18
	billion 2009 dollars	
1	1.25	0.17
2	0.69	0.17
3	0.82	0.14
4	(0.64)	(0.25)
5	(4.49)	(0.96)

TABLE V.44—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR COMPACT REFRIGERATION PRODUCTS, 7-PERCENT DISCOUNT RATE

Trial standard level	Compact refrigerators	Compact freezers
	Product classes 11, 11A, 12, 13, 13A, 14, and 15	Product classes 16, 17, 18
	billion 2009 dollars	
1	0.50	0.07
2	0.18	0.07
3	0.22	0.04
4	(0.59)	(0.19)
5	(2.68)	(0.60)

TABLE V.45—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR BUILT-IN REFRIGERATION PRODUCTS, 3-PERCENT DISCOUNT RATE

Trial standard level	Built-in all refrigerators	Built-in bottom-mount refrigerator-freezers	Built-in side-by-side refrigerator-freezers	Built-in upright freezers
	Product class 3A–BI	Product classes 5–BI and 5I–BI	Product classes 4–BI, 4I–BI and 7–BI	Product class 9–BI
	billion 2009 dollars			
1	0.03	0.02	0.04	0.04
2	0.05	0.00	0.04	0.04
3	(0.01)	0.00	(0.43)	(0.02)
4	(0.10)	(0.36)	(0.43)	(0.02)
5	(0.17)	(0.54)	(0.83)	(0.07)

TABLE V.46—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR BUILT-IN REFRIGERATION PRODUCTS, 7-PERCENT DISCOUNT RATE

Trial standard level	Built-in all refrigerators (3A–BI)	Built-in bottom-mount refrigerator-freezers	Built-in side-by-side refrigerator-freezers	Built-in upright freezers (9–BI)
	Product class 3A–BI	Product classes 5–BI and 5I–BI	Product classes 4–BI, 4I–BI and 7–BI	Product class 9–BI
	billion 2009 dollars			
1	0.01	0.01	0.01	0.02
2	0.02	(0.00)	0.01	0.00
3	(0.02)	(0.00)	(0.28)	(0.03)
4	(0.07)	(0.21)	(0.28)	(0.03)
5	(0.11)	(0.32)	(0.51)	(0.06)

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 refrigeration products to reduce energy bills for consumers 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, above, to estimate these effects DOE used an input/output model of the U.S. economy. Table V.47 presents the estimated net indirect employment impacts in 2020 and 2043 for the TSLs that DOE considered in this rulemaking. Chapter 13 of the NOPR TSD presents more detailed results.

TABLE V.47—NET INCREASE IN JOBS FROM INDIRECT EMPLOYMENT EFFECTS UNDER REFRIGERATION PRODUCT TSLS

	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
	thousands				
Standard-Size Refrigerator-Freezers:					
2020	1.30	1.07	0.74	−2.87	−7.16
2043	10.99	12.05	13.49	12.95	10.34
Standard-Size Freezers:					
2020	0.72	0.69	0.69	0.18	−0.97
2043	4.34	5.79	5.79	6.77	5.80
Compact Refrigeration Products:					
2020	0.46	0.43	0.49	0.29	−0.45
2043	1.24	1.26	1.44	1.21	0.14
Built-In Refrigeration Products:					
2020	0.02	0.01	−0.10	−0.18	−0.31
2043	0.10	0.13	0.08	0.01	−0.13

The input/output model suggests that today's proposed standards are likely to increase the net demand for labor in the economy. However, the model suggests that the projected gains are very small relative to total national employment (currently approximately 120 million). Moreover, neither the BLS data nor the input/output model DOE uses includes the quality or wage level of the jobs. Therefore, because the analysis indicates an increased demand for labor would likely result from the amended energy conservation standards under consideration in this rulemaking, DOE has tentatively concluded that the proposed standards are likely to produce employment benefits sufficient to offset fully any adverse impacts on employment in the manufacturing industry for the refrigeration products that are the subject 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 substantially reduce the utility or performance of the products under consideration in this rulemaking. However, manufacturers may reduce the availability of features that increase energy use, such as multiple drawers. Manufacturers currently offer refrigeration products that meet or exceed the proposed standards for most of the product classes. (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 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 (B)(ii))

To assist the Attorney General in making such determination, DOE has provided DOJ with copies of this NOPR and the TSD for review. DOE will consider DOJ's comments on the proposed rule in preparing the final rule, and DOE will publish and respond to DOJ's comments in that document.

6. Need of the Nation to Conserve Energy

An improvement in the energy efficiency of the products subject to today's 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. As a measure of this reduced demand, Table V.48 presents the estimated reduction in generating capacity in 2043 for the TSLs that DOE considered in this rulemaking.

TABLE V.48—REDUCTION IN ELECTRIC GENERATING CAPACITY IN 2043 UNDER REFRIGERATION PRODUCT TSLS

	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
	Gigawatts				
Standard-Size Refrigerator-Freezers	2.28	2.63	3.10	4.23	5.07
Standard-Size Freezers	0.740	0.740	1.25	1.42	1.53
Compact Refrigeration Products	0.271	0.324	0.383	0.475	0.506
Built-In Refrigeration Products	0.019	0.027	0.054	0.067	0.080

DOE 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 standards. The projected impacts on prices, and their value to electricity consumers, are presented in chapter 14 and chapter 10, respectively, of the NOPR TSD. Although the aggregate benefits for all electricity users are potentially large, there may be negative effects on the actors involved in electricity supply. Because there is uncertainty about the extent to which the calculated impacts from reduced electricity prices would be a transfer from the actors involved in electricity supply to electricity consumers, DOE has concluded that, at present, it should not assign a heavy weight to this factor in considering the economic justification of standards on refrigeration products.

Energy savings from amended standards for refrigeration products could also produce environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases associated with electricity production. Table V.49 provides DOE's estimate of cumulative CO_2, NO_X, and Hg emissions reductions projected to result from the TSLs considered in this rulemaking. DOE reports annual CO_2, NO_X, and Hg emissions reductions for each TSL in chapter 15 of the NOPR TSD.

As discussed in section IV.M, DOE did not report SO_2 emissions reductions from power plants because there is uncertainty about the effect of energy conservation standards on the overall level of SO_2 emissions in the United States due to SO_2 emissions caps. DOE also did not include NO_X emissions reduction from power plants in States subject to CAIR because an energy conservation standard would not affect the overall level of NO_X emissions in those States due to the emissions caps mandated by CAIR.

TABLE V.49—SUMMARY OF EMISSIONS REDUCTION ESTIMATED FOR REFRIGERATION PRODUCT TSLS (CUMULATIVE FOR 2014 THROUGH 2043)

	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Standard-Size Refrigerator-Freezers:					
CO2 (Mt)	154	177	208	283	338
NOX (kt)	124	142	168	228	272
Hg (t)	0.79	0.91	1.07	1.45	1.73
Standard-Size Freezers:					
CO2 (Mt)	48	69	81	92	99
NOX (kt)	39	55	65	74	79
Hg (t)	0.24	0.34	0.41	0.47	0.50
Compact Refrigeration Products:					
CO2 (Mt)	20	24	28	35	39
NOX (kt)	16	19	23	28	31
Hg (t)	0.10	0.12	0.15	0.19	0.21
Built-In Refrigeration Products:					
CO2 (Mt)	1.23	1.79	3.58	4.45	5.32
NOX (kt)	0.99	1.44	2.88	3.58	4.28
Hg (t)	0.01	0.01	0.02	0.02	0.03

As part the analysis for this proposed rule, DOE estimated monetary benefits likely to result from the reduced emissions of CO_2 and NO_X that DOE estimated for each of the TSLs considered. As discussed in section IV.M, DOE used values for the SCC developed by an interagency process. The four values for CO_2 emissions reductions resulting from that process (expressed in 2007$) are $4.7/ton (the average value from a distribution that uses a 5-percent discount rate), $21.4/ton (the average value from a distribution that uses a 3-percent discount rate), $35.1/ton (the average value from a distribution that uses a 2.5-percent discount rate), and $64.9/ton (the 95th-percentile value from a distribution that uses a 3-percent discount rate). These values correspond to the value of emission reductions in 2010; the values for later years are higher due to increasing damages as the magnitude of climate change increases.

Table V.50 through Table V.53 present the global values of CO_2 emissions reductions at each TSL. For each of the four cases, DOE calculated a present value of the stream of annual values using the same discount rate as was used in the studies upon which the dollar-per-ton values are based. DOE calculated domestic values as a range from 7 percent to 23 percent of the global values, and these results are presented in Table V.54 through Table V.57.

TABLE V.50—STANDARD-SIZE REFRIGERATOR-FREEZERS: ESTIMATES OF GLOBAL PRESENT VALUE OF CO_2 EMISSIONS REDUCTION IN 2014–2043 UNDER TRIAL STANDARD LEVELS

TSL	Million 2009$			
	5% discount rate, average *	3% discount rate, average *	2.5% discount rate, average *	3% discount rate, 95th percentile *
1	526	2,696	4,570	8,223
2	605	3,104	5,261	9,465
3	713	3,653	6,192	11,140
4	970	4,975	8,432	15,170
5	1,160	5,947	10,080	18,135

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

TABLE V.51—STANDARD-SIZE FREEZERS: ESTIMATES OF GLOBAL PRESENT VALUE OF CO_2 EMISSIONS REDUCTION IN 2014–2043 UNDER TRIAL STANDARD LEVELS

TSL	Million 2009$			
	5% discount rate, average *	3% discount rate, average *	2.5% discount rate, average *	3% discount rate, 95th percentile *
1	164	840	1,425	2,562
2	234	1,205	2,043	3,673
3	277	1,421	2,409	4,332
4	314	1,615	2,738	4,923
5	337	1,733	2,938	5,283

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

TABLE V.52—COMPACT REFRIGERATION PRODUCTS: ESTIMATES OF GLOBAL PRESENT VALUE OF CO_2 EMISSIONS REDUCTION IN 2014–2043 UNDER TRIAL STANDARD LEVELS

TSL	Million 2009$			
	5% discount rate, average *	3% discount rate, average *	2.5% discount rate, average *	3% discount rate, 95th percentile *
1	65	333	564	1,015
2	78	400	678	1,220
3	93	475	804	1,448
4	117	598	1,013	1,823
5	130	665	1,126	2,029

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

TABLE V.53—BUILT-IN REFRIGERATION PRODUCTS: ESTIMATES OF GLOBAL PRESENT VALUE OF CO_2 EMISSIONS REDUCTION IN 2014–2043 UNDER TRIAL STANDARD LEVELS

TSL	Million 2009$			
	5% discount rate, average *	3% discount rate, average *	2.5% discount rate, average *	3% discount rate, 95th percentile *
1	4	22	37	66
2	6	31	53	96
3	12	63	106	191
4	15	78	132	238
5	18	93	158	284

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

TABLE V.54—STANDARD-SIZE REFRIGERATOR-FREEZERS: ESTIMATES OF DOMESTIC PRESENT VALUE OF CO_2 EMISSIONS REDUCTION IN 2014–2043 UNDER TRIAL STANDARD LEVELS

TSL	Million 2009$*			
	5% discount rate, average **	3% discount rate, verage **	2.5% discount rate, average **	3% discount rate, 95th percentile **
1	37 to 121	189 to 620	320 to 1,051	576 to 1,891.
2	42 to 139	217 to 714	368 to 1,210	663 to 2,177.
3	50 to 164	256 to 840	433 to 1,424	780 to 2,562.
4	68 to 223	348 to 1,144	590 to 1,939	1,062 to 3,489.
5	81 to 267	416 to 1,368	706 to 2,318	1,269 to 4,171.

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

TABLE V.55—STANDARD-SIZE FREEZERS: ESTIMATES OF DOMESTIC PRESENT VALUE OF CO_2 EMISSIONS REDUCTION IN 2014–2043 UNDER TRIAL STANDARD LEVELS

TSL	Million 2009$*			
	5% discount rate, average **	3% discount rate, average **	2.5% discount rate, average **	3% discount rate, 95th percentile **
1	11 to 38	59 to 193	100 to 328	179 to 589.
2	16 to 54	84 to 277	143 to 470	257 to 845.
3	19 to 64	99 to 327	169 to 554	303 to 996.
4	22 to 72	113 to 371	192 to 630	345 to 1,132.
5	24 to 78	121 to 398	206 to 676	370 to 1,215.

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

TABLE V.56—COMPACT REFRIGERATION PRODUCTS: ESTIMATES OF DOMESTIC PRESENT VALUE OF CO_2 EMISSIONS REDUCTION IN 2014–2043 UNDER TRIAL STANDARD LEVELS

TSL	Million 2009$*			
	5% discount rate, average **	3% discount rate, average **	2.5% discount rate, average **	3% discount rate, 95th percentile **
1	5 to 15	23 to 77	39 to 130	71 to 233.
2	5 to 18	28 to 92	47 to 156	85 to 281.
3	6 to 21	33 to 109	56 to 185	101 to 333.
4	8 to 27	42 to 137	71 to 233	128 to 419.
5	9 to 30	47 to 153	79 to 259	142 to 467.

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

TABLE V.57—BUILT-IN REFRIGERATION PRODUCTS: ESTIMATES OF DOMESTIC PRESENT VALUE OF CO_2 EMISSIONS REDUCTION IN 2014–2043 UNDER TRIAL STANDARD LEVELS

TSL	Million 2009$ *			
	5% discount rate, average**	3% discount rate, average**	2.5% discount rate, average**	3% discount rate, 95th percentile**
1	0 to 1	2 to 5	3 to 8	5 to 15.
2	0 to 1	2 to 7	4 to 12	7 to 22.
3	1 to 3	4 to 14	7 to 24	13 to 43.
4	1 to 4	5 to 18	9 to 30	17 to 55.
5	1 to 4	7 to 21	11 to 36	20 to 65.

* Domestic values are presented as a range between 7% and 23% of the global values.
** Columns are labeled by the discount rate used to calculate the SCC and whether it is an average value or drawn from a different part of the distribution. Values presented in the table are based on escalating 2007$ to 2009$ for consistency with other values presented in this notice, and incorporate the escalation of the SCC 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 the comments on this subject that are part of the public record for this and other rulemakings, as well as other methodological assumptions and issues. However, consistent with DOE's legal obligations, and taking into account the uncertainty involved with this particular issue, DOE has included in this NOPR 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 refrigeration products. The dollar-per-ton values that DOE used are discussed in section IV.M. Table V.58 presents the cumulative present values for each TSL calculated using seven-percent and three-percent discount rates.

TABLE V.58—ESTIMATES OF PRESENT VALUE OF NO_X EMISSIONS REDUCTION IN 2014–2043 UNDER REFRIGERATION PRODUCT TRIAL STANDARD LEVELS

	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
	million 2009$				
Standard-Size Refrigerator-Freezers:					
Using 7% discount rate.	11 to 117	13 to 135	15 to 159	21 to 217	25 to 260.
Using 3% discount rate.	27 to 278	31 to 320	37 to 376	50 to 513	60 to 614.
Standard-Size Freezers:					
Using 7% discount rate.	3.5 to 36	5.0 to 52	5.9 to 61	6.8 to 69	7.3 to 75.
Using 3% discount rate.	8.4 to 86	12 to 123	14 to 146	16 to 166	17 to 178.
Compact Refrigeration Products:					
Using 7% discount rate.	1.3 to 13	1.5 to 16	1.8 to 19	2.3 to 24	2.7 to 28.
Using 3% discount rate.	3.3 to 33	3.9 to 40	4.7 to 48	5.9 to 60	6.6 to 68.
Built-In Refrigeration Products:					
Using 7% discount rate.	0.1 to 0.9	0.1 to 1.4	0.3 to 2.7	0.3 to 3.4	0.4 to 4.0.
Using 3% discount rate.	0.2 to 2.2	0.3 to 3.2	0.6 to 6.5	0.8 to 8.0	0.9 to 9.6.

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.59 shows an example of the calculation of the combined NPV including benefits from emissions reductions for the case of TSL 3 for standard-size refrigerator-freezers. Table V.60 and Table V.61 present the NPV values that would result if DOE were to add the estimates of the potential economic benefits resulting from reduced CO_2 and NO_X emissions in each of four valuation scenarios to the NPV of consumer savings calculated for each TSL considered in this rulemaking, at both a seven-percent and three-percent discount rate. The CO_2 values used in the columns of each table correspond to the four scenarios for the valuation of CO_2 emission reductions presented in section IV.M.

TABLE V.59—ADDING NET PRESENT VALUE OF CONSUMER SAVINGS TO PRESENT VALUE OF MONETIZED BENEFITS FROM CO_2 AND NO_X EMISSIONS REDUCTIONS AT TSL 3 FOR STANDARD-SIZE REFRIGERATOR-FREEZERS

Category	Present value *billion 2009$*	Discount rate (in percent)
Benefits:		
Operating Cost Savings	13.62	7
	34.75	3
CO_2 Reduction Monetized Value (at $4.7/Metric Ton)*	0.713	5
CO_2 Reduction Monetized Value (at $21.4/Metric Ton)*	3.65	3
CO_2 Reduction Monetized Value (at $35.1/Metric Ton)*	6.19	2.5
CO_2 Reduction Monetized Value (at $64.9/Metric Ton)*	11.14	3
NO_X Reduction Monetized Value (at $2,519/Ton)*	0.087	7
	0.206	3
Total Monetary Benefits**	17.36	7
	38.61	3
Costs:		
Total Incremental Installed Costs	13.21	7
	24.35	3
Net Benefits/Costs:		
Including CO_2 and NO_X**	4.15	7
	14.26	3

*These values represent global values (in 2007$) of the social cost of CO_2 emissions in 2010 under several scenarios. The values of $4.7, $21.4, and $35.1 per ton are the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The value of $64.9 per ton represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. *See* section IV.M for details. The value for NO_X (in 2009$) is the average of the low and high values used in DOE's analysis.

**Total Monetary Benefits for both the 3% and 7% cases utilize the central estimate of social cost of CO_2 emissions calculated at a 3% discount rate, which is equal to $21.4/ton in 2010 (in 2007$).

TABLE V.60—ESTIMATES OF ADDING NET PRESENT VALUE OF CONSUMER SAVINGS (AT 7% DISCOUNT RATE) TO NET PRESENT VALUE OF MONETIZED BENEFITS FROM CO_2 AND NO_X EMISSIONS REDUCTIONS AT TRIAL STANDARD LEVELS FOR REFRIGERATION PRODUCTS

TSL	Consumer NPV at 7% discount rate added with:			
	SCC value of $4.7/metric ton CO_2* and low value for NO_X** *billion 2009$*	SCC value of $21.4/metric ton CO_2* and medium value for NO_X** *billion 2009$*	SCC value of $35.1/metric ton CO_2* and Medium Value for NO_X** *billion 2009$*	SCC value of $64.9/metric ton CO_2* and High Value for NO_X** *billion 2009$*
1	6.07	9.28	11.98	17.33
2	5.03	8.94	12.24	18.75
3	3.27	7.90	11.81	19.52
4	(10.43)	(4.43)	0.62	10.60
5	(29.30)	(22.33)	(16.47)	(4.86)

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

TABLE V.61—ESTIMATES OF ADDING NET PRESENT VALUE OF CONSUMER SAVINGS (AT 3% DISCOUNT RATE) TO NET PRESENT VALUE OF MONETIZED BENEFITS FROM CO_2 AND NO_X EMISSIONS REDUCTIONS AT TRIAL STANDARD LEVELS FOR REFRIGERATION PRODUCTS

TSL	Consumer NPV at 3% discount rate added with:			
	SCC value of $4.7/metric ton CO_2* and low value for NO_X** *billion 2009$*	SCC value of $21.4/metric ton CO_2* and medium value for NO_X** *billion 2009$*	SCC value of $35.1/metric ton CO_2* and Medium Value for NO_X** *billion 2009$*	SCC value of $64.9/metric ton CO_2* and High Value for NO_X** *billion 2009$*
1	20.82	24.14	26.85	32.30
2	21.04	25.09	28.39	35.04
3	19.93	24.72	28.62	36.49
4	(1.80)	4.40	9.45	19.65
5	(34.16)	(26.96)	(21.09)	(9.25)

* These label values represent the global SCC of CO_2 in 2010, in 2007$. Their present values have been calculated with scenario-consistent discount rates. *See* section IV.M for a 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 refrigeration products shipped in 2014–2043. The SCC values, on the other hand, reflect the present value of all 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 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))) DOE is aware of pending legislation that proposes to phase out substances with significant GWP and that HFCs are included in the list of substances to be phased out. DOE recognizes the significance that such legislation would have to the refrigeration products industry and the impact it would have on the ability of manufacturers to meet energy conservation standards. Given the uncertainty regarding such legislation, however, DOE did not factor the impact of potential HFC limitations in developing the proposed levels presented in today's NOPR.

C. Proposed Standards

When considering proposed 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 NOPR, DOE considered the impacts of standards at each trial standard level, 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 most efficient level that is both technologically feasible and economically justified and saves a significant amount of energy.

For ease of presentation, DOE separately discusses the benefits and/or burdens of each trial standard level for standard-size refrigerator-freezers, standard-size freezers, compact refrigeration products, and built-in refrigeration products. To aid the reader as DOE discusses the benefits and/or burdens of each trial standard level, 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 a national standard. Section V.B.1 presents the estimated impacts of each TSL for these subgroups.

DOE notes that the proposed standards set forth in the Joint Comments were also carefully considered by the agency. These suggested standards, along with the comments from all interested parties and the agency's analytical work developed in preparation of today's NOPR, were considered during the development of the standards being proposed today. DOE is giving serious consideration to these suggested standards as well as alternative standards that differ from them. As with other aspects of this proposal, the agency solicits comments from interested parties on these proposed standards as well as any other issues commenters believe merit consideration.

DOE also notes that the economics literature provides a wide-ranging discussion of how consumers trade off upfront costs and energy savings in the absence of government intervention. Much of this literature attempts to explain why consumers appear to undervalue energy efficiency improvements. This undervaluation suggests that regulation that promotes energy efficiency can produce significant net private gains (as well as producing social gains by, for example, reducing pollution). There is evidence that consumers undervalue future energy savings as a result of (1) A lack of information, (2) a lack of sufficient savings to warrant delaying or altering purchases (e.g. an inefficient ventilation fan in a new building or the delayed replacement of a water pump), (3) inconsistent (e.g. excessive short-term) weighting of future energy cost savings relative to available returns on other investments, (4) computational or other difficulties associated with the evaluation of relevant tradeoffs, and (5) a divergence in incentives (e.g. renter versus owner; builder v. purchaser). Other literature indicates that with less than perfect foresight and a high degree of uncertainty about the future, consumers may trade off these types of investments at a higher than expected rate between current consumption and uncertain future energy cost savings. While DOE is not prepared at present to provide a fuller quantifiable framework for this discussion at this time, DOE seeks comments on how to assess these possibilities.

1. Standard-Size Refrigerator-Freezers

Table V.62 presents a summary of the quantitative impacts estimated for each TSL for standard-size refrigerator-freezers. The efficiency levels contained in each TSL are described in section V.A.

TABLE V.62—SUMMARY OF RESULTS FOR STANDARD-SIZE REFRIGERATOR-FREEZERS

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
National Energy Savings (quads).	2.25	2.59	3.05	4.14	4.94
NPV of Consumer Benefits (2009$ billion):					
3% discount rate	11.83	11.08	10.40	(7.51)	(29.33)
7% discount rate	2.53	1.58	0.41	(11.05)	(24.08)
Industry Impacts:					
Standard-Size Refrigerator-Freezers:					
Industry NPV (2009$ million).	(84.8) to (301.7)	(175.9) to (459.8)	(287.5) to (662.1)	(643.0) to (1,496.8)	(828.9) to (2,154.7)
Industry NPV (% change).	(2.7) to (9.5)	(5.5) to (14.5)	(9.1) to (20.9)	(20.3) to (47.2)	(26.1) to (67.9)
Cumulative Emissions Reduction:					
CO_2 (Mt)	154	177	208	283	338
NO_X (kt)	124	142	168	228	272
Hg (t)	0.79	0.91	1.07	1.45	1.73
Value of Cumulative Emissions Reduction:					
CO_2 (2009$ billion)*	0.53 to 8.22	0.61 to 9.47	0.71 to 11.14	0.97 to 15.17	1.16 to 18.14
NO_X—3% discount rate (2009$ million).	27 to 278	31 to 320	37 to 376	50 to 513	60 to 614
NO_X—7% discount rate (2009$ million).	11 to 117	13 to 135	15 to 159	21 to 217	25 to 260
Mean LCC Savings** (2009$):					
Top-Mount Refrigerator-Freezers.	29	29	22	(37)	(133)
Bottom-Mount Refrigerator-Freezers.	19	19	19	(79)	(180)
Side-by-Side Refrigerator-Freezers.	53	37	37	(55)	(134)
Median PBP (years):					
Top-Mount Refrigerator-Freezers	9.2	9.2	10.9	15.4	20.5
Bottom-Mount Refrigerator-Freezers.	4.9	4.9	4.9	24.8	29.0

TABLE V.62—SUMMARY OF RESULTS FOR STANDARD-SIZE REFRIGERATOR-FREEZERS—Continued

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Side-by-Side Refrigerator-Freezers.	4.8	10.9	10.9	18.6	22.6
Distribution of Consumer LCC Impacts:					
Top-Mount Refrigerator-Freezers:					
Net Cost (%)	42.3	42.3	54.9	73.8	85.4
No Impact (%)	8.1	8.1	0.0	0.0	0.0
Net Benefit (%)	49.6	49.6	45.1	26.2	14.6
Bottom-Mount Refrigerator-Freezers:					
Net Cost (%)	4.5	4.5	4.5	88.2	93.3
No Impact (%)	67.8	67.8	67.8	0.0	0.0
Net Benefit (%)	27.7	27.7	27.7	11.8	6.7
Side-by-Side Refrigerator-Freezers:					
Net Cost (%)	7.3	50.8	50.8	77.7	86.2
No Impact (%)	36.9	0.0	0.0	0.0	0.0
Net Benefit (%)	55.8	49.2	49.2	22.3	13.9
Generation Capacity Reduction (GW).†	2.28	2.63	3.10	4.23	5.07
Employment Impacts:					
Total Potential Changes in Domestic Production Workers in 2014 (thousands).	(0.22) to (8.52)	(0.26) to (8.52)	(0.21) to (8.52)	(0.28) to (8.52)	(0.43) to (8.52)
Indirect Domestic Jobs (thousands).†	10.99	12.05	13.49	12.95	10.34

Parentheses indicate negative (−) values.
* Range of the economic value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions.
** For LCCs, a negative value means an increase in LCC by the amount indicated.
† Changes in 2043.

DOE first considered TSL 5, which represents the max-tech efficiency levels. TSL 5 would save 4.94 quads of energy, an amount DOE considers significant. Under TSL 5, the NPV of consumer benefit would be –$24.08 billion, using a discount rate of 7 percent, and –$29.33 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 5 are 338 Mt of CO_2, 272 kt of NO_X, and 1.73 t of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 5 ranges from $1.16 billion to $18.14 billion. Total generating capacity in 2043 is estimated to decrease by 5.07 GW under TSL 5.

At TSL 5, the average LCC impact is a cost (LCC increase) of $133 for top-mount refrigerator-freezers, a cost of $180 for bottom-mount refrigerator-freezers, and a cost of $134 for side-by-side refrigerator-freezers. The median payback period is 21 years for top-mount refrigerator-freezers, 29 years for bottom-mount refrigerator-freezers, and 23 years for side-by-side refrigerator-freezers. The fraction of consumers experiencing an LCC benefit is 15 percent for top-mount refrigerator-freezers, 7 percent for bottom-mount refrigerator-freezers, and 14 percent for side-by-side refrigerator-freezers. The fraction of consumers experiencing an LCC cost is 85 percent for top-mount refrigerator-freezers, 93 percent for bottom-mount refrigerator-freezers, and 86 percent for side-by-side refrigerator-freezers.

At TSL 5, the projected change in INPV ranges from a decrease of $828.9 million to a decrease of $2,154.7 million. At TSL 5, DOE recognizes the risk of very 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 5 could result in a net loss of 68 percent in INPV to standard-size refrigerator-freezer manufacturers.

The Secretary tentatively concludes that at TSL 5 for standard-size refrigerator-freezers, 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 tentatively concluded that TSL 5 is not economically justified.

DOE then considered TSL 4. TSL 4 would save 4.14 quads of energy, an amount DOE considers significant. Under TSL 4, the NPV of consumer benefit would be −$11.05 billion, using a discount rate of 7 percent, and −$7.51 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 4 are 283 Mt of CO_2, 228 kt of NO_X, and 1.45 t of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 4 ranges from $0.97 billion to $15.17 billion. Total generating capacity in 2043 is estimated to decrease by 4.23 GW under TSL 4.

At TSL 4, DOE projects that the average LCC impact is a cost (LCC increase) of $37 for top-mount refrigerator-freezers, a cost of $79 for bottom-mount refrigerator-freezers, and a cost of $55 for side-by-side refrigerator-freezers. The median payback period is 15 years for top-mount refrigerator-freezers, 25 years for bottom-mount refrigerator-freezers, and 19 years for side-by-side refrigerator-freezers. The fraction of consumers experiencing an LCC benefit is 26 percent for top-mount refrigerator-freezers, 12 percent for bottom-mount refrigerator-freezers, and 22 percent for side-by-side refrigerator-freezers. The fraction of consumers experiencing an LCC cost is 74 percent for top-mount refrigerator-freezers, 88 percent for bottom-mount refrigerator-freezers, and 78 percent for side-by-side refrigerator-freezers.

At TSL 4, the projected change in INPV ranges from a decrease of $643.0 million to a decrease of $1,496.8 million. 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 4 could result in a net loss of 47 percent in INPV to standard-size refrigerator-freezer manufacturers.

The Secretary tentatively concludes that at TSL 4 for standard-size refrigerator-freezers, the benefits of energy savings, generating capacity reductions, and 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 substantial reduction in INPV for the manufacturers. Consequently, the Secretary has tentatively concluded that TSL 4 is not economically justified.

DOE then considered TSL 3. TSL 3 would save 3.05 quads of energy, an amount DOE considers significant. Under TSL 3, the NPV of consumer benefit would be $0.41 billion, using a discount rate of 7 percent, and $10.40 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 3 are 208 Mt of CO_2, 168 kt of NO_X, and 1.07 t of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 3 ranges from $0.71 billion to $11.14 billion. Total generating capacity in 2043 is estimated to decrease by 3.10 GW under TSL 3.

At TSL 3, the average LCC impact is a gain (consumer savings) of $22 for top-mount refrigerator-freezers, a gain of $19 for bottom-mount refrigerator-freezers, and a gain of $37 for side-by-side refrigerator-freezers. The median payback period is 11 years for top-mount refrigerator-freezers, 5 years for bottom-mount refrigerator-freezers, and 11 years for side-by-side refrigerator-freezers. The fraction of consumers experiencing an LCC benefit is 45 percent for top-mount refrigerator-freezers, 28 percent for bottom-mount refrigerator-freezers, and 49 percent for side-by-side refrigerator-freezers. The fraction of consumers experiencing an LCC cost is 55 percent for top-mount refrigerator-freezers, 5 percent for bottom-mount refrigerator-freezers, and 51 percent for side-by-side refrigerator-freezers.

At TSL 3, the projected change in INPV ranges from a decrease of $287.5 million to a decrease of $662.1 million. 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 3 could result in a net loss of 21 percent in INPV to standard-size refrigerator-freezer manufacturers.

The Secretary tentatively concludes that at TSL 3 for standard-size refrigerator-freezers, 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 outweigh the economic burden on a significant fraction of consumers due to the increases in product cost, and the capital conversion costs and profit margin impacts that could result in a reduction in INPV for the manufacturers. In addition to the aforementioned benefits of the proposed standards, DOE notes that the efficiency levels in TSL 3 correspond to the recommended levels in the Joint Comments.

After considering the analysis, comments to the November 2009 notice and the preliminary TSD, and the benefits and burdens of TSL 3, the Secretary tentatively concludes that this trial standard level will offer the maximum improvement in efficiency that is technologically feasible and economically justified, and will result in the significant conservation of energy. Therefore, DOE today proposes to adopt TSL 3 for standard-size refrigerator-freezers. The proposed amended energy conservation standards for standard-size refrigerator-freezers, expressed as equations for maximum energy use, are shown in Table V.63.

TABLE V.63—PROPOSED STANDARDS FOR STANDARD-SIZE REFRIGERATORS AND REFRIGERATOR-FREEZERS

Product class	Equations for maximum energy use (kWh/yr)	
	based on AV (ft³)	based on av (L)
1. Refrigerators and refrigerator-freezers with manual defrost	7.99AV + 225.0	0.282av + 225.0
1A. All-refrigerators—manual defrost	6.79AV + 193.6	0.240av + 193.6
2. Refrigerator-freezers—partial automatic defrost	7.99AV + 225.0	0.282av + 225.0
3. Refrigerator-freezers—automatic defrost with top-mounted freezer without an automatic icemaker	8.04AV + 232.7	0.284av + 232.7
3I. Refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic icemaker without through-the-door ice service.	8.04AV + 316.7	0.284av + 316.7
3A. All-refrigerators—automatic defrost	7.07AV + 201.6	0.250av + 201.6
4. Refrigerator-freezers—automatic defrost with side-mounted freezer without an automatic icemaker	8.48AV + 296.5	0.299av + 296.5
4I. Refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker without through-the-door ice service.	8.48AV + 380.5	0.299av + 380.5
5. Refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker	8.80AV + 315.4	0.311av + 315.4
5I. Refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker without through-the-door ice service.	8.80AV + 399.4	0.311av + 399.4
5A. Refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service.	9.15AV + 471.3	0.323av + 471.3
6. Refrigerator-freezers—automatic defrost with top-mounted freezer with through-the-door ice service	8.36AV + 384.1	0.295av + 384.1
7. Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service	8.50AV + 431.1	0.300av + 431.1

AV = adjusted volume in cubic feet; av = adjusted volume in liters.

2. Standard-Size Freezers

Table V.64 presents a summary of the quantitative impacts estimated for each TSL for standard-size freezers. The efficiency levels contained in each TSL are described in section V.A.

TABLE V.64—SUMMARY OF RESULTS FOR STANDARD-SIZE FREEZERS

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
National Energy Savings (quads).	0.71	1.01	1.19	1.35	1.45
NPV of Consumer Benefits (2009$ billion):					
3% discount rate	6.64	7.78	7.87	6.02	0.51
7% discount rate	2.14	2.12	1.81	0.55	(2.63)
Industry Impacts:					
Standard-Size Freezers:					
Industry NPV (2009$ million).	(24.9) to (57.3)	(110.6) to (186.0)	(94.5) to (201.1)	(59.0) to (218.9)	(102.4) to (365.1)
Industry NPV (% change).	(6.2) to (14.2)	(27.5) to (46.2)	(23.5) to (49.9)	(14.6) to (54.4)	(25.4) to (90.7)
Cumulative Emissions Reduction:					
CO_2 (Mt)	48	69	81	92	99
NO_X (kt)	39	55	65	74	79
Hg (t)	0.24	0.34	0.41	0.47	0.50
Value of Cumulative Emissions Reduction:					
CO_2 (2009$ billion)*	0.16 to 2.56	0.23 to 3.67	0.27 to 4.33	0.31 to 4.92	0.33 to 5.28
NO_X—3% discount rate (2009$ million).	8.4 to 86	12 to 123	14 to 143	16 to 166	17 to 178
NO_X—7% discount rate (2009$ million).	3.5 to 36	5.0 to 52	5.9 to 61	6.8 to 69	7.3 to 75
Mean LCC Savings** (2009$):					
Upright Freezers	111	148	130	87	(63)
Chest Freezers	70	50	56	17	(71)
Median PBP (years):					
Upright Freezers	4.8	6.2	8.4	11.0	17.4
Chest Freezers	4.2	8.7	9.1	13.1	19.3
Distribution of Consumer LCC Impacts:					
Upright Freezers:					
Net Cost (%)	11.7	18.7	30.8	45.0	70.2
No Impact (%)	0.6	0.2	0.0	0.0	0.0
Net Benefit (%)	87.8	81.1	69.2	55.0	29.8
Chest Freezers:					
Net Cost (%)	1.6	25.8	28.3	53.5	79.0
No Impact (%)	0.2	0.2	0.2	0.0	0.0
Net Benefit (%)	98.2	74.0	71.5	46.5	21.0
Generation Capacity Reduction (GW)†.	0.74	0.74	1.25	1.42	1.53
Employment Impacts:					
Total Potential Changes in Domestic Production Workers in 2014 (thousands).	(0.05) to (1.90)	(0.12) to (1.90)	(0.17) to (1.90)	(0.27) to (1.90)	(0.40) to (1.90)
Indirect Domestic Jobs (thousands)†.	4.34	5.79	5.79	6.77	5.80

Parentheses indicate negative (−) values.
*Range of the economic value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions.
**For LCCs, a negative value means an increase in LCC by the amount indicated.
† Changes in 2043.

DOE first considered TSL 5, which represents the max-tech efficiency levels. TSL 5 would save 1.45 quads of energy, an amount DOE considers significant. Under TSL 5, the NPV of consumer benefit would be –$2.63 billion, using a discount rate of 7 percent, and $0.51 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 5 are 99 Mt of CO_2, 79 kt of NO_X, and 0.50 t of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 5 ranges from $0.33 billion to $5.28 billion. Total generating capacity in 2043 is estimated to decrease by 1.53 GW under TSL 5.

At TSL 5, the average LCC impact is a cost (LCC increase) of $63 for upright freezers, and a cost of $71 for chest freezers. The median payback period is 17 years for upright freezers and 19 years for chest freezers. The fraction of consumers experiencing an LCC benefit is 30 percent for upright freezers and 21 percent for chest freezers. The fraction of consumers experiencing an LCC cost is 70 percent for upright freezers and 79 percent for chest freezers.

At TSL 5, the projected change in INPV ranges from a decrease of $102.4 million to a decrease of $365.1 million. DOE recognizes the risk of very large negative impacts if manufacturers' expectations concerning reduced profit margins are realized. Standards at TSL 5 would require efficiency levels that are far higher than the most efficient products currently available on the market. Manufacturing products to meet standards at TSL 5 would require large investments in product redesign and conversion of facilities. Because standard-size freezers are currently low-cost, low-margin products, there is a limited ability to pass on to consumers the required conversion costs and added product costs associated with efficiency-improving technologies for freezers. If the high end of the range of impacts is reached as DOE expects, TSL 5 could result in a net loss of 91 percent in INPV to standard-size freezer manufacturers.

The Secretary tentatively concludes that at TSL 5 for standard-size freezers, 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 be outweighed by 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 tentatively concluded that TSL 5 is not economically justified.

DOE then considered TSL 4. TSL 4 would save 1.35 quads of energy, an amount DOE considers significant. Under TSL 4, the NPV of consumer benefit would be $0.55 billion, using a discount rate of 7 percent, and $6.02 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 4 are 92 Mt of CO_2, 74 kt of NO_X, and 0.47 t of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 4 ranges from $0.31 billion to $4.92 billion. Total generating capacity in 2043 is estimated to decrease by 1.42 GW under TSL 4.

At TSL 4, the average LCC impact is a gain (consumer savings) of $87 for upright freezers and a gain of $17 for chest freezers. The median payback period is 11 years for upright freezers and 13 years for chest freezers. The fraction of consumers experiencing an LCC benefit is 55 percent for upright freezers and 47 percent for chest freezers. The fraction of consumers experiencing an LCC cost is 45 percent for upright freezers and 54 percent for chest freezers.

At TSL 4, the projected change in INPV ranges from a decrease of $59.0 million to a decrease of $218.9 million. DOE recognizes the risk of very large negative impacts if manufacturers' expectations concerning reduced profit margins are realized. Standards at TSL 4 would require efficiency levels that are substantially higher than the most efficient products currently available on the market. Manufacturing products to meet standards at TSL 4 would require large investments in product redesign and conversion of facilities. Because standard-size freezers are currently low-cost, low-margin products, there is a limited ability to pass on to consumers the required conversion costs and added product costs associated with efficiency-improving technologies for freezers. If the high end of the range of impacts is reached as DOE expects, TSL 4 could result in a net loss of 54 percent in INPV to standard-size freezer manufacturers.

The Secretary tentatively concludes that at TSL 4 for standard-size freezers, the benefits of energy savings, positive NPV of consumer benefits, generating capacity reductions, emission reductions, the estimated monetary value of the cumulative CO_2 emissions reductions, and the economic benefit on a significant fraction of upright freezer consumers would be outweighed by the economic burden on a significant fraction of chest freezer consumers due to the increase in product cost, and the large capital conversion costs and margin impacts that could result in a large reduction in INPV for the manufacturers.

DOE then considered TSL 3. TSL 3 would save 1.19 quads of energy, an amount DOE considers significant. Under TSL 3, the NPV of consumer benefit would be $1.81 billion, using a discount rate of 7 percent, and $7.87 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 3 are 81 Mt of CO_2, 65 kt of NO_X, and 0.41 t of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 3 ranges from $0.27 billion to $4.33 billion. Total generating capacity in 2043 is estimated to decrease by 1.25 GW under TSL 3.

At TSL 3, the average LCC impact is a gain (consumer savings) of $130 for upright freezers and a gain of $56 for chest freezers. The median payback period is 8 years for upright freezers and 9 years for chest freezers. The fraction of consumers experiencing an LCC benefit is 69 percent for upright freezers and 72 percent for chest freezers. The fraction of consumers experiencing an LCC cost is 31 percent for upright freezers and 28 percent for chest freezers.

At TSL 3, the projected change in INPV ranges from a decrease of $94.5 million to a decrease of $201.1 million. DOE recognizes the risk of very large negative impacts if manufacturers' expectations concerning reduced profit margins are realized. Standards at TSL 3 would require efficiency levels that are substantially higher than the most efficient products currently available on the market. Similar to the case of TSL 4, manufacturing products to meet standards at TSL 3 would require large investments in product redesign and conversion of facilities. Because standard-size freezers are currently low-cost, low-margin products, there is a limited ability to pass on to consumers the required conversion costs and added product costs associated with efficiency-improving technologies for freezers. If the high end of the range of impacts is reached as DOE expects, TSL 3 could result in a net loss of 50 percent in INPV to standard-size freezer manufacturers.

The Secretary tentatively concludes that at TSL 3 for standard-size freezers, the benefits of energy savings, positive NPV of consumer benefits, generating capacity reductions, emission reductions, the estimated monetary value of the cumulative CO_2 emissions reductions, and the economic benefit for a significant fraction of freezer consumers would be outweighed by the large capital conversion costs and profit margin impacts that could result in a large reduction in INPV for the manufacturers.

DOE then considered TSL 2. TSL 2 would save 1.01 quads of energy, an amount DOE considers significant. Under TSL 2, the NPV of consumer benefit would be $2.12 billion, using a discount rate of 7 percent, and $7.78 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 2 are 69 Mt of CO_2, 55kt of NO_X, and 0.34 t of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 2 ranges from $0.23 billion to $3.67 billion. Total generating capacity in 2043 is estimated to decrease by 0.74 GW under TSL 2.

At TSL 2, the average LCC impact is a gain (consumer savings) of $148 for upright freezers and a gain of $50 for chest freezers. The median payback period is 6 years for upright freezers and 9 years for chest freezers. The fraction of consumers experiencing an LCC benefit is 81 percent for upright freezers and 74 percent for chest freezers. The fraction of consumers experiencing an LCC cost is 19 percent for upright freezers and 26 percent for chest freezers.

DOE estimated the projected change in INPV ranges from a decrease of $110.6 million to a decrease of $186.0 million. At TSL 2, DOE recognizes the risk of negative impacts if manufacturers' expectations concerning reduced profit margins are realized. Standards at TSL 2 would pose many of the same issues as discussed above for TSL3, but the projected negative impacts are somewhat less. If the high end of the range of impacts is reached as DOE expects, TSL 2 could result in a net loss of 46 percent in INPV to standard-size freezer manufacturers.

The Secretary tentatively concludes that at TSL 2 for standard-size freezers, the benefits of energy savings, positive NPV of consumer benefits, generating capacity reductions, emission reductions, the estimated monetary value of the cumulative CO_2 emissions reductions, and the economic benefit for a significant fraction of freezer consumers would outweigh the capital conversion costs and profit margin impacts that could result in a reduction in INPV for the manufacturers. In addition to the aforementioned benefits of the proposed standards, DOE notes that the efficiency levels in TSL 2 correspond to the recommended levels in the Joint Comments.

After considering the analysis, comments on the November 2009 notice and the preliminary TSD, and the benefits and burdens of TSL 2, the Secretary tentatively concludes that this trial standard level will offer the maximum improvement in efficiency that is technologically feasible and economically justified, and will result in significant conservation of energy. Therefore, DOE today proposes to adopt TSL 2 for standard-size freezers. The proposed amended energy conservation standards for standard-size freezers, expressed as equations for maximum energy use, are shown in Table V.65.

TABLE V.65—PROPOSED STANDARDS FOR STANDARD-SIZE FREEZERS

Product class	Equations for maximum energy use (kWh/yr)	
	based on AV (ft^3)	based on av (L)
8. Upright freezers with manual defrost	5.57AV + 193.7	0.197av + 193.7
9. Upright freezers with automatic defrost without an automatic icemaker	8.62AV + 228.3	0.305av + 228.3
10. Chest freezers and all other freezers except compact freezers	7.29AV + 107.8	0.257av + 107.8
10A. Chest freezers with automatic defrost	10.24AV + 148.1	0.362av + 148.1

AV= adjusted volume in cubic feet; av = adjusted volume in liters.

3. Compact Refrigeration Products

Table V.66 presents a summary of the quantitative impacts estimated for each TSL for compact refrigeration products. The efficiency levels contained in each TSL are described in section V.A.

TABLE V.66—SUMMARY OF RESULTS FOR COMPACT REFRIGERATION PRODUCTS

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
National Energy Savings (quads).	0.30	0.37	0.43	0.54	0.59
NPV of Consumer Benefits (2009$ billion):					
3% discount rate	1.42	0.86	0.96	(0.89)	(5.45)
7% discount rate	0.58	0.25	0.27	(0.78)	(3.28)
Industry Impacts					
Compact Refrigeration Products:					
Industry NPV (2009$ million).	(14.3) to (32.1)	(30.8) to (66.7)	(56.8) to (99.2)	(29.6) to (114.4)	(133.0) to (295.6)
Industry NPV (% change)	(7.2) to (16.1)	(15.4) to (33.4)	(28.4) to (49.6)	(14.8) to (57.3)	(66.6) to (148.0)
Cumulative Emissions Reduction:					
CO_2 (Mt)	20	24	28	35	39
NO_X (kt)	16	19	23	28	31
Hg (t)	0.10	0.12	0.15	0.19	0.21
Value of Cumulative Emissions Reduction:					
CO_2 (2009$ billion)*	0.07 to 1.02	0.08 to 1.22	0.10 to 1.45	0.12 to 1.82	0.13 to 2.03
NO_X—3% discount rate (2009$ million).	3.3 to 33	3.9 to 40	4.7 to 48	5.9 to 60	6.6 to 68
NO_X—7% discount rate (2009$ million).	1.3 to 13	1.5 to 16	1.8 to 19	2.3 to 24	2.7 to 28
Mean LCC Savings** (2009$):					
Compact Refrigerators	15	10	8	(13)	(105)
Compact Freezers	11	11	7	(30)	(121)
Median PBP (years):					
Compact Refrigerators	2.8	3.9	4.4	6.5	11.6
Compact Freezers	2.5	2.5	4.6	10.0	15.9
Distribution of Consumer LCC Impacts:					

TABLE V.66—SUMMARY OF RESULTS FOR COMPACT REFRIGERATION PRODUCTS—Continued

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Compact Refrigerators					
Net Cost (%)	24.4	43.3	50.6	76.1	93.8
No Impact (%)	1.4	1.0	0.9	0.0	0.0
Net Benefit (%)	74.2	55.7	48.5	23.9	6.2
Compact Freezers					
Net Cost (%)	9.9	9.9	40.6	88.5	97.8
No Impact (%)	4.7	4.7	0.0	0.0	0.0
Net Benefit (%)	85.4	85.4	59.4	11.5	2.3
Generation Capacity Reduction (GW) †.	0.02	0.32	0.38	0.48	0.51
Employment Impacts:					
Total Potential Changes in Domestic Production Workers in 2014 (thousands).	(0.00) to (0.03)	(0.00) to (0.03)	(0.00) to (0.03)	(0.00) to (0.03)	(0.02) to (0.03)
Indirect Domestic Jobs (thousands) †.	1.24	1.26	1.44	1.21	0.14

Parentheses indicate negative (−) values.
* Range of the economic value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions.
** For LCCs, a negative value means an increase in LCC by the amount indicated.
† Changes in 2043.

DOE first considered TSL 5, which represents the max-tech efficiency levels. TSL 5 would save 0.59 quads of energy, an amount DOE considers significant. Under TSL 5, the NPV of consumer benefit would be −$3.28 billion, using a discount rate of 7 percent, and −$5.45 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 5 are 39 Mt of CO_2, 31 kt of NO_X, and 0.21 t of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 5 ranges from $0.13 billion to $2.03 billion. Total generating capacity in 2043 is estimated to decrease by 0.51 GW under TSL 5.

At TSL 5, the average LCC impact is a cost (LCC increase) of $105 for compact refrigerators and a cost of $121 for compact freezers. The median payback period is 12 years for compact refrigerators and 16 years for compact freezers. The fraction of consumers experiencing an LCC benefit is 6 percent for compact refrigerators and 2 percent for compact freezers. The fraction of consumers experiencing an LCC cost is 94 percent for compact refrigerators and 98 percent for compact freezers.

At TSL 5, the projected change in INPV ranges from a decrease of $133.0 million to a decrease of $295.6 million. DOE recognizes the risk of very large negative impacts if manufacturers' expectations concerning reduced profit margins are realized. Manufacturing products to meet standards at TSL 5 would require large investments in product redesign and conversion of facilities. Because compact refrigeration products are currently low-cost, low-margin products, there is a limited ability to pass on to consumers the required conversion costs and added product costs associated with efficiency-improving technologies. If the high end of the range of impacts is reached as DOE expects, TSL 5 could result in a net loss of 148.0 percent in INPV to compact refrigeration product manufacturers.

The Secretary tentatively concludes that at TSL 5 for compact refrigeration products, 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 product cost, the capital conversion costs and profit margin impacts that could result in a large reduction in INPV for the manufacturers. Consequently, the Secretary has tentatively concluded that TSL 5 is not economically justified.

DOE then considered TSL 4. TSL 4 would save 0.54 quads of energy, an amount DOE considers significant. Under TSL 4, the NPV of consumer benefit would be −$0.78 billion, using a discount rate of 7 percent, and −$0.89 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 4 are 35 Mt of CO_2, 28 kt of NO_X, and 0.19 t of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 4 ranges from $0.12 billion to $1.82 billion. Total generating capacity in 2043 is estimated to decrease by 0.48 GW under TSL 4.

At TSL 4, the average LCC impact is a cost (LCC increase) of $13 for compact refrigerators and a cost of $30 for compact freezers. The median payback period is 7 years for compact refrigerators and 10 years for compact freezers. The fraction of consumers experiencing an LCC benefit is 24 percent for compact refrigerators and 12 percent for compact freezers. The fraction of consumers experiencing an LCC cost is 76 percent for compact refrigerators and 89 percent for compact freezers.

At TSL 4, the projected change in INPV ranges from a decrease of $29.6 million to a decrease of $114.4 million. DOE recognizes the risk of very large negative impacts if manufacturers' expectations about reduced profit margins are realized. Manufacturing products to meet standards at TSL 4 would require large investments in product redesign and conversion of facilities. Because compact refrigeration products are currently low-cost, low-margin products, there is a limited ability to pass on to consumers the required conversion costs and added product costs associated with efficiency-improving technologies. If the high end of the range of impacts is reached as DOE expects, TSL 4 could result in a net loss of 57 percent in INPV to compact refrigeration product manufacturers.

The Secretary tentatively concludes that at TSL 4 for compact refrigeration products, 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 product costs, 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 tentatively concluded that TSL 4 is not economically justified.

DOE then considered TSL 3. TSL 3 would save 0.43 quads of energy, an amount DOE considers significant. Under TSL 3, the NPV of consumer benefit would be $0.27 billion, using a discount rate of 7 percent, and $0.96 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 3 are 28 Mt of CO_2, 23 kt of NO_X, and 0.15 t of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 3 ranges from $0.10 billion to $1.45 billion. Total generating capacity in 2043 is estimated to decrease by 0.38 GW under TSL 3.

At TSL 3, the average LCC impact is a gain (consumer savings) of $8 for compact refrigerators and a gain of $7 for compact freezers. The median payback period is 4 years for compact refrigerators and 5 years for compact freezers. The fraction of consumers experiencing an LCC benefit is 49 percent for compact refrigerators and 59 percent for compact freezers. The fraction of consumers experiencing an LCC cost is 51 percent for compact refrigerators and 41 percent for compact freezers.

At TSL 3, the projected change in INPV ranges from a decrease of $56.8 million to a decrease of $99.2 million. DOE recognizes the risk of large negative impacts if manufacturers' expectations about reduced profit margins are realized. Manufacturing products to meet standards at TSL 3 would require large investments in product redesign and conversion of facilities. Because compact refrigeration products are currently low-cost, low-margin products, there is a limited ability to pass on to consumers the required conversion costs and added product costs associated with efficiency-improving technologies. If the high end of the range of impacts is reached as DOE expects, TSL 3 could result in a net loss of 50 percent in INPV to compact refrigeration product manufacturers.

The Secretary tentatively concludes that at TSL 3 for compact refrigeration products, the benefits of energy savings, positive NPV of consumer benefits, generating capacity reductions, emission reductions, and the estimated monetary value of the cumulative CO_2 emissions reductions would be outweighed by the economic burden on a significant fraction of consumers due to the increases in product costs, and by the capital conversion costs and profit margin impacts that could result in a large reduction in INPV for the manufacturers. Consequently, the Secretary has tentatively concluded that TSL 3 is not economically justified.

DOE then considered TSL 2. TSL 2 would save 0.37 quads of energy, an amount DOE considers significant. Under TSL 2, the NPV of consumer benefit would be $0.25 billion, using a discount rate of 7 percent, and $0.86 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 2 are 24 Mt of CO_2, 19 kt of NO_X, and 0.12 t of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 2 ranges from $0.08 billion to $1.22 billion. Total generating capacity in 2043 is estimated to decrease by 0.32 GW under TSL 2.

At TSL 2, the average LCC impact is a gain (consumer savings) of $10 for compact refrigerators and a gain of $11 for compact freezers. The median payback period is 4 years for compact refrigerators and 3 years for compact freezers. The fraction of consumers experiencing an LCC benefit is 56 percent for compact refrigerators and 85 percent for compact freezers. The fraction of consumers experiencing an LCC cost is 43 percent for compact refrigerators and 10 percent for compact freezers.

At TSL 2, the projected change in INPV ranges from a decrease of $30.8 million to a decrease of $66.7 million. DOE recognizes the risk of negative impacts if manufacturers' expectations about reduced profit margins are realized. Manufacturing products to meet standards at TSL 2 would require investments in product redesign and conversion of facilities. Because compact refrigeration products are currently low-cost, low-margin products, there is a limited ability to pass on to consumers the required conversion costs and added product costs associated with efficiency-improving technologies. If the high end of the range of impacts is reached as DOE expects, TSL 2 could result in a net loss of 33 percent in INPV to compact refrigeration product manufacturers.

The Secretary tentatively concludes that at TSL 2 for compact refrigeration products, the benefits of energy savings, positive NPV of consumer benefits, generating capacity reductions, emission reductions, the estimated monetary value of the cumulative CO_2 emissions reductions, and the economic benefit to a significant fraction of consumers would outweigh the capital conversion costs that could result in a reduction in INPV for the manufacturers. In addition to the aforementioned benefits of the proposed standards, DOE notes that the efficiency levels in TSL 2 correspond to the recommended levels in the Joint Comments.

After considering the analysis, comments on the November 2009 notice and the preliminary TSD, and the benefits and burdens of TSL 2, the Secretary tentatively concludes that this trial standard level will offer the maximum improvement in efficiency that is technologically feasible and economically justified, and will result in significant conservation of energy. Therefore, DOE today proposes to adopt TSL 2 for compact refrigeration products. The proposed amended energy conservation standards for compact refrigeration products, expressed as equations for maximum energy use, are shown in Table V.67.

TABLE V.67—PROPOSED STANDARDS FOR COMPACT REFRIGERATION PRODUCTS

Product class	Equations for maximum energy use (kWh/yr)	
	based on AV (ft^3)	based on av (L)
11. Compact refrigerators and refrigerator-freezers with manual defrost	9.03AV + 252.3	0.319av + 252.3
11A. Compact refrigerators and refrigerator-freezers with manual defrost	7.84AV + 219.1	0.277av + 219.1
12. Compact refrigerator-freezers—partial automatic defrost	5.91AV + 335.8	0.209av + 335.8
13. Compact refrigerator-freezers—automatic defrost with top-mounted freezer	11.80AV + 339.2	0.417av + 339.2
13A. Compact all-refrigerator—automatic defrost	9.17AV + 259.3	0.324av + 259.3
14. Compact refrigerator-freezers—automatic defrost with side-mounted freezer	6.82AV + 456.9	0.241av + 456.9
15. Compact refrigerator-freezers—automatic defrost with bottom-mounted freezer	12.88AV + 368.7	0.455av + 368.7
16. Compact upright freezers with manual defrost	8.65AV + 225.7	0.306av + 225.7
17. Compact upright freezers with automatic defrost	10.17AV + 351.9	0.359av + 351.9

TABLE V.67—PROPOSED STANDARDS FOR COMPACT REFRIGERATION PRODUCTS—Continued

Product class	Equations for maximum energy use (kWh/yr)	
	based on AV (ft^3)	based on av (L)
18. Compact chest freezers	9.25AV + 136.8	0.327av + 136.8

AV = adjusted volume in cubic feet; av = adjusted volume in liters

4. Built-In Refrigeration Products

Table V.68 presents a summary of the quantitative impacts estimated for each TSL for built-in refrigeration products. The efficiency levels contained in each TSL are described in section V.A.

TABLE V.68—SUMMARY OF RESULTS FOR BUILT-IN REFRIGERATION PRODUCTS

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
National Energy Savings (quads).	0.02	0.03	0.05	0.07	0.08
NPV of Consumer Benefits (2009$ billion):					
3% discount rate	0.13	0.12	(0.46)	(0.91)	(1.62)
7% discount rate	0.04	0.02	(0.34)	(0.60)	(1.00)
Industry Impacts:					
Built-in Refrigeration Products:					
Industry NPV (2009$ million).	(51.7) to (52.9)	(54.7) to (57.0)	(65.8) to (80.5)	(79.7) to (103.0)	(84.9) to (120.3)
Industry NPV (% change).	(7.9) to (8.0)	(8.3) to (8.7)	(10.0) to (12.2)	(12.1) to (15.6)	(12.9) to (18.3)
Cumulative Emissions Reduction:					
CO_2 (Mt)	1	2	4	5	5
NO_X (kt)	1	1	3	4	4
Hg (t)	0.01	0.01	0.02	0.02	0.03
Value of Cumulative Emissions Reduction					
CO_2 (2009$ billion)*	0.00 to 0.07	0.01 to 0.10	0.01 to 0.19	0.02 to 0.24	0.02 to 0.28
NO_X—3% discount rate (2009$ million).	0 to 2	0 to 3	1 to 7	1 to 8	1 to 10
NO_X—7% discount rate (2009$ million).	0 to 1	0 to 1	0 to 3	0 to 3	0 to 4
Mean LCC Savings** (2009$):					
Built-in All-Refrigerators:	47	63	(34)	(195)	(318)
Built-in Bottom-Mount Refrigerator-Freezers:	7	0	0	(164)	(244)
Built-in Side-by-Side Refrigerator-Freezers:	7	7	(116)	(116)	(219)
Built-in Upright Freezers:	54	24	(78)	(78)	(169)
Median PBP (years):					
Built-in All-Refrigerators	1.6	3.0	15.9	29.7	36.7
Built-in Bottom-Mount Refrigerator-Freezers.	4.4	12.9	12.9	62.8	61.8
Built-in Side-by-Side Refrigerator-Freezers.	8.7	8.7	36.7	36.7	60.0
Built-in Upright Freezers	3.4	12.8	21.1	21.1	26.8
Distribution of Consumer LCC Impacts:					
Built-in All-Refrigerators					
Net Cost (%)	0.3	2.6	69.1	94.5	97.2
No Impact (%)	22.6	18.4	9.1	0.0	0.0
Net Benefit (%)	77.2	79.0	21.9	5.5	2.8
Built-in Bottom-Mount Refrigerator-Freezers					
Net Cost (%)	1.2	8.2	8.2	99.0	99.3
No Impact (%)	87.1	87.0	87.0	0.0	0.0
Net Benefit (%)	11.7	4.8	4.8	1.1	0.7
Built-in Side-by-Side Refrigerator-Freezers					
Net Cost (%)	8.0	8.0	60.2	60.2	98.8
No Impact (%)	78.5	78.5	37.2	37.2	0.0
Net Benefit (%)	13.5	13.5	2.5	2.5	1.2
Built-in Upright Freezers					

TABLE V.68—SUMMARY OF RESULTS FOR BUILT-IN REFRIGERATION PRODUCTS—Continued

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Net Cost (%)	4.3	53.1	78.2	78.2	87.1
No Impact (%)	19.9	0.6	0.5	0.5	0.3
Net Benefit (%)	75.8	46.3	21.3	21.3	12.6
Generation Capacity Reduction (GW) †.	0.02	0.03	0.05	0.07	0.08
Employment Impacts:					
Total Potential Changes in Domestic Production Workers in 2014 (thousands).	0.00 to (1.32)	(0.00) to (1.32)	0.01 to (1.32)	0.01 to (1.32)	0.04 to (1.32)
Indirect Domestic Jobs (thousands) †.	0.10	0.13	0.08	0.01	(0.13)

Parentheses indicate negative (−) values.
* Range of the economic value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions.
** For LCCs, a negative value means an increase in LCC by the amount indicated.
† Changes in 2043.

DOE first considered TSL 5, which represents the max-tech efficiency levels. TSL 5 would save 0.08 quads of energy, an amount DOE considers significant. Under TSL 5, the NPV of consumer benefit would be −$1.00 billion, using a discount rate of 7 percent, and −$1.62 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 5 are 5 Mt of CO_2, 4 kt of NO_X, and 0.03 t of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 5 ranges from $0.02 billion to $0.28 billion. Total generating capacity in 2043 is estimated to decrease by 0.08 GW under TSL 5.

At TSL 5, the average LCC impact is a cost (LCC increase) of $318 for built-in all-refrigerators, a cost of $244 for built-in bottom-mount refrigerator-freezers, a cost of $219 for built-in side-by-side refrigerator-freezers, and a cost of $169 for built-in upright freezers. The median payback period is 37 years for built-in all-refrigerators, 62 years for built-in bottom-mount refrigerator-freezers, 60 years for built-in side-by-side refrigerator-freezers, and 27 years for built-in upright freezers. The fraction of consumers experiencing an LCC benefit is 3 percent for built-in all-refrigerators, 1 percent for built-in bottom-mount refrigerator-freezers, 1 percent for built-in side-by-side refrigerator-freezers, and 13 percent for built-in upright freezers. The fraction of consumers experiencing an LCC cost is 97 percent for built-in all-refrigerators, 99 percent for built-in bottom-mount refrigerator-freezers, 99 percent for built-in side-by-side refrigerator-freezers, and 87 percent for built-in upright freezers.

At TSL 5, the projected change in INPV ranges from a decrease of $84.9 million to a decrease of $120.3 million. If the high end of the range of impacts is reached as DOE expects, TSL 5 could result in a net loss of 18 percent in INPV to built-in refrigeration product manufacturers.

The Secretary tentatively concludes that at TSL 5 for built-in refrigeration products, 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 reduction in INPV for the manufacturers. Consequently, the Secretary has tentatively concluded that TSL 5 is not economically justified.

DOE then considered TSL 4. TSL 4 would save 0.07 quads of energy, an amount DOE considers significant. Under TSL 4, the NPV of consumer benefit would be −$0.60 billion, using a discount rate of 7 percent, and −$0.91 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 4 are 5 Mt of CO_2, 4 kt of NO_X, and 0.02 t of Hg. The estimated monetary value of the cumulative CO_2 emissions reductions at TSL 4 ranges from $0.02 billion to $0.24 billion. Total generating capacity in 2043 is estimated to decrease by 0.07 GW under TSL 4.

At TSL 4, DOE projects that the average LCC impact is a cost (LCC increase) of $195 for built-in all-refrigerators, a cost of $164 for built-in bottom-mount refrigerator-freezers, a cost of $116 for built-in side-by-side refrigerator-freezers, and a cost of $78 for built-in upright freezers. The median payback period is 30 years for built-in all-refrigerators, 63 years for built-in bottom-mount refrigerator-freezers, 37 years for built-in side-by-side refrigerator-freezers, and 21 years for built-in upright freezers. The fraction of consumers experiencing an LCC benefit is 6 percent for built-in all-refrigerators, 1 percent for built-in bottom-mount refrigerator-freezers, 3 percent for built-in side-by-side refrigerator-freezers, and 21 percent for built-in upright freezers. The fraction of consumers experiencing an LCC cost is 95 percent for built-in all-refrigerators, 99 percent for built-in bottom-mount refrigerator-freezers, 60 percent for built-in side-by-side refrigerator-freezers, and 78 percent for built-in upright freezers.

At TSL 4, the projected change in INPV ranges from a decrease of $79.7 million to a decrease of $103.0 million. If the high end of the range of impacts is reached as DOE expects, TSL 4 could result in a net loss of 16 percent in INPV to built-in refrigeration product manufacturers.

The Secretary tentatively concludes that at TSL 4 for built-in refrigeration products, 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 product cost, and the capital conversion costs and profit margin impacts that could result in a reduction in INPV for the manufacturers. Consequently, the Secretary has tentatively concluded that TSL 4 is not economically justified.

DOE then considered TSL 3. TSL 3 would save 0.05 quads of energy, an amount DOE considers significant. Under TSL 3, the NPV of consumer benefit would be −$0.34 billion, using a discount rate of 7 percent, and −$0.46

billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 3 are 4 Mt of CO_2, 3 kt of NO_X, and 0.02 t of Hg. The estimated monetary value of the cumulative CO_2 emissions reduction at TSL 3 ranges from $0.01 billion to $0.19 billion. Total generating capacity in 2043 is estimated to decrease by 0.05 GW under TSL 3.

At TSL 3, the average LCC impact is a cost (LCC increase) of $34 for built-in all-refrigerators, a cost of $0 for built-in bottom-mount refrigerator-freezers, a cost of $116 for built-in side-by-side refrigerator-freezers, and a cost of $78 for built-in upright freezers. The median payback period is 16 years for built-in all-refrigerators, 13 years for built-in bottom-mount refrigerator-freezers, 37 years for built-in side-by-side refrigerator-freezers, and 21 years for built-in upright freezers. The fraction of consumers experiencing an LCC benefit is 22 percent for built-in all-refrigerators, 5 percent for built-in bottom-mount refrigerator-freezers, 3 percent for built-in side-by-side refrigerator-freezers, and 21 percent for built-in upright freezers. The fraction of consumers experiencing an LCC cost is 69 percent for built-in all-refrigerators, 8 percent for built-in bottom-mount refrigerator-freezers, 60 percent for built-in side-by-side refrigerator-freezers, and 78 percent for built-in upright freezers. Although a significant fraction of consumers would experience an LCC cost, in the majority of cases the cost as a percentage of the purchase price (which ranges from approximately $4,500 to $8,000) is small.

At TSL 3, the projected change in INPV ranges from a decrease of $65.8 million to a decrease of $80.5 million. If the high end of the range of impacts is reached as DOE expects, TSL 3 could result in a net loss of 12 percent in INPV to built-in refrigeration product manufacturers.

The Secretary tentatively concludes that at TSL 3 for built-in refrigeration products, the benefits of energy savings, generating capacity reductions, emission reductions, and the estimated monetary value of the CO_2 emissions reductions would outweigh the negative NPV of consumer benefits, the slight economic burden on a significant fraction of consumers due to the increases in product cost, and the capital conversion costs and profit margin impacts that could result in a reduction in INPV for the manufacturers. In addition to the aforementioned benefits of the proposed standards, DOE notes that the efficiency levels in TSL 3 correspond to the recommended levels in the Joint Comments.

After considering the analysis, comments on the November 2009 notice and the preliminary TSD, and the benefits and burdens of TSL 3, the Secretary tentatively concludes that this trial standard level will offer the maximum improvement in efficiency that is technologically feasible and economically justified, and will result in significant conservation of energy. Therefore, DOE today proposes to adopt TSL 3 for built-in refrigeration products. The proposed amended energy conservation standards for built-in refrigeration products, expressed as equations for maximum energy use, are shown in Table V.69.

DOE requests comment on the considerations leading to the above conclusion, particularly regarding the negative net consumer impacts of the proposed standards for built-in refrigeration products. (*See* Issue 20 under "Issues on Which DOE Seeks Comment" in section VII.E of this NOPR, below.)

TABLE V.69—PROPOSED STANDARDS FOR BUILT-IN REFRIGERATION PRODUCTS

Product class	Equations for maximum energy use (kWh/yr)	
	Based on AV (ft^3)	Based on av (L)
3–BI. Built-in refrigerator-freezer—automatic defrost with top-mounted freezer without an automatic ice-maker.	8.57AV + 248.2	0.303av + 248.2
3I–BI. Built-in refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic ice-maker without through-the-door ice service.	8.57AV + 332.2	0.303av + 332.2
3A–BI. Built-in all-refrigerators—automatic defrost	7.55AV + 215.1	0.266av + 215.1
4–BI. Built-in refrigerator-freezers—automatic defrost with side-mounted freezer without an automatic icemaker.	9.04AV + 316.2	0.319av + 316.2
4I–BI. Built-in refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic ice-maker without through-the-door ice service.	9.04AV + 400.2	0.319av + 400.2
5–BI. Built-in refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker.	9.35AV + 335.1	0.330av + 335.1
5I–BI. Built-in refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker without through-the-door ice service.	9.35AV + 419.1	0.330av + 419.1
5A–BI. Built-in refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service.	9.72AV + 495.5	0.343av + 495.5
7–BI. Built-in refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service.	9.07AV + 454.3	0.320av + 454.3
9–BI. Built-in upright freezers with automatic defrost without an automatic icemaker	9.24AV + 244.6	0.326av + 244.6

AV = adjusted volume in cubic feet; av = adjusted volume in liters

5. Summary of Benefits and Costs (Annualized) of Proposed Standards

The benefits and costs of today's proposed standards can also be expressed in terms of annualized values over the 2014–2043 period. Estimates of annualized values are shown in Table V.70. 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 proposed 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.[47] The value of the

[47] DOE used a two-step calculation process to convert the time-series of costs and benefits into annualized values. First, DOE calculated a present value for the time-series of costs and benefits using a discount rate of either three or seven percent.

Continued

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.

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 timeframes for analysis. The national operating cost savings is measured for the lifetime of refrigeration products shipped in 2014–2043. The SCC values, on the other hand, reflect the present value of all future climate-related impacts resulting from the emission of one ton of carbon dioxide in each year. These impacts go well beyond 2100.

Using a 7-percent discount rate and the SCC value of $21.40/ton in 2010 (in 2007$), the cost of the standards proposed in today's rule is $1,841 million per year in increased equipment costs, while the annualized benefits are $2,112 million per year in reduced equipment operating costs, $316 million in CO_2 reductions, and $7 million in reduced NO_X emissions. In this case, the net benefit amounts to $594 million per year. Using a 3-percent discount rate and the SCC value of $21.40/ton in 2010 (in 2007$), the cost of the standards proposed in today's rule is $1,849 million per year in increased equipment costs, while the benefits are $2,929 million per year in reduced operating costs, $316 million in CO_2 reductions, and $33 million in reduced NO_X emissions. At a 3-percent discount rate, the net benefit amounts to $1,429 million per year.

TABLE V.70—ANNUALIZED BENEFITS AND COSTS OF PROPOSED STANDARDS FOR REFRIGERATION PRODUCTS FOR 2014–2043 PERIOD

	Discount rate	Primary estimate *	Low estimate *	High estimate *
		Monetized (million 2009$/year)		
Benefits:				
Operating Cost Savings	7%	2112	1852	2377
	3%	2929	2520	3335
CO_2 Reduction at $4.7/t **	5%	85	85	85
CO_2 Reduction at $21.4/t **	3%	316	316	316
CO_2 Reduction at $35.1/t **	2.5%	492	492	492
CO_2 Reduction at $64.9/t **	3%	963	963	963
NO_X Reduction at $2,519/t **	7%	7	7	7
	3%	33	33	33
Total †	7% plus CO_2 range	2204–3082	1944–2822	2469–3348
	7%	2435	2175	2700
	3%	3278	2869	3684
	3% plus CO_2 range	3047–3925	2638–3516	3453–4331
Costs:				
Incremental Product Costs	7%	1841	1733	1950
	3%	1849	1729	1969
Net Benefits/Costs:				
Total †	7% plus CO_2 range	363–1241	211–1089	519–1397
	7%	594	442	750
	3%	1429	1140	1714
	3% plus CO_2 range	1198–2076	909–1787	1483–2362

* The Primary, Low, and High Estimates utilize forecasts of energy prices and housing starts from the AEO2010 Reference case, Low Economic Growth case, and Low Economic Growth case, respectively.

** The CO_2 values represent global values (in 2007$) of the social cost of CO_2 emissions in 2010 under several scenarios. The values of $4.70, $21.40, and $35.10 per ton are the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The value of $64.90 per ton represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The value for NO_X (in 2009$) is the average of the low and high values used in DOE's analysis. NO_X savings are in addition to the regulatory emissions reductions modeled in the Annual Energy Outlook forecast.

† Total Benefits for both the 3% and 7% cases are derived using the SCC value calculated at a 3% discount rate, which is $21.40/ton in 2010 (in 2007$). 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 with the $4.70/ton value at the low end, and the $64.90/ton value at the high end.

6. Energy Standard Round-Off

The rounding off of energy use measurements for refrigeration products is discussed in the test procedure NOPR published on May 27, 2010. 75 FR 29824, 29849. Comments received from stakeholders during the test procedure rulemaking comment period support rounding off such measurements to the nearest kWh per year. (Whirlpool, Refrigerator Test Procedure Rulemaking No. 12 at p. 7; AHAM, Refrigerator Test Procedure Rulemaking No. 16 at pp. 10, 11) The test procedure NOPR mentions that, if the test procedure calls for such round off, the energy standard would also need to include round off, in order to avoid noncompliance associated with inconsistency between the two rules. For example, if the energy standard was 500.7 kWh for a product whose energy use measurement was 500.6 kWh, rounding the measurement to 501 kWh might appear to show energy use higher

From the present value, DOE then calculated the fixed annual payment over the analysis time period (2014 through 2043) that yielded the same present value. The fixed annual payment is the annualized value. Although DOE calculated annualized values, this does not imply that the time-series of cost and benefits from which the annualized values were determined is a steady stream of payments.

than the maximum allowable under the standard.

DOE expects to implement rounding off of energy use measurements in the refrigeration product test procedure. Hence, DOE also proposes such round off for the energy standard. DOE proposes to implement this by including in 10 CFR part 430.32(a) the following statement: "The energy standards as determined by the equations of the following table shall be rounded off to the nearest kWh per year."

DOE requests comment on this proposal for round off of the energy standard. (See Issue 21 under "Issues on Which DOE Seeks Comment" in section VII.E of this NOPR, below.)

VI. Procedural Issues and Regulatory Review

A. Review Under Executive Order 12866

Section 1(b)(1) of Executive Order 12866, "Regulatory Planning and Review," 58 FR 51735 (Oct. 4, 1993), requires each agency to identify 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 home appliance market.

(2) There is asymmetric information (one party to a transaction has more and better information than the other) and/or high transactions costs (costs of gathering information and effecting exchanges of goods and services).

(3) There are external benefits resulting from improved energy efficiency of heating products that are not captured by the users of such equipment. These benefits include externalities related to environmental protection and energy security that are not reflected in energy prices, such as reduced emissions of greenhouse gases.

In addition, DOE has determined that today's regulatory action is 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 (Chapter 16) 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 a.m. and 4 p.m., Monday through Friday, except Federal holidays.

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) requires preparation of an initial regulatory flexibility analysis (IRFA) for any rule that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by Executive Order 13272, "Proper Consideration of Small Entities in Agency Rulemaking," 67 FR 53461 (August 16, 2002), DOE published procedures and policies on February 19, 2003, to ensure that the potential impacts of its rules on small entities are properly considered during the rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of the General Counsel's Web site (*http://www.gc.doe.gov*).

For manufacturers of residential refrigerators, refrigerator-freezers, and freezers, the Small Business Administration (SBA) has set a size threshold, which defines those entities classified as "small businesses" for the purposes of the statute. DOE used the SBA's small business size standards to determine whether any small entities would be subject to the requirements of the rule. 65 FR 30836, 30850 (May 15, 2000), as amended at 65 FR 53533, 53545 (September 5, 2000) and codified at 13 CFR part 121. The size standards are listed by North American Industry Classification System (NAICS) code and industry description and are available at *http://www.sba.gov/idc/groups/public/documents/sba_homepage/serv_sstd_tablepdf.pdf*. Residential refrigeration product manufacturing is classified under NAICS 335222, "Household Refrigerator and Home Freezer Manufacturing." The SBA sets a threshold of 1,000 employees or less for an entity to be considered as a small business for this category.

DOE reviewed the potential standard levels considered in today's NOPR under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. To better assess the potential impacts of this rulemaking on small entities, DOE conducted a more focused inquiry of the companies that could be small business manufacturers of products covered by this rulemaking. During its market survey, DOE used all available public information to identify potential small manufacturers. DOE's research involved industry trade association membership directories (including AHAM), product databases (*e.g.,* FTC, The Thomas Register, CEC, and ENERGY STAR databases), individual company Web sites, and marketing research tools (*e.g.,* Dunn and Bradstreet reports) to create a list of every company that manufactures or sells residential refrigeration products covered by this rulemaking. DOE also asked stakeholders and industry representatives if they were aware of any additional small manufacturers during manufacturer interviews and at DOE public meetings. DOE reviewed all publicly-available data and contacted various companies on its complete list of manufacturers, as necessary, to determine whether they met the SBA's definition of a small business manufacturer of covered residential refrigeration products. DOE screened out companies that do not offer products covered by this rulemaking, do not meet the definition of a "small business," or are foreign owned and operated.

DOE initially identified at least 65 distinct brands of residential refrigeration products sold in the U.S. by 47 parent companies. Out of these 47 companies, DOE determined that the majority (31 of 47) were distributors or resellers of branded products rather than original equipment manufacturers. Of the 16 manufacturers, DOE found 15 to be either large manufacturers or foreign-owned and operated. Thus, DOE identified one small residential refrigeration product manufacturer that produces covered products and can be considered a small business. Next, DOE contacted this potential small business manufacturer to request an interview about the possible impacts on small business manufacturers generally. From these discussions, DOE determined the expected impacts of the rule on affected small entities and whether an initial regulatory flexibility analysis was needed (*i.e.,* whether DOE could certify that this rulemaking would not have a significant economic impact on a substantial number of small entities).

The majority of residential refrigeration products are currently manufactured in the United States, though production for the domestic market has increasingly been relocated to Mexico. For standard-size refrigerator-freezers, three large manufacturers control the overwhelming majority of sales. Many foreign-owned manufacturers of standard-size refrigerator-freezers offer products for sale in the United States and constitute part of the remaining domestic standard-size refrigerator-freezer market. These products are either manufactured domestically or imported depending on the specific manufacturer. Additionally, several domestic companies focus on premium built-in standard-size refrigerator-freezers, which represent the remainder of the market. None of the standard-size refrigerator manufacturers DOE identified are small business manufacturers.

For standard-size freezers, one large manufacturer controls the majority of the market. Another domestic manufacturer with a significant standard-size freezer market share recently went out of business, but its market share is expected to be taken by other large manufacturers of refrigeration products. The remaining market share is spread in small percentages across foreign-owned and foreign-operated manufacturers and some of the same niche manufacturers that produce premium built-in standard-size refrigerator-freezers. None of the standard-size freezer manufacturers identified by DOE are small business manufacturers.

The majority of compact refrigeration products are imported, and market share is divided among many domestic and foreign manufacturers. Several manufacturers who still produce compact products domestically focus on the premium niche market of undercounter refrigerators and freezers. Undercounter refrigerator and freezers are high-end products that are meant to be either free-standing or recessed. Based on its market research, the one small business manufacturer of residential refrigeration products identified by DOE is a niche manufacturer that produces these premium undercounter units. The company manufactures primarily products that are covered by this rulemaking, such as undercounter refrigerators and refrigerator-freezers, plus several products outside of the scope of coverage for this rulemaking, such as ice makers and wine coolers. The small business manufacturer currently offers five basic ENERGY STAR models (13 individual products) but many of its product lines may need upgrading or may be discontinued in response to the proposed energy conservation standards.

DOE does not believe the small business manufacturer will be differentially impacted by the proposed energy conservation standard. The small business manufacturer has the largest market share of undercounter refrigerator and freezers. Since undercounter units are a very small segment of compact refrigerators and freezers, the small business manufacturer is the market leader of a very small segment of compact products. The company represents an even smaller percentage of total shipments of covered products. Many of the other undercounter manufacturers, while not technically small businesses by the SBA definition, also have low overall production volumes. Finally, the undercounter market is a niche market that does not compete with overall compact refrigeration sales. Undercounter products are luxury items purchased by consumers that are typically less concerned about first costs compared to purchasers of other residential refrigeration products. While most compact sales are inexpensive products with retail prices in the low hundreds of dollars, undercounter products typically cost many times that. Despite the small size of this niche market, the much higher sales price and lower volumes indicate that profit margins are likely higher.

Since only one small business manufacturer would potentially be impacted by the proposed energy conservation standards in today's rule and that manufacturer represents a small percentage of covered products is a leader in a niche market, DOE believes that these combined factors make it likely that the manufacturer would not be differentially impacted compared to its competition. As a result, DOE certifies that the standards for residential refrigeration products set forth in the proposed rule, if promulgated, would not have a significant economic impact on a substantial number of small entities. Accordingly, DOE has not prepared a regulatory flexibility analysis for this rulemaking. DOE will transmit the certification and supporting statement of factual basis to the Chief Counsel for Advocacy of the Small Business Administration for review under 5 U.S.C. 605(b).

DOE requests comment on the above analysis, as well as any information concerning small businesses that could be impacted by this rulemaking and the nature and extent of those potential impacts of the proposed energy conservation standards on small residential refrigeration product manufacturers. (*See* Issue 22 under "Issues on Which DOE Seeks Comment" in section VII.E of this NOPR, below.)

C. Review Under the Paperwork Reduction Act

This rulemaking will impose no new information or record keeping requirements. Accordingly, OMB clearance is not required under the Paperwork Reduction Act. (44 U.S.C. 3501 *et seq.*)

D. Review Under the National Environmental Policy Act of 1969

DOE has prepared a draft environmental assessment (EA) of the impacts of the proposed rule pursuant to the National Environmental Policy Act of 1969 (42 U.S.C. 4321 *et seq.*), the regulations of the Council on Environmental Quality (40 CFR parts 1500–1508), and DOE's regulations for compliance with the National Environmental Policy Act 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 draft EA has been included as chapter 15 of the NOPR TSD. Before issuing a final rule for refrigeration products, DOE will consider public comments and, as appropriate, determine whether to issue a finding of no significant impact (FONSI) as part of a final EA or to prepare an environmental impact statement (EIS) for this rulemaking.

E. Review Under Executive Order 13132

Executive Order 13132, "Federalism," 64 FR 43255 (August 10, 1999) imposes certain requirements on agencies formulating and implementing policies or regulations that preempt State law or that have federalism implications. The Executive Order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and to carefully assess the necessity for such actions. The Executive Order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of today's proposed rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297) 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 (February 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 proposed rule meets the relevant standards of Executive Order 12988.

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA) requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Public Law 104–4, sec. 201 (codified at 2 U.S.C. 1531). For a proposed regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a proposed "significant intergovernmental mandate," and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect small governments. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820; also available at *http://www.gc.doe.gov.*

Although today's proposed rule does not contain a Federal intergovernmental mandate, it may impose expenditures of $100 million or more on the private sector. Specifically, the proposed rule will likely result in a final rule that could impose expenditures of $100 million or more. Such expenditures may include (1) investment in research and development and in capital expenditures by refrigeration product manufacturers in the years between the final rule and the compliance date for the new standard, and (2) incremental additional expenditures by consumers to purchase higher-efficiency refrigeration products, starting in 2014.

Section 202 of UMRA authorizes an agency to respond to the content requirements of UMRA in any other statement or analysis that accompanies the proposed rule. 2 U.S.C. 1532(c). The content requirements of section 202(b) of UMRA relevant to a private sector mandate substantially overlap the economic analysis requirements that apply under section 325(o) of EPCA and Executive Order 12866. The **SUPPLEMENTARY INFORMATION** section of the notice of proposed rulemaking and the "Regulatory Impact Analysis" section of the TSD for this proposed rule respond to those requirements.

Under section 205 of UMRA, the Department is obligated to identify and consider a reasonable number of regulatory alternatives before promulgating a rule for which a written statement under section 202 is required. 2 U.S.C. 1535(a). DOE is required to select from those alternatives the most cost-effective and least burdensome alternative that achieves the objectives of the 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(h) and (o), 6313(e), and 6316(a), today's proposed rule would establish energy conservation standards for residential refrigeration products that are designed to achieve the maximum improvement in energy efficiency that DOE has determined to be both technologically feasible and economically justified. A full discussion of the alternatives considered by DOE is presented in the "Regulatory Impact Analysis" section of the TSD for today's proposed rule.

H. Review Under the Treasury and General Government Appropriations Act, 1999

Section 654 of the Treasury and General Government Appropriations Act, 1999 (Pub. L. 105–277) requires Federal agencies to issue a Family Policymaking Assessment for any rule that may affect family well-being. This rule would not have any impact on the autonomy or integrity of the family as an institution. Accordingly, DOE has concluded that it is not necessary to prepare a Family Policymaking Assessment.

I. Review Under Executive Order 12630

DOE has determined, under Executive Order 12630, "Governmental Actions and Interference with Constitutionally Protected Property Rights" 53 FR 8859 (March 18, 1988), that this regulation would not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution.

J. Review Under the Treasury and General Government Appropriations Act, 2001

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516, note) provides for agencies to review most disseminations of information to the public under guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (February 22, 2002), and DOE's guidelines were published at 67 FR 62446 (October 7, 2002). DOE has reviewed today's NOPR under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

Executive Order 13211, "Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use" 66 FR 28355 (May 22, 2001), requires Federal agencies to prepare and submit to OIRA at OMB, a Statement of Energy Effects for any proposed significant energy action. A "significant energy action" is defined as any action by an agency that promulgates or is expected to lead to promulgation of a final rule, and that (1) Is a significant regulatory action under Executive Order 12866, or any successor order; and (2) is likely to have a significant adverse effect on the supply, distribution, or use of energy, or (3) is designated by the Administrator of OIRA as a significant energy action. For any proposed significant energy action, the agency must give a detailed statement of any adverse effects on energy supply, distribution, or use should the proposal be implemented, and of reasonable alternatives to the action and their expected benefits on energy supply, distribution, and use.

DOE has tentatively concluded that today's regulatory action, which sets forth energy conservation standards for refrigeration products, is not a significant energy action because the proposed standards are not likely to have a significant adverse effect on the supply, distribution, or use of energy, nor has it been designated as such by the Administrator at OIRA. Accordingly, DOE has not prepared a Statement of Energy Effects on the proposed rule.

L. Review Under the Information Quality Bulletin for Peer Review

On December 16, 2004, OMB, in consultation with the Office of Science and Technology (OSTP), issued its Final Information Quality Bulletin for Peer Review (the Bulletin). 70 FR 2664 (January 14, 2005). The Bulletin establishes that certain scientific information shall be peer reviewed by qualified specialists before it is disseminated by the Federal Government, including influential scientific information related to agency regulatory actions. The purpose of the bulletin is to enhance the quality and credibility of the Government's scientific information. Under the Bulletin, the energy conservation standards rulemaking analyses are "influential scientific information," which the Bulletin defines as "scientific information the agency reasonably can determine will have or does have a clear and substantial impact on important public policies or private sector decisions." 70 FR 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.*

VII. Public Participation

A. Attendance at Public Meeting

The time, date and location of the public meeting are listed in the **DATES** and **ADDRESSES** sections at the beginning of this document. To attend the public meeting, please notify Ms. Brenda Edwards at (202) 586–2945 or *Brenda.Edwards@ee.doe.gov*. As explained in the **ADDRESSES** section, foreign nationals visiting DOE Headquarters are subject to advance security screening procedures.

B. Procedure for Submitting Requests To Speak

Any person who has an interest in today's NOPR, or who is a representative of a group or class of persons that has an interest in these issues, may request an opportunity to make an oral presentation. Such persons may hand-deliver requests to speak, along with a computer diskette or CD in WordPerfect, Microsoft Word, PDF, or text (ASCII) file format, to the address shown in the **ADDRESSES** section at the beginning between the hours of 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays. Requests may also be sent by mail, or by e-mail to: *Brenda.Edwards@ee.doe.gov.*

Persons requesting an opportunity to speak should briefly describe the nature of their interest in this rulemaking and provide a telephone number for contact. DOE requests persons scheduled to make an oral presentation to submit an advance copy of their statements at least one week before the public meeting. At its discretion, DOE may permit any person who cannot supply an advance copy of their statement to participate, if that person has made advance alternative arrangements with the Building Technologies Program. The request to give an oral presentation should ask for such alternative arrangements.

C. Conduct of Public Meeting

DOE will designate a DOE official to preside at the public meeting and may also use a professional facilitator to aid discussion. The meeting will not be a judicial or evidentiary-type public hearing, but DOE will conduct it in accordance with 5 U.S.C. 553 and section 336 of EPCA, 42 U.S.C. 6306. A court reporter will be present to record the proceedings and prepare a transcript. DOE reserves the right to schedule the order of presentations and to establish the procedures governing the conduct of the public meeting. After the public meeting, interested parties may submit further comments on the proceedings as well as on any aspect of the rulemaking until the end of the comment period.

The public meeting will be conducted in an informal, conference style. DOE will present summaries of comments received before the public meeting, allow time for presentations by participants, and encourage all interested parties to share their views on issues affecting this rulemaking. Each participant will be allowed to make a prepared general statement (within time limits determined by DOE), before the discussion of specific topics. DOE will permit other participants to comment briefly on any general statements.

At the end of all prepared statements on a topic, DOE will permit participants to clarify their statements briefly and comment on statements made by others. Participants should be prepared to answer questions by DOE and by other participants concerning these issues. DOE representatives may also ask questions of participants concerning other matters relevant to this rulemaking. The official conducting the public meeting will accept additional comments or questions from those attending, as time permits. The presiding official will announce any further procedural rules or modification of the above procedures that may be needed for the proper conduct of the public meeting.

DOE will make the entire record of this proposed rulemaking, including the transcript from the public meeting, available for inspection at the U.S. Department of Energy, Resource Room of the Building Technologies Program, 950 L'Enfant Plaza, SW., Washington, DC 20024, (202) 586–2945, between 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays. Any person may buy a copy of the transcript from the transcribing reporter.

D. Submission of Comments

DOE will accept comments, data, and information regarding the proposed rule before or after the public meeting, but no later than the date provided at the beginning of this NOPR. Comments, data, and other information submitted to DOE's e-mail address for this rulemaking should be provided in WordPerfect, Microsoft Word, PDF, or text (ASCII) file format. Interested parties should avoid the use of special characters or any form of encryption and, wherever possible, comments should carry the electronic signature of the author. Absent an electronic signature, comments submitted electronically must be followed and authenticated by submitting a signed original paper document to the address provided at the beginning of this notice. Comments, data, and information submitted to DOE via mail or hand delivery/courier should include one signed original paper copy. No telefacsimiles (faxes) will be accepted.

According to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit two copies: one copy of the document including all the information believed to be confidential, and one copy of the document with the information believed to be confidential deleted. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

Factors of interest to DOE when evaluating requests to treat submitted information as confidential include: (1) A description of the items; (2) whether and why such items are customarily treated as confidential within the industry; (3) whether the information is generally known by or available from other sources; (4) whether the information has previously been made available to others without obligation concerning its confidentiality; (5) an explanation of the competitive injury to the submitting person which would result from public disclosure; (6) when such information might lose its confidential character due to the passage of time; and (7) why disclosure of the information would be contrary to the public interest.

E. Issues on Which DOE Seeks Comment

In addition to the issues that DOE has identified throughout the earlier portions of this preamble, DOE is particularly interested in receiving comments and views of interested parties concerning the following issues:

1. DOE requests comment on its baseline treatment of regulatory emissions reductions.

2. DOE requests comment on the max-tech levels identified, and on the combinations of design options considered applicable to achieve max-tech designs. DOE requests that comments also address as appropriate the differences in applicable design options for different product classes.

3. DOE requests comments on the establishment of product classes for refrigeration products with automatic icemakers, including comment on the approach DOE proposes to use to account for icemakers in the product class structure.

4. DOE requests comment on the proposal to establish separate product classes for built-in refrigeration products. DOE also requests comment on the proposed definition for built-in products, including what changes could be made to further strengthen it while not disqualifying any true built-in products, and whether any adjustment of the 24-inch dimension specified in the proposed definition should be made.

5. DOE requests comment on whether any additional product classes are required to fully address icemaking and built-in products.

6. DOE requests comment on the proposal to combine product class 2 (refrigerator-freezer—partial automatic defrost) with product class 1 (refrigerators and refrigerator-freezers with manual defrost) and the proposal to combine product class 12 (compact refrigerator-freezer—partial automatic defrost) with product class 11 (compact refrigerators and refrigerator-freezers with manual defrost).

7. DOE requests comment on the proposal to eliminate the current 36-inch height limitation for compact products.

8. DOE requests comment on DOE's findings regarding projections regarding supply of high-efficiency and variable-speed compressors. In particular, DOE seeks information that would confirm or cast doubt on DOE's conclusions regarding compressor supply.

9. DOE requests comment on the consideration of use of isobutane refrigerant as a design option only for compact refrigerators.

10. DOE requests comment and information on aspects of VIP technology that affect its suitability for consideration as a design option. DOE in particular seeks any new information not already discussed or considered in the rulemaking.

11. DOE requests comment on the approach used to develop Proposed Procedure Reduced Baseline Energy Use equations with adjusted slopes for product classes 4 (refrigerator-freezers—automatic defrost with side-mounted freezer without through-the-door ice service), 5 (refrigerator-freezers—automatic defrost with bottom-mounted freezer without through-the-door ice service), and 5A (refrigerator-freezers—automatic defrost with bottom-mounted freezer with through-the-door ice service). DOE also seeks relevant data that would allow adjustment of the curve intercept so that the shipment-weighted average impact of the slope change would be neutral (*i.e.,* zero change) with respect to energy use. DOE also seeks any additional information that would support similar development of adjusted-slope baseline energy curves for other product classes.

12. DOE requests comment on its treatment of design options in the engineering analysis.

13. DOE requests comments, information, and data that would inform adjustment of energy modeling input and/or results that would allow more accurate representation of the energy use impacts of design options using the ERA energy model.

14. DOE requests information regarding the response of retailers to incremental change in the CGS of appliances associated with proposed energy conservation standards.

15. DOE requests comment on the weighting of the 2005 RECS sample using income relationships and volume scaling.

16. DOE requests comments on its approach for developing UAFs using field-metered data.

17. DOE requests comment on the approach used for estimating repair costs.

18. DOE requests comments on its approach for estimating base-case efficiency distributions.

19. DOE requests comments on its approach for forecasting base-case and standards-case efficiency distributions.

20. DOE requests comment on its considerations leading to the proposed standards for built-in refrigeration products, particularly regarding the negative net consumer impacts of the proposed standards.

21. DOE requests comment on the proposal for round off of the energy standard.

22. DOE requests comment on the regulatory flexibility determination, as well as any information concerning small businesses that could be impacted by this rulemaking and the nature and extent of those potential impacts of the proposed energy conservation standards on small residential refrigeration product manufacturers.

VIII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of today's proposed rule.

List of Subjects in 10 CFR Part 430

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, Reporting and recordkeeping requirements, and Small businesses.

Issued in Washington, DC, on August 27, 2010.

Cathy Zoi,

Assistant Secretary, Energy Efficiency and Renewable Energy.

For the reasons set forth in the preamble, DOE proposes to amend chapter II, subchapter D, of title 10 of the Code of Federal Regulations, as set forth below:

PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

1. The authority citation for part 430 continues to read as follows:

Authority: 42 U.S.C. 6291–6309; 28 U.S.C. 2461 note.

2. In § 430.2, add the definition for "Built-in refrigerator/refrigerator-freezer/freezer," in alphabetical order, and revise the definition for "Compact refrigerator/refrigerator-freezer/freezer" to read as follows:

§ 430.2 Definitions.

* * * * *

Built-in refrigerator/refrigerator-freezer/freezer means any refrigerator, refrigerator-freezer or freezer with 7.75 cubic feet or greater total volume and 24 inches or less depth not including handles and not including custom front panels; is designed to be encased on the sides and rear by cabinetry; is designed to be securely fastened to adjacent cabinetry, walls or floor; and has sides which are not fully finished and are not designed to be visible after installation.

* * * * *

Compact refrigerator/refrigerator-freezer/freezer means any refrigerator, refrigerator-freezer or freezer with total volume less than 7.75 cubic foot (220 liters) (rated volume as determined in appendix A1 and B1 of subpart B of this part).

* * * * *

3. In § 430.32 revise paragraph (a) to read as follows:

§ 430.32 Energy and water conservation standards and their effective dates.

* * * * *

(a) *Refrigerators/refrigerator-freezers/freezers.* These standards do not apply to refrigerators and refrigerator-freezers with total refrigerated volume exceeding 39 cubic foot (1104 liters) or freezers with total refrigerated volume exceeding 30 cubic foot (850 liters). The energy standards as determined by the equations of the following table shall be rounded off to the nearest kWh per year.

Product class	Equations for maximum energy use (kWh/yr)	
	based on AV (ft^3)	based on av (L)
1. Refrigerators and refrigerator-freezers with manual defrost	7.99AV + 225.0	0.282av + 225.0
1A. All-refrigerators—manual defrost	6.79AV + 193.6	0.240av + 193.6
2. Refrigerator-freezers—partial automatic defrost	7.99AV + 225.0	0.282av + 225.0
3. Refrigerator-freezers—automatic defrost with top-mounted freezer without an automatic icemaker	8.04AV + 232.7	0.284av + 232.7
3–BI. Built-in refrigerator-freezer—automatic defrost with top-mounted freezer without an automatic icemaker.	8.57AV + 248.2	0.303av + 248.2
3I. Refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic icemaker without through-the-door ice service.	8.04AV + 316.7	0.284av + 316.7
3I–BI. Built-in refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic icemaker without through-the-door ice service.	8.57AV + 332.2	0.303av + 332.2
3A. All-refrigerators—automatic defrost	7.07AV + 201.6	0.250av + 201.6
3A–BI. Built-in All-refrigerators—automatic defrost	7.55AV + 215.1	0.266av + 215.1
4. Refrigerator-freezers—automatic defrost with side-mounted freezer without an automatic icemaker	8.48AV + 296.5	0.299av + 296.5
4–BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer without an automatic icemaker.	9.04AV + 316.2	0.319av + 316.2
4I. Refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker without through-the-door ice service.	8.48AV + 380.5	0.299av + 380.5
4I–BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker without through-the-door ice service.	9.04AV + 400.2	0.319av + 400.2
5. Refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker	8.80AV + 315.4	0.311av + 315.4
5–BI. Built-In Refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker.	9.35AV + 335.1	0.330av + 335.1
5I. Refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker without through-the-door ice service.	8.80AV + 399.4	0.311av + 399.4
5I–BI. Built-In Refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker without through-the-door ice service.	9.35AV + 419.1	0.330av + 419.1
5A. Refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service.	9.15AV + 471.3	0.323av + 471.3
5A–BI. Built-in refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service.	9.72AV + 495.5	0.343av + 495.5
6. Refrigerator-freezers—automatic defrost with top-mounted freezer with through-the-door ice service	8.36AV + 384.1	0.295av + 384.1
7. Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service	8.50AV + 431.1	0.300av + 431.1
7–BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service.	9.07AV + 454.3	0.320av + 454.3
8. Upright freezers with manual defrost	5.57AV + 193.7	0.197av + 193.7
9. Upright freezers with automatic defrost without an automatic icemaker	8.62AV + 228.3	0.305av + 228.3
9–BI. Built-In Upright freezers with automatic defrost without an automatic icemaker	9.24AV + 244.6	0.326av + 244.6
10. Chest freezers and all other freezers except compact freezers	7.29AV + 107.8	0.257av + 107.8
10A. Chest freezers with automatic defrost	10.24AV + 148.1	0.362av + 148.1
11. Compact refrigerators and refrigerator-freezers with manual defrost	9.03AV + 252.3	0.319av + 252.3
11A. Compact refrigerators and refrigerator-freezers with manual defrost	7.84AV + 219.1	0.277av + 219.1
12. Compact refrigerator-freezers—partial automatic defrost	5.91AV + 335.8	0.209av + 335.8
13. Compact refrigerator-freezers—automatic defrost with top-mounted freezer	11.80AV + 339.2	0.417av + 339.2
13A. Compact all-refrigerator—automatic defrost	9.17AV + 259.3	0.324av + 259.3
14. Compact refrigerator-freezers—automatic defrost with side-mounted freezer	6.82AV + 456.9	0.241av + 456.9
15. Compact refrigerator-freezers—automatic defrost with bottom-mounted freezer	12.88AV + 368.7	0.455av + 368.7

Product class	Equations for maximum energy use (kWh/yr)	
	based on AV (ft^3)	based on av (L)
16. Compact upright freezers with manual defrost	8.65AV + 225.7	0.306av + 225.7
17. Compact upright freezers with automatic defrost	10.17AV + 351.9	0.359av + 351.9
18. Compact chest freezers	9.25AV + 136.8	0.327av + 136.8

AV = Total adjusted volume, expressed in ft^3, as determined in Appendices A and B of subpart B of this part.
av = Total adjusted volume, expressed in Liters.

* * * * *

[FR Doc. 2010–23692 Filed 9–20–10; 4:15 pm]

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