DEPARTMENT OF ENERGY

10 CFR Part 430

[Docket Number EE–2007–BT–STD–0016]

RIN 1904–AB50

Energy Conservation Program: Energy Conservation Standards for Fluorescent Lamp Ballasts

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

ACTION: Final rule.

SUMMARY: The Energy Policy and Conservation Act of 1975 (EPCA), as amended, prescribes energy conservation standards for various consumer products and certain commercial and industrial equipment, including fluorescent lamp ballasts. EPCA also requires the U.S. Department of Energy (DOE) to determine whether any new or amended standards would be technologically feasible and economically justified, and would save a significant amount of energy. In this final rule, DOE adopts new and amended federal energy conservation standards for fluorescent lamp ballasts. It has determined that the new and amended energy conservation standards for these products would result in significant conservation of energy, and are technologically feasible and economically justified.

DATES: The effective date of this rule is January 13, 2012. Compliance with the new and amended standards established for fluorescent lamp ballasts in today's final rule is required as of November 14, 2014.

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

A link to the docket Web page can be found at: *http://www1.eere.energy.gov/buildings/appliance_standards/residential/fluorescent_lamp_ballasts.html*. The regulations.gov page contains instructions on how to access all documents, including public comments, in the docket.

For further information on how to review the docket, contact Ms. Brenda Edwards at (202) 586–2945 or by email: *Brenda.Edwards@ee.doe.gov*.

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SUPPLEMENTARY INFORMATION:

I. Summary of the Final Rule

Title III, Part B[1] of the Energy Policy and Conservation Act of 1975 (EPCA or the Act), Public Law 94–163 (42 U.S.C. 6291–6309, as codified), established the Energy Conservation Program for Consumer Products Other Than Automobiles. Pursuant to EPCA, any new or amended energy conservation standard that DOE prescribes for certain products, such as fluorescent lamp ballasts (ballasts), shall 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, the new or amended standard must result in a significant conservation of energy. (42 U.S.C. 6295(o)(3)(B)) In accordance with these and other statutory provisions discussed in this notice, DOE adopts new and amended energy conservation standards for ballasts. The new and amended standards, which are based on ballast luminous efficiency (BLE), the ratio of total lamp arc power to ballast input power as defined in Appendix Q1 of title 10 of the Code of Federal Regulations (CFR), part 430, are shown in Table I.1. These new and amended standards apply to all products listed in Table I.1 and manufactured in, or imported into, the United States on or after the compliance date specified in the **DATES** section.

TABLE I.1—NEW AND AMENDED ENERGY CONSERVATION STANDARDS FOR FLUORESCENT LAMP BALLASTS

Fluorescent lamp ballasts * shall have a ballast luminous efficiency no less than A/(1 + B * total lamp arc power^-C) where A, B, and C are as follow:				Percent improvement over current standard or baseline **
Product Class	A	B	C	
Instant start and rapid start ballasts (not classified as residential) that are designed to operate 4-foot medium bipin lamps 2-foot U-shaped lamps 8-foot slimline lamps	0.993	0.27	0.25	5.7
Programmed start ballasts (not classified as residential) that are designed to operate 4-foot medium bipin lamps 2-foot U-shaped lamps 4-foot miniature bipin standard output lamps 4-foot miniature bipin high output lamps	0.993	0.51	0.37	10.8
Instant start and rapid start ballasts (not classified as sign ballasts) that are designed to operate 8-foot high output lamps	0.993	0.38	0.25	26.5
Programmed start ballasts (not classified as sign ballasts) that are designed to operate 8-foot high output lamps	0.973	0.70	0.37	26.2
Sign ballasts that operate 8-foot high output lamps	0.993	0.47	0.25	15.1
Instant start and rapid start residential ballasts that operate 4-foot medium bipin lamps 2-foot U-shaped lamps 8-foot slimline lamps	0.993	0.41	0.25	7.2
Programmed start residential ballasts that are designed to operate 4-foot medium bipin lamps 2-foot U-shaped lamps	0.973	0.71	0.37	5.8

* Fluorescent ballasts that are exempt from these standards are listed in section III.A.3.
** Percent improvement is applicable to the average of ballasts directly analyzed.

A. Benefits and Costs to Consumers

Table I.2 presents DOE's evaluation of the economic impacts of today's standards on consumers of ballasts for the product classes analyzed as representative (see section V.B.6), as measured by the average life-cycle cost (LCC) savings and the median payback period (PBP). The average LCC savings are positive for all product classes. For example, the estimated average LCC savings are $37 − $40 for 2-lamp instant start (IS) and rapid start (RS) ballasts that operate 4-foot T8[2] lamps in the commercial sector. When there was more than one baseline for a representative ballast type, DOE performed separate LCC analyses comparing replacement lamp-and-ballast systems to each baseline. Because T8 systems are generally more efficient and have lower overall LCCs than T12 systems, the LCC savings relative to the T8 baseline are lower than when comparing the same efficiency levels to a T12 baseline. At the adopted standard levels, however, LCC savings are positive for all replacement events and baselines analyzed.

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

[2] A lamp description in the form ''T8'' refers to a lamp that (1) is tubular (linear) and (2) has a diameter of 8 eighths of an inch (1 inch).

TABLE I.2—IMPACTS OF TODAY'S STANDARDS ON CONSUMERS OF BALLASTS

Product Class *	Average LCC savings (*2010$*)	Median payback period (*years*) *
IS and RS ballasts (not classified as residential) that operate:		
4-foot MBP lamps (T12 baseline)	$37 to $40	−1.2 to −1.3.
4-foot MBP lamps (T8 baseline)	$3 to $8	2.7 to 4.4.
8-foot slimline lamps (T12 baseline)	$22 to $33	0.1.
8-foot slimline lamps (T8 baseline)	$5 to $7	0.5 to 0.6.
PS ballasts (not classified as residential) that operate:		
4-foot MBP lamps	$6 to $35	1.3 to 6.0.
4-foot MiniBP SO lamps	$10 to $19	2.4 to 3.8.
4-foot MiniBP HO lamps	$26 to $28	2.0 to 2.1.
IS and RS ballasts (not classified as sign ballasts) that operate:		
8-foot HO lamps (T12 baseline)	$134 to $230	−0.7 to −1.3.
Sign ballasts that operate:		
8-foot HO lamps	$251 to $403	−0.2 to −0.3.
IS and RS residential ballasts that operate:		
4-foot MBP lamps	$15 to $21	−5.5 to −9.5.

*IS = instant start; RS = rapid start; MBP = medium bipin; MiniBP = miniature bipin; PS = programmed start; SO = standard output; HO = high output.
**Negative PBP values indicate standards that reduce operating costs and installed costs.

B. Impact on Manufacturers

The industry net present value (INPV) is the sum of the discounted cash flows to the industry from the base year through the end of the analysis period (2014 to 2043). Using a real discount rate of 7.4 [3] percent, DOE estimates that the INPV for manufacturers of ballasts in the base case ranges from $733 million to $1.22 billion in 2010 dollars (2010$). Under today's standards, DOE expects that ballast manufacturers may lose up to 36.7 percent of their INPV, which is approximately $268.6 million. Based on DOE's interviews with the manufacturers of ballasts, however, DOE does not expect any plant closings or significant employment loss. See section VII.B.2.b and VIII.B.3.b for additional discussion on this topic.

C. National Benefits

DOE's analyses indicate that today's ballast standards would save a significant amount of energy over 30 years (2014–2043)—an estimated 2.7–5.6 quadrillion British thermal units (quads) of cumulative energy. This amount is equivalent to the annual energy use of 14 million to 28 million U.S. homes.[4]

The cumulative national net present value (NPV) of total consumer costs and savings of today's ballast standards in 2010$ ranges from $6.7 billion (at a 7-percent discount rate) to $21.6 billion (at a 3-percent discount rate). This NPV expresses the estimated total value of future operating-cost savings less the estimated increased product costs for products purchased in 2014–2043, discounted to 2011.

In addition, today's ballast standards would have significant environmental benefits. The energy savings would result in cumulative greenhouse gas emission reductions of 27–106 million metric tons (Mt) of carbon dioxide (CO_2) from 2014 through 2043. During this period, the standards would also result in emissions reductions [5] of 22–39 thousand tons of nitrogen oxides (NO_X) and 0.40–1.47 tons of mercury (Hg).[6]

The value of the CO_2 reductions is calculated using a range of values per metric ton of CO_2 (otherwise known as the Social Cost of Carbon, or SCC) developed by a recent interagency process. The derivation of the SCC values is discussed in section V.L. DOE estimates that the net present monetary value of the CO_2 emissions reductions is between $0.26 and $3.94 billion, expressed in 2010$ and discounted to 2011. DOE also estimates that the net present monetary value of the NO_X emissions reductions, expressed in 2010$ and discounted to 2011, is $3.91 to $40.2 million at a 7-percent discount rate, and $7.67 to $78.8 million at a 3-percent discount rate.[7]

Table I.3 summarizes the national economic costs and benefits expected to result from today's standards for fluorescent lamp ballasts.

[3] For ballasts, DOE uses a real discount rate of 7.4 percent. DOE's discount rate estimate was derived from industry financials then modified according to feedback during manufacturer interviews.

[4] This estimate is based on the energy use of homes in 2008, which is the most recent data available. See Rosenfeld, Arthur H. and Satish Kumar. Tables to Convert Energy or CO2 (saved or used) to Familiar Equivalents—Cars, Homes, or Power Plants (US Average Data for 2005). May 2008. *http://www.energy.ca.gov/commissioners/rosenfeld_docs/EquivalenceMatrix2008.doc*

[5] DOE calculates emissions reductions relative to the most recent version of the *Annual Energy Outlook* (*AEO*) Reference case forecast. As noted in TSD chapter 16, this forecast accounts for regulatory emissions reductions through 2008, including the Clean Air Interstate Rule (CAIR, 70 FR 25162 (May 12, 2005)), but not the Clean Air Mercury Rule (CAMR, 70 FR 28606 (May 18, 2005)). Subsequent regulations, including the currently proposed CAIR replacement rule, the Clean Air Transport Rule (75 FR 45210 (Aug. 2, 2010)), do not appear in the forecast.

[6] Results for NO_X and Hg are presented in short tons. One short ton equals 2000 lbs.

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

TABLE I.3—SUMMARY OF NATIONAL ECONOMIC BENEFITS AND COSTS OF FLUORESCENT LAMP BALLAST ENERGY CONSERVATION STANDARDS

Category	Present value *Billion 2010$*	Discount rate (percent)
Benefits		
Operating Cost Savings	12.0	7
	24.1	3
CO_2 Reduction Monetized Value (at $4.9/t) *	0.26	5
CO_2 Reduction Monetized Value (at $22.3/t) *	1.29	3
CO_2 Reduction Monetized Value (at $36.5/t) *	2.16	2.5
CO_2 Reduction Monetized Value (at $67.6/t) *	3.94	3
NO_X Reduction Monetized Value (at $450/ton) *	0.004	7
	0.01	3
NO_X Reduction Monetized Value (at $4,623/ton) *	0.04	7
	0.08	3
Total Benefits†	13.3	7
	25.4	3
Costs		
Incremental Installed Costs	3.68	7
	6.91	3
Net Benefits		
Including CO_2 and NO_X†	9.62	7
	18.5	3

* The CO_2 values represent global monetized values of the SCC in 2010 under several scenarios. The values of $4.9, $22.3, and $36.5 per metric ton (t) are the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The value of $67.6/t represents the 95th percentile of the SCC distribution calculated using a 3% discount rate.

† Total Benefits for both the 3% and 7% cases are derived using the SCC value calculated at a 3% discount rate, and the average of the low and high NO_X values used in DOE's analysis.

The benefits and costs of today's standards, for products sold in 2014–2043, can also be expressed in terms of annualized values. The annualized monetary values are the sum of (1) the annualized national economic value, expressed in 2010$, of the benefits from operating the product (consisting primarily of operating cost savings from using less energy, minus increases in equipment purchase and installation costs, which is another way of representing consumer NPV, plus (2) the annualized monetary value of the benefits of emission reductions, including CO_2 emission reductions.[8]

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 cost savings are domestic U.S. consumer monetary savings that occur as a result of market transactions, while the value of CO_2 emissions 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 different time frames for analysis. The national operating cost savings are measured for the lifetime of ballasts shipped in 2014–2043. The SCC values, alternatively, reflect the present value of all future climate-related impacts resulting from the emission of one metric ton of CO_2 in each year, with impacts continuing well beyond 2100.

Estimates of annualized benefits and costs of today's standards are shown in Table I.4. (The following monetary values are expressed in 2010$.) The results under the primary estimate are as follows. Using a 7-percent discount rate for benefits and costs other than CO_2 reduction, for which DOE used a 3-percent discount rate along with the SCC series corresponding to a value of $22.3/ton in 2010, the cost of the standards in today's rule is $363 million per year in increased equipment costs, while the benefits are $1.2 billion per year in reduced equipment operating costs, $92 million in CO_2 reductions, and $2.2 million in reduced NO_X emissions. In this case, the net benefit amounts to $920 million per year. Using a 3-percent discount rate for all benefits and costs and the SCC series corresponding to a value of $22.3/ton in 2010, the cost of the standards in today's rule is $385 million per year in increased equipment costs, while the benefits are $1.3 billion per year in reduced operating costs, $92 million in CO_2 reductions, and $2.4 million in reduced NO_X emissions. In this case, the net benefit amounts to $1.1 billion per year.

[8] DOE used a two-step calculation process to convert the time-series of costs and benefits into annualized values. First, DOE calculated a present value in 2011, the year used for discounting the NPV of total consumer costs and savings, for the time-series of costs and benefits using discount rates of three and seven percent for all costs and benefits except for the value of CO_2 reductions. For the latter, DOE used a range of discount rates, as shown in Table I.3. From the present value, DOE then calculated the fixed annual payment over a 30-year period (2014 through 2043) that yields the same present value. This payment includes benefits to consumers which accrue after 2043 from the ballasts purchased from 2014 to 2043. Costs incurred by manufacturers, some of which may be incurred prior to 2014 in preparation for the rule, are not directly included, but are indirectly included as part of incremental product costs. 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.4—ANNUALIZED BENEFITS AND COSTS OF NEW AND AMENDED STANDARDS FOR BALLASTS SOLD IN 2014–2043*

	Discount rate	Monetized million 2010$/year		
		Primary estimate	Low estimate (emerging technologies, roll-up scenario)	High estimate (existing technologies, shift scenario)
Benefits				
Operating Cost Savings	7%	1,189	886	1,492.
	3%	1,344	934	1,754.
CO_2 Reduction at $4.9/t**	5%	20	9	30.
CO_2 Reduction at $22.3/t**	3%	92	41	143.
CO_2 Reduction at $36.5/t**	2.5%	151	66	237.
CO_2 Reduction at $67.6/t**	3%	280	124	435.
NO_X Reduction at $2,537/t**	7%	2.2	1.3	3.0.
	3%	2.4	1.6	3.2.
Total (Operating Cost Savings, CO_2 Reduction and NO_X Reduction)†	7% plus CO_2 range	1,211 to 1,471	896 to 1,011	1,525 to 1,930.
	7%	1,283	928	1,637.
	3%	1,438	976	1,900.
	3% plus CO_2 range	1,366 to 1,626	945 to 1,059	1,788 to 2,193.
Costs				
Incremental Product Costs	7%	363	227	498.
	3%	385	218	553.
Net Benefits/Costs				
Total (Operating Cost Savings, CO_2 Reduction and NO_X Reduction, Minus Incremental Product Costs)†	7% plus CO_2 range	848 to 1,108	669 to 784	1,027 to 1,432.
	7%	920	700	1,139.
	3%	1,053	758	1,347.
	3% plus CO_2 range	981 to 1,241	727 to 842	1,235 to 1,640.

* This table presents the annualized costs and benefits associated with fluorescent lamp ballasts shipped between 2014 and 2043. These results include benefits to consumers which accrue after 2043 from the ballasts purchased from 2014 to 2043. Costs incurred by manufacturers, some of which may be incurred prior to 2014 in preparation for the rule, are not directly included, but are indirectly included as part of incremental product costs. The Primary, Low Benefits, and High Benefits Estimates utilize forecasts of energy prices and housing starts from the *AEO2010* Reference case, with the Low and High Estimates based on forecasted ballast shipments in the Emerging Technologies, Roll-up and Existing Technologies, Shift scenarios, respectively. In addition, all estimates use incremental product costs that reflect constant prices (no learning rate) for product prices. The different techniques used to evaluate projected price trends for each estimate are discussed in section V.E.1.

** The CO_2 values represent global monetized values (in 2010$) of the social cost of CO_2 emissions in 2010 under several scenarios. The values of $4.9, $22.3, and $36.5 per metric ton are the averages of SCC distributions calculated using 5-percent, 3-percent, and 2.5-percent discount rates, respectively. The value of $67.6/t represents the 95th percentile of the SCC distribution calculated using a 3-percent discount rate. The value for NO_X (in 2010$) is the average of the low and high values used in DOE's analysis.

† Total Benefits for both the 3-percent and 7-percent cases are derived using the SCC value calculated at a 3-percent discount rate, which is $22.3/t in 2010 (in 2010$). 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.

D. Conclusion

Based on the analyses culminating in this final rule, DOE found the benefits to the nation of the standards (energy savings, consumer LCC savings, positive NPV of consumer benefit, and emission reductions) outweigh the costs (loss of INPV). DOE has concluded that the standards in today's final rule represent the maximum improvement in energy efficiency that is technologically feasible and economically justified, and would result in significant conservation of energy. DOE further notes that in all product classes, ballasts achieving the standard levels are already commercially available.

II. Introduction

The following section briefly discusses the statutory authority underlying today's final rule, as well as some of the historical background related to the establishment of standards for ballasts.

A. Authority

Title III, Part B of the Energy Policy and Conservation Act of 1975, Public Law 94–163 (42 U.S.C. 6291–6309, as codified) established the Energy Conservation Program for Consumer Products Other Than Automobiles,[9] a program covering most major household appliances (collectively referred to as ''covered products''), which includes the types of ballasts that are the subject of this final rule. (42 U.S.C. 6292(a)(13)) EPCA prescribed energy conservation standards for these products (42 U.S.C. 6295(g)(5), (6), and (8)), and directed DOE to conduct two cycles of rulemakings to determine whether to amend these standards. (42 U.S.C. 6295(g)(7))

Pursuant to EPCA, DOE's energy conservation program for covered products consists essentially of four parts: (1) Testing; (2) labeling; (3) the establishment of Federal energy conservation standards; and (4) certification and enforcement procedures. The Federal Trade Commission (FTC) is primarily responsible for labeling, and DOE

[9] For editorial reasons, upon codification in the U.S. Code (U.S.C.), Part B was redesignated Part A.

implements the remainder of the program. Subject to certain criteria and conditions, DOE is required to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating cost of each covered product. (42 U.S.C. 6293) Manufacturers of covered products must use the prescribed DOE test procedure as the basis for certifying to DOE that their products comply with the applicable energy conservation standards adopted under EPCA and when making representations to the public regarding the energy use or efficiency of those products. (42 U.S.C. 6293(c) and 6295(s)) Similarly, DOE must use these test procedures to determine whether the products comply with standards adopted pursuant to EPCA. *Id.* The DOE test procedures for ballasts currently appear at 10 CFR part 430, subpart B, appendices Q and Q1. Compliance with the ballast efficacy factor energy conservation standards, required until the compliance date specified in the **DATES** section, is determined according to appendix Q. Compliance with the BLE standards adopted in this rule must be determined according to appendix Q1. The procedures in appendix Q1 were established by the ballast active mode test procedure final rule. 76 FR 25211 (May 4, 2011).

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

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

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

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

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

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

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

7. Other factors the Secretary of Energy (the Secretary) considers relevant.

(42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII))

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

Further, EPCA, as codified, establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the energy savings during the first year that the consumer will receive as a result of the standard, as calculated under the applicable test procedure. 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. *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 may, however, grant waivers of Federal preemption for particular State laws or regulations, in accordance with the procedures and other provisions set forth under 42 U.S.C. 6297(d).

Pursuant to the amendments contained in section 310(3) of the Energy Independence and Security Act of 2007 (EISA 2007), any final rule for new or amended energy conservation standards promulgated after July 1, 2010, is required to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) Specifically, when DOE adopts a standard for a covered product after that date, it must, if justified by the criteria for adoption of standards under EPCA (42 U.S.C. 6295(o)), incorporate standby mode and off mode energy use into the standard or, if that is not feasible, adopt a separate standard for such energy use for that product. (42 U.S.C. 6295(gg)(3)(A)–(B)) DOE has determined that ballasts do not operate in an ''off mode'' as defined by EPCA (42 U.S.C. 6291(gg)(1)(A)(ii)), and that the only ballasts that consume power in a ''standby mode'' as defined by EPCA (42 U.S.C. 6291(gg)(1)(A)(iii)) are those that incorporate an electronic circuit enabling the ballast to communicate with and be part of a lighting control system. DOE's test procedures for ballasts address such standby mode energy use. 74 FR 54455 (October 22, 2009) and 76 FR 25211 (May 4, 2011); 10 CFR part 430, subpart B, appendix Q, section 3.2 and appendix Q1, section 3. DOE did not adopt standards for standby mode energy use, however, because DOE did not find any covered ballasts capable of operating in this mode in its search of the marketplace. Therefore, this final rule does not include energy conservation standards for standby mode energy use. See section III.B for more detail.

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

DOE emphasizes as well that Executive Order 13563 requires agencies ''to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible.'' In its guidance, the Office of Information and Regulatory Affairs has emphasized that such techniques may include ''identifying changing future compliance costs that might result from technological innovation or anticipated behavioral changes.'' For the reasons stated in the preamble, DOE concludes that today's final rule is consistent with these principles, including the requirement that, to the extent permitted by law, benefits justify costs and that net benefits are maximized. Consistent with EO 13563, and the range of impacts analyzed in this final rule, the energy efficiency standards adopted herein by DOE achieve maximum net benefits.

B. Background

1. Ballast Efficacy Factor Standards

The Federal energy conservation standards for ballasts expressed in terms of ballast efficacy factor are set forth in Table II.1 and Table II.2. The standards in Table II.1 were adopted in a final rule published on September 19, 2000, which completed the first of the two rulemakings required under 42 U.S.C. 6295(g)(7) to consider amending the standards for ballasts (hereafter referred to as the 2000 Ballast Rule). 65 FR 56739. The standards in Table II.2 were established by amendments to EPCA in the Energy Policy Act of 2005 (EPAct 2005), Pub. L. 109–58.

TABLE II.1—ENERGY CONSERVATION STANDARDS FROM THE 2000 BALLAST RULE

Application for operation of *	Ballast input voltage	Total nominal lamp watts	Ballast efficacy factor
One F40T12 lamp	120	40	2.29
	277	40	2.29
Two F40T12 lamps	120	80	1.17
	277	80	1.17
Two F96T12 lamps	120	150	0.63
	277	150	0.63
Two F96T12HO lamps	120	220	0.39
	277	220	0.39

* F40T12, F96T12, and F96T12HO are defined in Appendix Q to Subpart B of Part 430.

10 CFR 430.32(m)(3).

TABLE II.2—ENERGY CONSERVATION STANDARDS FROM EPACT 2005

Application for operation of *	Ballast input voltage	Total nominal lamp watts	Ballast efficacy factor
One F34T12 lamp	120/277	34	2.61
Two F34T12 lamps	120/277	68	1.35
Two F96T12/ES lamps	120/277	120	0.77
Two F96T12HO/ES lamps	120/277	190	0.42

* F34T12, F96T12/ES, and F96T12HO/ES are defined in Appendix Q to Subpart B of Part 430.

(42 U.S.C. 6295(g)(8)(A); 10 CFR 430.32(m)(5))

In summary, as reflected in the previous two tables, the ballasts currently regulated under EPCA consist of ballasts that are designed to operate:

- One and two nominally 40-watt (W) and 34W 4-foot T12 medium bipin (MBP) lamps (F40T12 [10] and F34T12);
- Two nominally 75W and 60W 8-foot T12 single-pin (SP) slimline lamps (F96T12 and F96T12/ES); and
- Two nominally 110W and 95W 8-foot T12 recessed double contact high output lamps (F96T12HO and F96T12HO/ES) at nominal input voltages of 120 or 277 volts (V) with an input current frequency of 60 hertz (Hz).

[10] A notation in the form ''F40T12'' identifies a lamp type. This particular notation refers to a lamp that: (1) Is fluorescent; (2) has a nominal wattage of 40 W; (3) is linear (tubular); and (4) has a diameter of 12 eighths of an inch.

In addition, several ballasts are exempt from standards. These exemptions consist of ballasts designed to operate those lamps listed in Table II.1 that:

• Are designed for dimming to 50 percent or less of its maximum output;

• Are designed for use with two F96T12 high output (HO) lamps at ambient temperatures of −20 degrees Fahrenheit (F) or less and for use in an outdoor sign; or

• Have a power factor of less than 0.90 and are designed and labeled for use only in residential building applications.

2. History of Standards Rulemaking for Fluorescent Lamp Ballasts

EPCA establishes energy conservation standards for certain ballasts and requires that DOE conduct two cycles of rulemaking to determine whether to amend the standards for these ballasts, including whether to adopt standards for additional ballasts. (42 U.S.C. 6295(g)(5)–(8)) As indicated in section II.B.1, DOE completed the first of these rulemaking cycles by publishing the 2000 Ballast Rule. 65 FR 56740 (Sept. 19, 2000). In this rulemaking, the second rulemaking cycle required by 42 U.S.C. 6295(g)(7), DOE is amending the existing standards for ballasts and adopting standards for additional ballasts.

DOE initiated this rulemaking on January 14, 2008 by publishing in the **Federal Register** a notice announcing the availability of the ''Energy Conservation Standards Rulemaking Framework Document for Fluorescent Lamp Ballasts.'' (A PDF of the framework document is available at *http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/ballast_framework_011408.pdf.*) In that notice, DOE also announced a public meeting on the framework document and requested public comment on the matters raised in the document. 73 FR 3653 (Jan. 22, 2008). The framework document described the procedural and analytical approaches that DOE anticipated using to evaluate energy conservation standards for the ballasts, and identified various issues to be resolved in conducting this rulemaking.

DOE held the public meeting on February 6, 2008, where it: Presented the contents of the framework document; described the analyses it planned to conduct during the rulemaking; sought comments from interested parties on these subjects; and in general, sought to inform interested parties about, and facilitate their involvement in, the rulemaking. Interested parties at the public meeting discussed the active mode test procedure and several major analyses related to this rulemaking. At the meeting and during the period for commenting on the framework document, DOE received feedback that helped identify and resolve issues involved in this rulemaking.

DOE then gathered additional information and performed preliminary analyses to help develop potential energy conservation standards for ballasts. DOE published in the **Federal Register** an announcement of the availability of the preliminary technical support document (TSD) and of another public meeting to discuss and receive comments on the following matters: Product classes; 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. 75 FR 14319 (March 24, 2010) (hereafter referred to as the March 2010 notice). DOE also invited written comments on these subjects. *Id.* The preliminary TSD is available at *http://www1.eere.energy.gov/buildings/appliance_standards/residential/fluorescent_lamp_ballasts_ecs_prelim_tsd.html.* In the notice, DOE also requested comment on other relevant issues that would affect energy conservation standards for fluorescent lamp ballasts or that DOE should address in the notice of proposed rulemaking (NOPR). *Id.* at 14322.

The public meeting announced in the March 2010 notice took place on April 26, 2010. At that meeting, DOE presented the methodologies and results of the analyses set forth in the preliminary TSD. Interested parties discussed the following major issues at the public meeting: The efficiency metric; how test procedure variation might affect efficiency measurements; requirements for ballasts in environments that are sensitive to electromagnetic interference (EMI); product classes; manufacturer selling prices (MSPs) and overall pricing methodology; markups; the maximum technologically feasible ballast efficiency; cumulative regulatory burden; and shipments. DOE considered the comments received since publication of the March 2010 notice, including those received at the April 2010 public meeting, in the development of the NOPR.

In April 2011, DOE proposed new and amended energy conservation standards for fluorescent lamp ballasts. In conjunction with the NOPR, DOE also published on its Web site the complete TSD for the proposed rule, which incorporated the analyses DOE conducted and technical documentation for each analysis. The TSD included the engineering analysis spreadsheets, the LCC spreadsheet, the national impact analysis spreadsheet, and the manufacturer impact analysis (MIA) spreadsheet—all of which are available on DOE's Web site.[11] The proposed standards were as shown in Table II.3. 76 FR 20090, 20091 (April 11, 2011).

TABLE II.3—ENERGY CONSERVATION STANDARDS PROPOSED IN THE APRIL 2011 NOPR

Product class	Proposed BLE standard
IS and RS ballasts that operate 4-foot MBP lamps 8-foot slimline lamps	1.32 * ln(total lamp arc power) + 86.11.
PS ballasts that operate 4-foot MBP lamps 4-foot MiniBP SO lamps 4-foot MiniBP HO lamps	1.79 * ln(total lamp arc power) + 83.33.
IS and RS ballasts that operate 8-foot HO lamps	1.49 * ln(total lamp arc power) + 84.32.
PS ballasts that operate 8-foot HO lamps	1.46 * ln(total lamp arc power) + 82.63.
Ballasts that operate 8-foot HO lamps designed for cold temperature outdoor signs.	1.49 * ln(total lamp arc power) + 81.34.

[11] The Web site address for all the spreadsheets developed for this rulemaking proceeding are available at: *http://www1.eere.energy.gov/buildings/appliance_standards/residential/fluorescent_ballasts_nopr_analytical_tools.html.*

In the NOPR, DOE invited comment in particular on the following issues: (1) The exemption for T8 magnetic [12] ballasts in EMI-sensitive environments; (2) the appropriateness of establishing efficiency standards using an equation dependent on lamp-arc power; (3) the inclusion of several different ballast types in the same product class; (4) the methodology used to calculate manufacturer selling prices; (5) the efficiency levels considered; (6) the maximum technologically feasible level; (7) markups; (8) the inclusion T12 ballasts in the baseline analysis for life cycle costs; (9) the magnitude and timing of forecasted shipments; (10) the methodology and inputs DOE used for the manufacturer impact analysis—specifically, DOE's assumptions regarding markups, capital costs, and conversion costs; (12) the potential impacts of amended standards on small fluorescent lamp ballast manufacturers; (13) the trial standard levels (TSLs) considered; (14) the proposed standard level; and (15) potential approaches to maximize energy savings while mitigating impacts to certain fluorescent ballast consumer subgroups. 76 FR 20090, 20177 (April 11, 2011).

DOE held a public meeting on May 10, 2011, to hear oral comments on and solicit information relevant to the proposed rule (hereafter the May 2011 public meeting). At this meeting, the National Electrical Manufacturers Association (NEMA) presented test data that they found inconsistent with the data collected by DOE and that could affect the standards established in the final rule. In general, NEMA's ballast luminous efficiency values appeared to be lower than those obtained by DOE. NEMA and other stakeholders agreed that there were discrepancies between the two data sets and emphasized the importance of identifying the source of the differences. In addition, DOE received comments on the methodology used to account for compliance certification requirements, design variation, and lab-to-lab variation and on the appropriate shape of DOE's proposed efficiency level curves.

In light of these discrepancies, DOE published a notice of data availability (NODA) on August 24, 2011 to: (1) Announce the availability of additional test data collected by DOE and the data submitted by NEMA; (2) address the differences between test data obtained by DOE and test data submitted by NEMA; (3) describe the methodological changes DOE was considering for the final rule based on the additional data; (4) present efficiency levels developed using the revised methodology and all available test data; and (5) request public comment on these analyses.[13]

DOE considered the comments received in response to both the April 2011 NOPR and the August 2011 NODA when developing this final rule, and responds to these comments in the following sections.

III. Issues Affecting the Scope of This Rulemaking

A. Additional Fluorescent Lamp Ballasts for Which DOE is Adopting Standards

1. Scope of EPCA Requirement That DOE Consider Standards for Additional Ballasts

As discussed in section II.A, amendments to EPCA established energy conservation standards for certain fluorescent lamp ballasts and directed DOE to conduct two rulemakings to consider amending the standards. The first amendment was completed with the publication of the 2000 Ballast Rule. This rulemaking fulfills the statutory requirement to determine whether to amend standards a second time. EPCA specifically directs DOE, in this second amendment, to determine whether to amend the standards in effect for fluorescent lamp ballasts and whether such standards should be amended so that they would be applicable to additional fluorescent lamp ballasts. (42 U.S.C. 6295(g)(7)(B))

The April 2011 NOPR notes that a wide variety of fluorescent lamp ballasts are not currently covered by energy conservation standards, and thus are potential candidates for coverage under 42 U.S.C. 6295(g)(7). DOE encountered similar circumstances in a recent rulemaking that amended standards for general service fluorescent and incandescent reflector lamps (hereafter referred to as the 2009 Lamps Rule).[14] 74 FR 34080, 34087–8 (July 14, 2009). In that rule, DOE was directed by EPCA to consider expanding its scope of coverage to include additional general service fluorescent lamps (GSFL). EPCA defines GSFLs as fluorescent lamps that can satisfy the majority of fluorescent lamp applications and that are not designed and marketed for certain specified, non-general lighting applications. (42 U.S.C. 6291(30)(B)) As such, the term ''general service fluorescent lamp'' is defined by reference to the term ''fluorescent lamp,'' which EPCA defines as ''a low pressure mercury electric-discharge source in which a fluorescing coating transforms some of the ultraviolet energy generated by the mercury discharge into light,'' and as including the four enumerated types of fluorescent lamps for which EPCA already prescribes standards. (42 U.S.C. 6291(30)(A); 42 U.S.C. 6295(i)(1)(B)) To construe ''general service fluorescent lamp'' in 42 U.S.C. 6295(i)(5) as limited to those types of fluorescent lamps would mean there are no GSFLs that are not already subject to standards, and hence, there would be no ''additional'' GSFLs for which DOE could consider standards. Such an interpretation would conflict with the directive in 42 U.S.C. 6295(i)(5) that DOE consider standards for ''additional'' GSFLs, thereby nullifying that provision.

Therefore, DOE concluded that the term ''additional general service fluorescent lamps'' in 42 U.S.C. 6295(i)(5) allows DOE to set standards for GSFLs other than the four enumerated lamp types specified in the EPCA definition of ''fluorescent lamp.'' As a result, the 2009 Lamps Rule defined ''fluorescent lamp'' to include:

(1) Any straight-shaped lamp (commonly referred to as 4-foot medium bipin lamps) with medium bipin bases, a nominal overall length of 48 inches, and rated wattage of 25 or more;

(2) Any U-shaped lamp (commonly referred to as 2-foot U-shaped lamps) with medium bipin bases, a nominal overall length between 22 and 25 inches, and rated wattage of 25 or more;

(3) Any rapid start lamp (commonly referred to as 8-foot high output lamps) with recessed double contact bases and a nominal overall length of 96 inches;

(4) Any instant start lamp (commonly referred to as 8-foot slimline lamps) with single pin bases, a nominal overall length of 96 inches, and rated wattage of 52 or more;

(5) Any straight-shaped lamp (commonly referred to as 4-foot miniature bipin standard output lamps) with miniature bipin bases, a nominal overall length between 45 and 48 inches, and rated wattage of 26 or more; and

(6) Any straight-shaped lamp (commonly referred to 4-foot miniature bipin high output lamps) with miniature bipin bases, a nominal overall length between 45 and 48 inches, and rated wattage of 49 or more.

[12] When DOE refers to a magnetic ballast throughout this document, it is referring to a low frequency ballast as defined by as defined in ANSI C82.13–2002. Similarly, when DOE refers to an electronic ballast, it is referring to a high frequency ballast as defined by the same ANSI standard.

[13] The August 2011 NODA and accompanying data are available here: *http://www1.eere.energy.gov/buildings/appliance_standards/residential/notice_of_data_availability.html*.

[14] Documents for the 2009 Lamps Rule are available at: *http://www1.eere.energy.gov/buildings/appliance_standards/residential/incandescent_lamps.html*.

10 CFR 430.2

In this rulemaking, DOE is directed to consider whether any amended standard should be applicable to additional fluorescent lamp ballasts. (42 U.S.C. 6295(g)(7)(B)) EPCA defines a ''fluorescent lamp ballast'' as ''a device which is used to start and operate fluorescent lamps by providing a starting voltage and current and limiting the current during normal operation.'' (42 U.S.C. 6291(29)(A)) For this rule, DOE referenced the definition of fluorescent lamp adopted by the 2009 Lamps Rule. This definition allows DOE to consider expanding coverage to include additional fluorescent lamp ballasts while not eliminating coverage of any ballasts for which standards already exist.

2. Identification of the Additional Ballasts for Which DOE Establishes Standards

In considering whether to amend the standards in effect for fluorescent lamp ballasts so that they apply to ''additional'' fluorescent lamp ballasts as specified in section 325(g)(7)(B) of EPCA, DOE considered all fluorescent lamp ballasts (for which standards are not already prescribed) that operate fluorescent lamps, as defined in 10 CFR 430.2. For each additional fluorescent lamp ballast, DOE considered potential energy savings, technological feasibility and economic justification when determining whether to include them in the scope of coverage. In its analyses, DOE assessed the potential energy savings from market share estimates, potential ballast designs that improve efficiency, and other relevant factors. For market share estimates, DOE used both quantitative shipment data and information obtained during manufacturer interviews. DOE also assessed the potential to achieve energy savings in certain ballasts by considering whether those ballasts could serve as potential substitutes for other regulated ballasts.

In the April 2011 NOPR, DOE proposed extending coverage to several additional ballast types including those that operate: Additional numbers and diameters of 4-foot MBP lamps, 8-foot HO lamps, and 8-foot slimline lamps; 4-foot miniature bipin (MiniBP) standard output (SO) lamps; 4-foot MiniBP HO lamps; and 8-foot HO cold temperature lamps commonly used in outdoor signs. DOE did not propose to extend coverage to additional dimming ballasts or T8 magnetic ballasts that operate in EMI-sensitive environments, provided that these magnetic ballasts were designed and labeled for use in EMI-sensitive environments only and shipped by the manufacturer in packages of 10 or fewer ballasts.

The Northwest Energy Efficiency Alliance (NEEA) and the Northwest Power and Conservation Council (NPCC), the Northeast Energy Efficiency Partnerships (NEEP), the Appliance Standards Awareness Project (ASAP), and in a joint comment, ASAP, the Alliance to Save Energy, the American Council for an Energy-Efficient Economy, the National Consumer Law Center, and the National Resources Defense Council (hereafter the ''Joint Comment'') supported the proposed scope of coverage. ASAP and the Joint Comment stated that the expanded scope contributes significantly to the forecasted energy savings for this rulemaking. (NEEA and NPCC, No. 44 at p. 2 [15]; NEEP, No. 49 at p. 2; ASAP, Public Meeting Transcript, No. 43 at pp. 80–2; Joint Comment, No. 46 at p. 2) DOE also received several comments regarding the proposed exemption for T8 magnetic ballasts that operate in EMI-sensitive environments, coverage of residential ballasts, and additional comments recommending further exemptions. These comments are discussed in further detail in the following sections.

a. Ballasts That Operate in Environments Sensitive to Electromagnetic Interference

DOE received comments at the April 2010 public meeting that standards could eliminate magnetic ballasts that are currently used in certain EMI-sensitive environments. DOE conducted research and interviews with fluorescent lamp ballast and fixture manufacturers to identify the following applications as potentially sensitive to EMI: Medical operating room telemetry or life support systems; airport control systems; electronic test equipment; radio communication devices; radio recording studios; correctional facilities; clean rooms; facilities with low signal-to-noise ratios; and aircraft hangars or other buildings with predominantly metal construction.[16] DOE learned from manufacturer interviews that magnetic ballasts are typically recommended for situations in which EMI has been or is expected to be a concern.

Although there are several methods to reduce electromagnetic interference, available data do not indicate that EMI-related issues with electronic ballasts can be eliminated such that there are no longer safety concerns. For this reason, in the April 2011 NOPR DOE proposed an exemption for T8 magnetic ballasts designed and labeled for use in EMI-sensitive environments only and shipped by the manufacturer in packages containing 10 or fewer ballasts. DOE believed the exemption was necessary because in some environments, EMI could pose a serious safety concern that is best mitigated with magnetic ballast technology. DOE did not believe magnetic ballasts would likely be used as substitutes in current electronic ballast applications due to their higher cost and weight. 76 FR 20090, 20100–1 (April 11, 2011).

NEEA and NPCC, NEMA, and ASAP supported the exemption for magnetic ballasts in EMI-sensitive locations. (NEEA and NPCC, No. 44 at p. 2; NEMA, Public Meeting Transcript, No. 43 at p. 70; NEMA, No. 47 at pp. 2–3; ASAP, Public Meeting Transcript, No. 43 at pp. 80–2) ASAP and NEEA and NPCC suggested requiring the description ''designed, labeled, and marketed for use in EMI-sensitive applications'' to limit the possibility of exempted ballasts being sold in other applications. Philips commented that they are unsure how manufacturers would be able to control the marketing through distributors to the proper market. ASAP and NEEA and NPCC acknowledged that although manufacturers cannot control distribution, they can control how they market their products. (ASAP, Public Meeting Transcript, No. 43 at pp. 80–82; Philips, Public Meeting Transcript, No. 43 at p. 82; NEEA and NPCC, No. 44 at p. 2)

DOE did not receive any adverse comment regarding the exemption for T8 magnetic ballasts in EMI-sensitive applications and therefore, for the reasons discussed above, maintains this exemption in the final rule. DOE agrees with ASAP and NEEA and NPCC that this exemption should be designed such that, to the greatest extent possible, it does not become a pathway to circumvent compliance with standards adopted by this rulemaking. Therefore, DOE has modified the description of the exemption to cover ballasts ''designed, labeled, and marketed for use in EMI-sensitive applications.'' See appendix 5E of the TSD for more details on EMI-sensitive applications.

b. Ballasts That Operate in the Residential Sector

Radionic disagreed with DOE's decision to cover residential ballasts and stated that new residential models

[15] A notation in the form ''NEEA and NPCC, No. 44 at p. 2'' identifies a written comment that DOE has received and has included in the docket of this rulemaking. This particular notation refers to a comment: (1) Submitted by NEEA and NPCC; (2) in document number 44 of the docket; and (3) on page 2 of that document.

[16] This list is not all inclusive.

developed to meet standards are likely to have a high initial cost. Because residential consumers are sensitive to first cost, Radionic stated that consumers will choose less expensive and less efficient technologies, thereby potentially decreasing energy savings. (Radionic, No. 36 at p. 1)

As discussed in the April 2011 NOPR, DOE believes that residential ballasts represent a sizeable portion of the overall ballast market and represent significant potential energy savings. DOE agrees with comments received in response to the preliminary TSD, stating that demand for residential fluorescent ballasts will likely grow substantially as residential building codes become more stringent. For example, California, Oregon, and Washington have codes that require fluorescent or higher-efficacy systems in homes. Similarly, the 2009 International Energy Conservation Code requires that 50 percent of all permanently installed lighting in residences have a minimum efficacy of 45 lumens per watt. 76 FR 20090, 20099 (April 11, 2011). DOE projects that increased lighting efficacy requirements will drive consumers to continue to purchase fluorescent systems despite incremental increases in first cost. Furthermore, DOE notes that consumers are already purchasing higher efficiency fluorescent ballasts despite their higher initial first cost relative to other lighting technologies. As discussed in section V.A.1 and section V.B.5.g, standards for residential ballasts save significant amounts of energy, and are technologically feasible and economically justified. Therefore, DOE includes residential ballasts in the scope of coverage for this final rule.

c. Ballasts That Operate Below Minimum ANSI Current Levels

At the May 2011 public meeting, the General Electric Company (GE) commented that DOE's efficiency levels for programmed start (PS) ballasts assumed high efficiency filament cut-out at all arc powers. GE stated, however, that some low ballast factor (BF) PS ballasts operate at currents below minimum American National Standards Institute (ANSI) levels for T8 and T12 lamps and thus require filament heating to maintain lamp life. GE and NEMA noted that these ballasts would be unable to meet BLE requirements proposed in the April 2011 NOPR due to cathode heating, but would offer energy savings due to their relatively low power levels and use in conjunction with occupancy sensors. Thus, GE requested that these low BF ballasts be exempt from standards. (GE, Public Meeting Transcript, No. 43 at pp. 236, 238; NEMA, No. 47 at p. 6)

NEEA and NPCC recognized the operating limitations presented by these ballasts, but expressed concern over the lack of information about their fraction of shipments, the markets where they are most commonly sold, and their cost relative to other, more common ballast types designed to operate the same type and number of lamps. Specifically, NEEA and NPCC commented that these ballasts might be the kind of currently exempted product provided to the residential market, and that their continuing exemption could result in an increase in sales and accompanying loss in energy savings. (NEEA and NPCC, No. 44 at p. 4) The Joint Comment also highlighted the possibility of an increase in the use of these low BF ballasts in all applications if they were exempt from standards. They stated that the current small market share did not mean that shipments would not increase substantially in response to an exemption, thereby decreasing the potential energy savings due to the standards adopted by the rulemaking. (Joint Comment, No. 46 at pp. 2, 3)

DOE reviewed ANSI C78.81–2010 [17] and determined that ballasts designed to operate 4-foot MBP T8 lamps are required to use some level of cathode heating when operating lamps at currents less than 155 milliamperes (mA). Through testing, DOE learned the BF of these ballasts was similar to or less than 0.7. This low BF (which affects light output) is a unique utility that might be removed from the market if these ballasts were held to the established standard level. DOE analyzed test data for 4-foot MBP T8 programmed start ballasts with average currents less than 155 mA to determine if there was a trend between low current and low efficiency. DOE determined that as current decreased, the BLE also decreased. DOE concluded that none of the PS ballasts tested with an average current of less than 140 mA were able to meet the max tech efficiency levels analyzed in the PS product class. Therefore, DOE is exempting these PS low-current ballasts from the standards adopted in this final rule.

DOE does not believe that an exemption for these ballasts will lead to an increase in their use because when current is reduced, light output is also reduced. Consumers have light output requirements and would not consider a ballast that does not meet such a requirement to be an adequate substitute. Reduced light output could also require additional lighting fixtures to be purchased in order to meet expected lighting levels. It is unlikely, however, that consumers would purchase additional fixtures due to high first cost. As a result, DOE establishes an exemption for these PS, low-current ballasts. DOE has determined that the threshold for the exemption will be set at the current levels indicated in its testing, 140 mA for 4-foot MBP ballasts.

d. Other Exemptions

Radionic commented that DOE should consider exempting outdoor ballasts, cold weather ballasts, ''all ballasts for less than 30 watts'', ballasts that have a normal power factor [18] (a power factor equal to or greater than 0.6 and less than 0.9), and ballasts that are produced in small quantities for special applications. (Radionic, No. 36 at p. 1)

DOE notes that several of the ballasts mentioned by Radionic are already subject to standards. For example, because outdoor and cold weather ballasts, apart from sign ballasts, are already covered by current standards, DOE cannot exempt them from standards in this rulemaking due to anti-backsliding statutory provisions (discussed in section II.A). Similarly, DOE interpreted ''all ballasts for less than 30 watts'' as ballasts that operate total lamp arc powers less than 30 W. Some of these ballasts (such as ballasts that operate F34T12 lamps) are covered by current standards and cannot be exempted in this rulemaking. In general, DOE specifies efficiency levels using a power law equation that assigns BLE values as a function of total lamp arc power. In other words, the equation takes lower lamp arc power into account when assigning appropriate standard levels. Even though they operate lower wattage lamps, these ballasts still demonstrate significant potential energy savings and DOE test data shows they are capable of meeting the standard levels adopted by this final rule. Therefore, DOE will not exempt ballasts that operate total lamp arc powers less than 30 W in this final rule.

Ballasts with a normal power factor are classified as residential ballasts. DOE continues to cover residential ballasts as discussed in section III.A.2.b. For residential ballasts, as well as all other types listed above, Radionic did

[17] American National Standard for Electric Lamps—Double-Capped Fluorescent Lamps—Dimensional and Electrical Characteristics, Approved January 14, 2010.

[18] As defined by ANSI C82.13–2002, the power factor is calculated by determining the ratio of the input power to the apparent power. The input power is measured with a wattmeter, and the apparent power is the ballast input voltage multiplied by the ballast input current. For more information, see chapter 3 of the TSD.

not provide DOE with any specific information regarding ballasts produced in small quantities for special applications, or specific data indicating that these ballasts would be unable to meet any standards. DOE has looked at the market and has not identified any applications, other than those already defined, in which ballasts are unable to meet standards and would require an exemption. For all of the ballast types Radionic listed, DOE has determined that the adopted standard levels are technologically feasible and economically justified.

3. Summary of Fluorescent Lamp Ballasts To Which DOE Extends Coverage

With the exception of the comments discussed previously in this section, DOE received no other input related to coverage of fluorescent lamp ballasts. In addition, DOE's revised analyses indicate that energy conservation standards for the ballasts for which DOE proposed coverage in the April 2011 NOPR are still technologically feasible, economically justified, and would result in significant energy savings. Therefore, in summary, this final rule extends coverage to the following fluorescent lamp ballasts:

(1) Ballasts that operate 4-foot medium bipin lamps with a rated wattage [19] of 25W or more, and an input voltage at or between 120V and 277V;

(2) Ballasts that operate 2-foot medium bipin U-shaped lamps with a rated wattage of 25W or more, and an input voltage at or between 120V and 277V;

(3) Ballasts that operate 8-foot high output lamps with an input voltage at or between 120V and 277V;

(4) Ballasts that operate 8-foot slimline lamps with a rated wattage of 52W or more, and an input voltage at or between 120V and 277V;

(5) Ballasts that operate 4-foot miniature bipin standard output lamps with a rated wattage of 26W or more, and an input voltage at or between 120V and 277V;

(6) Ballasts that operate 4-foot miniature bipin high output lamps with a rated wattage of 49W or more, and an input voltage at or between 120V and 277V;

(7) Ballasts that operate 4-foot medium bipin lamps with a rated wattage of 25W or more, an input voltage at or between 120V and 277V, a power factor of less than 0.90, and are designed and labeled for use in residential applications; and

(8) Ballasts that operate 8-foot high output lamps with an input voltage at or between 120V and 277V, have an enclosure with an Underwriters Laboratories (UL) Type 2 rating, and are designed, labeled, and marketed for use in outdoor signs.[20]

The following ballasts are exempt from coverage:

(1) Additional dimming ballasts;

(2) Low frequency T8 ballasts that are designed, labeled, and marketed for use in EMI-sensitive environments and sold in packages of 10 or fewer;

(3) PS ballasts that operate 4-foot MBP T8 lamps and deliver on average less than 140mA to each lamp.

B. Off Mode and Standby Mode Energy Consumption Standards

EPCA requires energy conservation standards adopted for a covered product after July 1, 2010 to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) Because DOE is required by consent decree to publish a final rule establishing any amended standards for fluorescent lamp ballasts by October 28, 2011,[21] this rulemaking is required to consider standby mode and off mode energy use. DOE determined that it is not possible for the ballasts at issue in this final rule to meet the off-mode criteria because there is no condition in which a ballast is connected to the main power source and is not already in a mode accounted for in either active or standby mode. In the test procedure addressing standby mode energy consumption, DOE determined that the only ballasts that consume energy in standby mode are those that incorporate an electronic circuit that enables the ballast to communicate with and be part of a lighting control interface (*e.g.,* digitally addressable lighting interface (DALI) enabled ballasts). 74 FR 54445, 54447–8 (October 22, 2009). DOE believes that the only commercially available ballasts that incorporate an electronic circuit to communicate with a lighting control interface are dimming ballasts.

As discussed in the April 2011 NOPR, DOE did not expand the scope of coverage to include additional dimming ballasts. Therefore, the only covered dimming ballasts are the four products specified in 10 CFR 430.32(m)(5) that operate reduced-wattage lamps. DOE research has not identified any dimming ballasts currently on the market that operate these lamps because the fill gas composition of reduced-wattage lamps makes them undesirable for use in dimming applications. Because DOE is not aware of any other dimming products that are covered by existing standards, DOE was unable to characterize standby mode energy consumption. Therefore, DOE does not adopt provisions to address ballast operation in standby mode as part of the energy conservation standards that are the subject of this rulemaking.

IV. General Discussion

A. Test Procedures

1. Background

As noted previously, manufacturers must use the test procedures for ballasts at 10 CFR part 430, subpart B, appendix Q to determine compliance with the currently applicable ballast efficacy factor standards. On March 24, 2010, DOE issued a NOPR in which it proposed revisions to these test procedures. 75 FR 14288. The principal change DOE proposed to the existing test methods was, in an effort to reduce measurement variation, to eliminate photometric measurements used to determine ballast efficacy factor (BEF). Instead, DOE proposed to use electrical measurements to determine ballast efficiency (BE), which could then be converted to BEF using empirically derived transfer equations. The proposed changes specified that the ballast operate a resistive load rather than a lamp load during performance testing. For consistency with previous methods, no changes were proposed for the measurement of BF (which required photometric measurements). The preliminary TSD for this rulemaking considered standards in terms of BEF, as determined by the methods proposed in the active mode test procedure NOPR.

After reviewing comments submitted in response to the active mode test procedure NOPR (75 FR 14287, March 24, 2010) and conducting additional research, DOE issued a supplemental NOPR (SNOPR) proposing a lamp-based ballast efficiency metric instead of the resistor-based metric proposed in the NOPR. 75 FR 71570 (November 24, 2010). The new metric, BLE, was equal to the total lamp arc power divided by ballast input power. DOE believed this

[19] The 2009 Lamps Rule adopted a new definition for rated wattage that can be found in 10 CFR 430.2.

[20] In the April 2011 NOPR, these ballasts were described as ''ballasts that operate 8-foot high output lamps with an input voltage at or between 120V and 277V, and operate at ambient temperatures of −20 degrees F or less and are used in outdoor signs.'' For the reasons stated in section 0, DOE uses this revised description for the final rule.

[21] Under the consolidated Consent Decree in *New York* v. *Bodman*, No. 05 Civ. 7807 (S.D.N.Y. filed Sept. 7, 2005) and *Natural Resources Defense Council* v. *Bodman*, No. 05 Civ. 7808 (S.D.N.Y. filed Sept. 7, 2005), as amended, the U.S. Department of Energy is required to publish, as that term is defined in the consent decree, a final rule amending energy conservation standards for fluorescent lamp ballasts no later than October 28, 2011.

lamp-based metric more accurately assessed the real-life performance of a ballast and also reduced measurement variation relative to the existing test procedure for BEF. DOE also proposed a method for calculating the BF of a ballast by dividing the measured lamp arc power on the test ballast by the measured lamp arc power on a reference ballast. In cases where reference ballast operating conditions were unavailable, the SNOPR provided a reference lamp power (specific to the ballast type) from an ANSI standard or from empirical results. The April 2011 NOPR for the standards rulemaking used the BLE procedures specified in the test procedure SNOPR to propose energy conservation standards.

The final rule for the active mode test procedure, which was published in the **Federal Register** on May 4, 2011, adopted the BLE metric proposed in the SNOPR with a few modifications. 76 FR 25211. To account for the increase in lamp efficacy associated with high-frequency lamp operation versus low-frequency, DOE had proposed an adjustment to the BLE of low-frequency systems. DOE had proposed that low-frequency BLE be multiplied by 0.9 to account for the approximately 10 percent increase in lighting efficacy associated with high-frequency lamp operation. For the final rule, DOE assigned specific lamp operating frequency adjustment factors for each ballast type considered. The adjustment factors more accurately approximated the increase in lighting efficacy associated with high-frequency lamp operation. In addition, in the final rule, DOE did not adopt a BF measurement procedure because BF was no longer used to define product classes for energy conservation standards.

This final rule for energy conservation standards evaluates standards for ballasts in terms of the BLE metric adopted in the active mode test procedure. Appendix Q1 of 10 CFR part 430 Subpart B will be used to evaluate compliance with the standards adopted in this final rule. 76 FR 25211, 25213 (May 4, 2011)

DOE received comments in response to the April 2011 NOPR regarding the new fluorescent ballast testing procedure and BLE metric. Several stakeholders expressed support for the BLE metric. The Pacific Gas and Electric Company, Southern California Edison, the Southern California Gas Company, and San Diego Gas and Electric (hereafter the ''CA Utilities'') commented that the new BLE metric is an improvement over the existing BEF metric because it allows for efficiency comparison across a wider range of ballasts. (CA Utilities, No. 45 at p. 1) NEEP and CA Utilities stated that the new BLE metric successfully simplifies testing requirements and enables the vast consolidation of product classes, which will make the compliance and enforcement processes easier. (NEEP, No. 92 at p. 3; CA Utilities, No. 45 at pp. 1–2) CA Utilities also approved of the new test procedure, commenting that they support the use of lamps to measure lamp arc power instead of sets of resistor banks designed to simulate lamps. CA Utilities stated that actual lamps, which have varying impedance based on power, more accurately represent real world loads on ballasts. They added that maintaining different sets of resistor banks at every ballast factor would have increased the testing burden for manufacturers. (CA Utilities, No. 45 at p. 2)

DOE also received several comments requesting clarification on the new test procedure. These comments are discussed in the following sections.

2. Transfer Function

GE asked if DOE would be creating transfer functions, similar to those proposed in the active mode test procedure NOPR, to convert BLE to BEF for marketing purposes. GE noted that as BEF will continue to be more relevant for consumers using lumens and system watts, manufacturers will continue to publish those numbers even though they will not test the ballasts with that metric. (GE, Public Meeting Transcript, No. 43 at p. 237) As discussed in section VII.D, to verify that no backsliding had occurred, DOE developed a method to convert BEF to BLE in order to compare current and newly adopted standards. However, DOE requires manufacturers to certify compliance in terms of the BLE metric only and therefore does not provide a transfer function for converting BLE to BEF for marketing purposes.

3. Reference Lamp

GE noted that it is not always clear what lamp should be used when testing a ballast and requested clarification on this matter. (GE, Public Meeting Transcript, No. 43 at pp. 236–7) DOE notes that Table A in the ballast test procedure, Appendix Q1 of 10 CFR part 430 Subpart B, provides the appropriate lamp wattage, diameter and base to use in testing for each covered ballast type. For example, the first row of Table A shows that ballasts ''that operate straight-shaped lamps (commonly referred to as 4-foot medium bipin lamps) with medium bipin bases and a nominal overall length of 48 inches'' should be tested with 32W T8 MBP lamps.

4. Total Lamp Arc Power

The People's Republic of China (P.R. China) noted that in the April 2011 NOPR, the term ''total lamp arc power'' was not well-defined. They noted that ANSI C78.81–2010 specifies ''arc wattage'' for various fluorescent tube lamps but does not define ''total lamp arc power.'' Furthermore, while the test procedure SNOPR included a definition for ''total lamp arc power,'' it also included a table that listed a low and/or high frequency ''reference lamp arc power'' for each covered ballast type. 75 FR 71570, 71592 (November 24, 2010). P.R. China indicated that these terms caused confusion regarding the appropriate value to be used when calculating the efficiency standard. Therefore, they suggested DOE clarify the specific value of ''total lamp arc power'' and use consistent terminology to avoid confusion. (P.R. China, No. 51 at p. 3–4)

CA Utilities and NEEA and NPCC agreed that it was unclear which arc power should be used to calculate the applicable BLE standard. CA Utilities recommended that DOE require manufacturers to use the average lamp arc power of the tested sample to determine the BLE for a given model. (CA Utilities, No. 58 at p. 4; NEEA and NPCC, No. 59 at p. 3)

DOE notes that reference lamp arc power refers to the arc wattage listed in ANSI C78.81–2010 and, as shown in that standard, can vary depending on whether the reference ballast operates at low or high frequency settings.[22] These values were provided in the test procedure SNOPR for the purposes of calculating ballast factor. However, because the test procedure final rule did not adopt a procedure for calculating ballast factor, reference lamp arc powers are no longer relevant. Total lamp arc power is a measured, not listed, value and is evaluated according to the recently adopted test procedure.

DOE also notes that 10 CFR 429.26 does not currently reflect the new ballast luminous efficiency metric. DOE plans to consider certification procedures in upcoming rulemakings related to compliance certification and enforcement.[23] For this final rule, DOE

[22] The test procedure defines a low frequency ballast as a fluorescent lamp ballast that operates at a supply frequency of 50 to 60 Hz and operates the lamp at the same frequency as the supply. The test procedure incorporates the ANSI C82.13 definition of high frequency ballast as a device which operates at a supply frequency of 50 or 60 Hz and operates the lamp at frequencies greater than 10 kHz.

[23] Details on certification and enforcement procedures can be found at: *www1.eere.energy.gov/*

computed the reported ballast luminous efficiency and total lamp arc power assuming the ballast basic models would be certified in the following manner. To certify compliance, manufacturers would calculate the total lamp arc power and BLE for each sample tested according to 10 CFR 430, Subpart B, Appendix Q1. They would then average the total lamp arc power of each sample and input that average into the appropriate energy conservation standard efficiency level. The output of that equation dictates the minimum BLE that the reported BLE for each basic model must meet or exceed. To calculate the reported BLE for each basic model, manufacturers would follow the provisions laid out in 10 CFR 429.26(a)(2)(ii).

B. Technological Feasibility

1. General

In each standards rulemaking, DOE conducts a screening analysis based on information it has gathered on all current technology options and prototype designs that could improve the efficiency of the products that are the subject of the rulemaking. As the first step in such analysis, DOE develops a list of technology 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 technologies incorporated in commercially available products or in working prototypes to be technologically feasible. 10 CFR 430, subpart C, appendix A, section 4(a)(4)(i).

Once DOE has determined that particular technology options are technologically feasible, it further evaluates each of them in light of the following additional screening criteria: (1) Practicability to manufacture, install, or service; (2) adverse impacts on product utility or availability; and (3) adverse impacts on health or safety. For further details on the screening analysis for this rulemaking, see chapter 4 of the final rule TSD.

2. Maximum Technologically Feasible Levels

When DOE considers 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 that product. (42 U.S.C. 6295(p)(1)) Accordingly, DOE determined the maximum technologically feasible (''max tech'') ballast efficiency in the engineering analysis, using the design options identified in the screening analysis (see chapter 5 of the final rule TSD).

As a first step to identifying the max tech efficiency level, DOE conducted testing of commercially available ballasts. DOE was unable to identify working prototypes that had a higher efficiency than the tested products. Therefore, DOE has determined that TSL 3B, which is based on the most efficient commercially available ballasts tested, represents the highest efficiency level that is technologically feasible for a sufficient diversity of commercially available products (spanning several ballast factors, number of lamps per ballast, and types of lamps operated) within each product class. The max tech efficiency levels require the use of electronic ballasts with improved components (such as high efficiency transformers, diodes, capacitors, and transistors). The max tech levels also require IS instead of RS ballasts, or some form of cathode cut-out technology for PS ballasts. Table IV.1 presents the max tech levels for each product class.

TABLE IV.1—MAX TECH LEVELS

BLE = A/(1 + B * total lamp arc power ^-C) where A, B, and C are as follows			
Product class	A	B	C
IS and RS ballasts (not classified as residential) that operate 4-foot MBP lamps 2-foot U-shaped lamps 8-foot slimline lamps	0.993	0.27	0.25
PS ballasts (not classified as residential) that operate 4-foot MBP lamps 2-foot U-shaped lamps 4-foot MiniBP SO lamps 4-foot MiniBP HO lamps	0.993	0.51	0.37
IS and RS ballasts (not classified as sign ballasts) that operate 8-foot HO lamps	0.993	0.28	0.25
PS ballasts (not classified as sign ballasts) that operate 8-foot HO lamps	0.973	0.52	0.37
Sign ballasts that operate 8-foot HO lamps	0.993	0.47	0.25
IS and RS residential ballasts that operate 4-foot MBP lamps 2-foot U-shaped lamps 8-foot slimline lamps	0.993	0.29	0.25
PS residential ballasts that operate: 4-foot MBP lamps 2-foot U-shaped lamps	0.973	0.50	0.37

C. Energy Savings

1. Determination of Savings

DOE used its national impact analysis (NIA) spreadsheet to estimate energy savings from new or amended standards for the ballasts that are the subject of this final rule. (The NIA spreadsheet model is described in section V.F of this final rule and in chapter 11 of the final rule TSD.) DOE forecasted energy savings for each TSL, beginning in 2014, the year that compliance with the new and amended standards is required, 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 new and amended

buildings/appliance_standards/certification_enforcement.html.

mandatory efficiency standards, and considers market demand for higher-efficiency products. For example, DOE models a shift in the base case from covered fluorescent lamp ballasts toward emerging technologies such as light emitting diodes (LEDs).

The NIA spreadsheet model calculates the electricity savings in ''site energy'' expressed in kilowatt-hours (kWh). Site energy is the energy directly consumed by ballasts 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 energy used to generate and transmit the site energy. (See final rule TSD chapter 11.) To convert site energy to source (also known as primary) energy, DOE derived time-dependent conversion factors from the model used to prepare the Energy Information Administration's (EIA's) *Annual Energy Outlook 2010* (*AEO2010*).

2. Significance of Savings

As noted in section I, under 42 U.S.C. 6295(o)(3)(B) DOE is prohibited from adopting a standard for a covered product if such standard would not result in ''significant'' energy savings. While the term ''significant'' is not defined in the Act, the U.S. Court of Appeals, 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 final rule are nontrivial, and therefore DOE considers them ''significant'' within the meaning of section 325 of EPCA.

D. Economic Justification

1. Specific Criteria

As noted in section II.A, 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 addresses each of those seven factors in this rulemaking.

a. Economic Impact on Manufacturers and Consumers

In determining the impacts of a new or amended standard on manufacturers, DOE first determines the quantitative impacts using an annual cash-flow approach. This includes both a short-term assessment—based on the cost and capital requirements during the period between the announcement of a regulation and when the regulation requires compliance—and a long-term assessment over the 30-year analysis period. The impacts analyzed include INPV (which values the industry based on 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, including an analysis of 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. DOE also takes into account cumulative impacts of different related DOE regulations and other regulatory requirements on manufacturers.

For individual consumers, measures of economic impact include the changes in LCC and the payback period associated with new or amended standards. The LCC, which is separately specified as one of the seven factors to consider when 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 calculates the NPV from a national perspective of the economic impacts on consumers over the forecast period used in a particular rulemaking.

b. Life-Cycle Costs

The LCC is the sum of the purchase price of a product (including its installation) and the operating expense (including energy, 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 new or amended standards. The LCC analysis requires a variety of inputs, such as product prices, product energy consumption, energy prices, maintenance and repair costs, product lifetime, and consumer discount rates. DOE assumes in its analysis that consumers purchase the product in 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 achieve LCC savings or experiencing an LCC increase, in addition to the average LCC savings associated with a particular standard level. In addition to identifying ranges of impacts, DOE evaluates the LCC impacts of potential standards on identifiable sub-groups 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 savings.

d. Lessening of Utility or Performance of Products

In establishing classes of products, and in evaluating design options and the impact of potential standard levels, DOE seeks to develop standards that would not lessen the utility or performance of the products under consideration. The efficiency levels considered in this final rule will not affect any features valued by consumers, such as starting method, ballast factor, or cold temperature operation. Therefore, none of the TSLs presented in section VII.A would reduce the utility or performance of the ballasts that are the subject of this final rule. (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 likely to result from standards. It directs the Attorney General to determine the impact, if any, of any lessening of competition likely to result from standards and to transmit this determination to the Secretary, not later than 60 days after the publication of a proposed rule, together with an analysis of the nature and extent of this impact. (42 U.S.C. 6295(o)(2)(B)(i)(V) and (B)(ii)) To assist the Attorney General in making this determination, DOE transmitted a copy of the April 2011 NOPR and TSD to the Attorney General for review. The Attorney General's response is discussed in section VII.B.5, and is reprinted at the end of this rule.

f. Need of the Nation To Conserve Energy

The non-monetary benefits of the standards in this final rule are likely to be reflected in improvements to the security and reliability of the nation's energy system. Reduced 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 standards in this final rule are also likely to result in environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases (GHG) associated with energy production. DOE reports the environmental effects from the new and amended standards—and from each TSL it considered for ballasts—in the environmental assessment contained in chapter 16 of the final rule TSD. DOE also reports estimates of the economic value of reduced emissions reductions resulting from the considered TSLs.

g. Other Factors

The Act allows the Secretary of Energy to consider any other factors he or she deems relevant in determining whether a standard is economically justified. (42 U.S.C. 6295(o)(2)(B)(i)(VII)) Under this provision, DOE considers subgroups of consumers that may be adversely affected by the standards established in this rule. DOE specifically assesses the impact of standards on low-income consumers, institutions of religious worship, and institutions that serve low-income populations. In considering these subgroups, DOE analyzes variations on electricity prices, operating hours, discount rates, and baseline ballasts. See section V.G for further detail.

2. Rebuttable Presumption

As set forth in 42 U.S.C. 6295(o)(2)(B)(iii), EPCA provides for a rebuttable presumption that an energy conservation standard is economically justified if the additional cost to the consumer of a product that meets the standard is less than three times the value of the first-year energy (and, as applicable, water) savings resulting from the standard, as calculated under the applicable DOE test procedure. DOE's LCC and PBP analyses generate values that calculate the payback period for consumers of potential new and amended energy conservation standards. These analyses include, but are not limited to, the 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 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 VII.B.1.c.

V. Methodology and Discussion

DOE used three spreadsheets to estimate the impact of the adopted 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 NPV impacts of new energy conservation standards. Through the third, the Government Regulatory Impact Model (GRIM), DOE assesses manufacturer impacts.

Additionally, DOE uses a version of EIA's National Energy Modeling System (NEMS) to estimate the impacts of energy efficiency standards on electric utilities and the environment. The NEMS model simulates the energy sector of the U.S. economy. The version of NEMS used for appliance standards analysis is called NEMS-BT, and is based on the *AEO2010* version of NEMS with minor modifications. The NEMS-BT accounts for the interactions between the various energy supply and demand sectors and the economy as a whole.[24]

As a basis for this final rule, DOE has continued to use the spreadsheets and approaches explained in the April 2011 NOPR. DOE used the same general methodology as applied in the NOPR, but revised some of the assumptions and inputs for the final rule in response to public comments. The following sections discuss these revisions.

A. Product Classes

In evaluating and establishing energy conservation standards, DOE divides covered products into classes by the type of energy used, or by capacity or other performance-related feature that justifies a different standard for products having such feature. (See 42 U.S.C. 6295(q)) In deciding whether a feature justifies a different standard, DOE must consider factors such as the utility of the feature to users. *Id.* DOE establishes energy conservation standards for different product classes based on the criteria set forth in 42 U.S.C. 6295(o).

For the April 2011 NOPR, DOE undertook extensive testing of fluorescent lamp ballasts to evaluate the impact of numerous ballast characteristics on BLE. Using this test data, DOE empirically found a relationship between the BLE metric and lamp arc power. In general, as lamp arc power increases, BLE increases as well. DOE believes this association is due to the fixed losses of a ballast becoming proportionally less significant at higher lamp arc powers. This relationship allowed DOE to set efficiency levels as a function of total lamp arc power across a wide range of power levels, which simplified the product class structure and the amount of scaling required among product classes. In addition, setting efficiency levels with an equation allows for easier adaption of standards to future innovations. For example, an equation could account for the introduction of new ballast factors. It would also not necessarily have to be revised if the test procedure were modified to require testing with reduced-wattage lamps, toward which manufacturers have commented the market is moving. NEMA agreed that an efficiency standard using pure electrical measurements on a ballast operating a lamp load is appropriate provided the equation accounts for different operating characteristics of the various ballast types that are grouped into each product class. (NEMA, No. 47 at p. 3) NEMA's specific comments regarding the appropriate grouping of various ballast types are discussed later in this section.

After considering several potential class-setting factors, DOE proposed in the April 2011 NOPR to separate product classes based on starting method (instant start and rapid start versus programmed start), ballasts that operate 8-foot HO lamps, and ballasts that operate 8-foot HO lamps in cold-temperature outdoor signs. DOE noted that for each of those three ballast types, a difference in utility was accompanied by a difference in the BLE predicted by the power-efficiency relationship. These three distinctions resulted in five product classes for: IS/RS ballasts that operate 4-foot MBP and 8-foot slimline lamps; PS ballasts that operate 4-foot MBP, T5 SO, and T5 HO lamps, IS/RS ballasts that operate 8-foot HO lamps, PS ballast that operate 8-foot HO lamps, and ballasts that operate 8-foot HO lamps in cold temperature outdoor signs.

[24] The EIA approves the use of the name ''NEMS'' to describe only an *AEO* version of the model without any modification to code or data. Because the present analysis entails some minor code modifications and runs the model under various policy scenarios that deviate from *AEO* assumptions, the name ''NEMS-BT'' refers to the model as used here. (BT stands for DOE's Building Technologies Program.) For more information on NEMS, refer to *The National Energy Modeling System: An Overview,* DOE/EIA–0581 (98) (Feb.1998), available at: *tonto.eia.doe.gov/FTPROOT/forecasting/058198.pdf.*

ASAP and CA Utilities commented that the reduction from the 70 product classes considered in the preliminary analysis to the five product classes proposed in the NOPR provides a simpler standard and thus facilitates compliance and enforcement. (ASAP, Public Meeting Transcript, No. 43 at p. 80; CA Utilities, No. 45 at pp. 1–2) In addition, DOE received several comments related to the inclusion of residential and commercial ballasts in a single product class, the definition of the sign ballast product class, the grouping of ballasts with different starting methods, and the potential for additional subclasses within the 8-foot HO product class. These comments are discussed in the following sections.

1. Residential Ballasts

Separate minimum power factor and electromagnetic interference requirements exist for residential and commercial ballasts. Specifically, residential ballasts have more stringent (or lower maximum allowable) EMI requirements than commercial ballasts; they also have less stringent (or lower minimum allowable) power factor requirements.[25] Based on these differing requirements, in the April 2011 NOPR, DOE concluded that residential ballasts offer a unique utility in that they serve distinct market sectors and applications. However, because the April 2011 NOPR test data indicated residential ballasts could achieve similar levels of efficiency as commercial ballasts at the highest standard levels analyzed, DOE did not propose a separate product class for residential ballasts. In response to the April 2011 NOPR, DOE received several comments regarding this conclusion.

CA Utilities agreed with DOE's proposal that a separate product class is not necessary for residential ballasts because no specific characteristic affects efficiency. They stated that residential ballasts are not subject to more stringent FCC standards for EMI because these standards only apply to devices operating at frequencies greater than 30 megahertz (MHz). Thus, CA Utilities emphasized that starting method is more relevant to the efficiency of the ballast than the distinction of residential or commercial. (CA Utilities, No. 58 at p. 4; CA Utilities, No. 45 at p. 7) NEMA disagreed, commenting that not only are residential ballasts subject to more stringent standards for EMI, but that this requirement decreases ballast efficiency. NEMA and Universal added that while they support the inclusion of residential ballasts in this rulemaking, they oppose the inclusion of residential ballasts in the same product class as commercial ballasts, given their different efficiencies and application requirements. (NEMA, No. 47 at p. 4; Universal, Public Meeting Transcript, No. 43 at pp. 76–7)

Current regulatory requirements subject residential ballasts to more stringent conducted EMI requirements than commercial ballasts. In particular, DOE notes that separate FCC standards exist for both radiated and conducted EMI emissions. The 30 MHz standards cited by CA Utilities correspond to radiated EMI emissions frequencies, not to ballast operating frequencies. Devices that operate at frequencies less than 1.705 MHz, such as fluorescent lamp ballasts, are not required to measure radiated emissions that exist at frequencies above 30 MHz; therefore, radiated EMI standards do not apply to fluorescent lamp ballasts. Ballasts with *conducted* EMI emissions in the frequency range of 0.45 to 30 MHz, however, must comply with FCC standards for conducted EMI. The conducted EMI requirements are applicable to all fluorescent lamp ballasts, but are more stringent for residential ballasts, necessitating added interference filtration in order to comply.

CA Utilities also commented that although residential ballasts are subject to a lower minimum power factor requirement, they do not necessarily have low power factors; in fact, ballasts with either high or low power factors can be installed in the residential sector. CA Utilities concluded that therefore, many high-efficiency commercial ballasts available on the market today can be used in the residential sector without issue. (CA Utilities, No. 45 at pp. 6–7) Philips agreed that ballasts with high power factors can be installed in the residential sector, noting that the ENERGY STAR program for residential fixtures may soon require some level of power factor correction. Philips commented that increased power factor correction actually reduces the efficiency of residential ballasts because the losses associated with meeting FCC Class B requirements become more significant when including power factor correction. (Philips, Public Meeting Transcript, No. 43 at pp. 77–9)

Acuity Brands added that a residential ballast that achieves the same efficiency as the most efficient commercial product would be 50 percent more expensive because of the FCC EMI requirements. (Acuity Brands, Public Meeting Transcript, No. 43 at p. 79) NEMA pointed out that that a higher price could influence consumers to migrate from fluorescent luminaires to lower efficiency incandescent or halogen fixtures. (NEMA, No. 47 at p. 4) Edison Electric Institute (EEI) also expressed concern regarding the prices of residential ballasts, stating that a separate product class for residential ballasts is needed to improve economics for residential and low-income consumers. (EEI, No. 48 at p. 2)

DOE agrees that high power factor ballasts, similar to the power factors possessed by commercial products, can be installed in the residential sector. However, the addition of a power factor correction stage to a ballast circuit substantially increases the amount of electromagnetic interference due to the presence of high speed switches. Therefore, to meet the FCC requirements for residential products, commercial ballasts would require a more significant EMI filter and thus incur additional power losses.

As stated previously, DOE determined in the April 2011 NOPR that despite the differences in power factor and EMI requirements between residential and commercial 2-lamp 4-foot MBP IS/RS ballasts, both ballast types could reach achieve similar levels of efficiency at the highest levels analyzed. Based on the similarity in efficiency, DOE included both ballast types in the same product class. Since publication of the April 2011 NOPR, however, DOE has obtained additional test data for residential ballasts that indicate a separate product class for residential ballasts is warranted. Specifically, DOE tested 4-lamp residential ballasts and was unable to confirm that it was technologically feasible for 4-lamp residential ballasts to meet the commercial ballast efficiency levels. Thus, in the August 2011 NODA, DOE considered establishing a separate product class for residential ballasts. Because DOE proposed extending coverage to residential ballasts with both IS/RS and PS starting methods, DOE considered two new product classes: (1) IS/RS ballasts that operate 4-foot MBP lamps in the residential sector and (2) PS ballasts that operate 4-foot MBP lamps in the residential sector. A separate product class for residential ballasts would allow DOE to adopt separate standard levels for these products based on their associated consumer economics.

In response to the August 2011 NODA, the CA Utilities, NEEA and NPCC, and ASAP, the American Council for an Energy-Efficient Economy, and the Natural Resources Defense Council, in a second Joint

[25] ANSI C82.77–2002 requires residential ballasts to have a minimum power factor of 0.5 and commercial ballasts to have a minimum power factor of 0.9.

Comment, disagreed with the establishment of a separate product class for residential ballasts because residential ballasts can meet the same efficiency levels as commercial ballasts. The second Joint Comment added that although the data indicates that 4-lamp residential ballasts cannot achieve the same efficiency as their commercial counterparts, DOE should not establish a separate product class for this reason. They argued that 2-lamp ballasts are far more common in the residential sector than 4-lamp ballasts, which are often installed in commercial buildings. (CA Utilities, No. 58 at p. 4; NEEA and NPCC, No. 59 at p. 3; Second Joint Comment, No. 57 at p. 1–2)

In addition, the second Joint Comment, CA Utilities, and NEEA and NPCC stated that even if there were a difference in efficiency, DOE has not demonstrated that residential ballasts provide a unique consumer utility. (Second Joint Comment, No. 57 at pp. 1–2; CA Utilities, No. 58 at p. 4; NEEA and NPCC, No. 59 at p. 3) These interested parties stated that residential ballasts are not subject to more stringent FCC requirements for electromagnetic interference. CA Utilities added that even if they were, EMI filters are available and they do not believe these components affect efficiency. These interested parties also reiterated previous comments that, while residential ballasts have lower minimum power factor requirements, this did not prevent high power factor ballasts from being installed in this market sector. The second Joint Comment, CA Utilities, and NEEA and NPCC concluded that commercial ballasts could be used in the residential sector without issue.

DOE notes that both 2-lamp ballasts and 4-lamp ballasts are used in the residential sector. In addition, while 2-lamp ballasts may be more popular in the residential sector, ballasts that operate different numbers of lamps, such as the 4-lamp ballasts described by the second Joint Comment above, provide a unique utility, as explained in the following paragraph. EPCA requires DOE to consider any lessening of the utility or the performance of the covered products likely to result from the imposition of a standard. 42 U.S.C. 6295(o)(2)(B)(i)(IV). EPCA also prohibits DOE from establishing standards that are likely to result in the unavailability of performance characteristics, features, sizes, capacities and volumes that are substantially the same as those generally available in the United States when the standard is established. 42 U.S.C. 6295(o)(4). EPCA further requires DOE to prescribe a lower energy efficiency level for product classes in which the products have a performance-related feature, considering the utility of that feature to consumers and other factors, that justifies a lower efficiency level. 42 U.S.C. 6295(q). Available data indicates that these products cannot achieve the same efficiencies as their commercial counterparts and that, therefore, a separate product class and efficiency standard is warranted.

DOE disagrees with the assertion that commercial ballasts can be used as substitutes for residential products. Although both ballasts can have high power factors, residential ballasts are subject to more stringent FCC standards for conducted EMI emissions. DOE agrees that EMI can be mitigated by the addition of a filter, but disputes the CA Utilities' claim that the filter does not affect efficiency. If a residential ballast were designed to have a high power factor, the addition of a power factor correction stage would increase the amount of conducted emissions. Thus, the residential ballast must possess a stronger EMI filter to comply with FCC requirements. DOE notes that only one T8 residential ballast in the data set had a power factor greater than 0.9, and this model did not meet the most efficient EL considered for the residential product class. For these reasons, DOE concludes that residential ballasts are less efficient than commercial ballasts and also offer unique consumer utility. Therefore, as stated above, DOE has established a separate product class for these products in this final rule.

DOE also received comments regarding the types of ballasts that should be included in the residential product class. NEMA suggested that the residential ballast product class include ballasts that operate 8-foot slimline lamps in addition to ballasts that operate 4-foot MBP lamps. (NEMA, No. 47 at p. 6) In its search of the market, DOE discovered a small number of 8-foot slimline ballasts in product catalogs that are intended for use in the residential sector. DOE also noted that residential ballasts that are designed to operate 4-foot MBP lamps can also operate 2-foot U-shaped lamps. As described above, DOE finds that residential ballasts cannot achieve the same efficiency levels as commercial ballasts and that they offer the consumer unique utility. Therefore, DOE has modified the description of the residential product class to include: (1) IS/RS ballasts that operate 4-foot MBP, 2-foot U-shaped, and 8-foot slimline lamps in the residential sector and (2) PS ballasts that operate 4-foot MBP and 2-foot U-shaped lamps in the residential sector.[26]

2. Sign Ballasts

In the April 2011 NOPR, DOE proposed establishing a separate product class for ballasts that operate 8-foot HO lamps in cold temperature outdoor signs. This proposal was based on their unique utility and associated decrease in efficiency relative to standard 8-foot HO ballasts. Sign ballasts operate outdoors in wet and cold temperature environments and have highly flexible lamp pairing possibilities, both in terms of varied individual lamp lengths and different total lamp length (sum of the length of all lamps operated by the ballast). In response to the April 2011 NOPR, DOE received comments that the proposed sign ballast product class description was not sufficient.

ASAP encouraged DOE to ensure that the definition of the sign ballast product class is sufficiently narrow. (ASAP, No. 46 at p. 2) CA Utilities commented that DOE should reevaluate the defining characteristics of sign ballasts because it does not seem to accurately capture the products for which it was intended. In particular, CA Utilities and ASAP cited the description ''ballasts that operate 8-foot HO lamps'' as problematic because it could leave out sign ballasts that are designed for other lamp lengths. (CA Utilities, No. 45 at p. 7; ASAP, No. 46 at p. 2)

DOE agrees that sign ballasts capable of operating other lamp lengths, in addition to 8-foot lamps, should be included in the sign ballast product class. However, DOE does not agree that ballasts designed to operate solely these alternate lamps, other than 8-foot HO lamps, should be considered in the sign ballast product class or scope of coverage. In determining the scope of fluorescent ballasts covered by this rulemaking, DOE's research indicated that the vast majority of sign ballasts are capable of operating 8-foot HO lamps, in addition to other lamp lengths. Because sign ballasts that cannot operate 8-foot HO lamps were so rare, there was insufficient available data to analyze the efficiency potential of these ballasts. DOE does not include those ballasts that cannot operate 8-foot HO lamps in the sign ballast product class. DOE defined the added scope of sign ballasts based on their operation of 8-foot HO lamps and assessed the BLE of sign ballasts based on their performance when

[26] PS ballasts are not used in combination with 8-foot slimline lamps because the base of these lamps only has a single pin rather than the two required for electrode heating.

operating 8-foot HO lamps. Therefore, if the sign ballast cannot operate an 8-foot HO lamp, DOE did not include it in the scope of coverage of this rulemaking.[27]

CA Utilities also commented that it is not clear in the NOPR whether the usage of the phrase ''cold temperature'' in the product class description is a key factor in the definition of sign ballasts. They pointed out that some standard commercial ballasts and NEMA Premium products are rated for negative 20 degree F temperatures. (CA Utilities, Public Meeting Transcript, No. 43 at pp. 83–5) ASAP and the CA Utilities encouraged DOE to define the sign ballast product class in a way that does not reference cold temperature operation because it is not unique to these products. If the definition does not include better identifying characteristics, the CA Utilities expressed concern that sign ballasts that are not designed for cold temperature environments might be exempt from standards (ASAP, Public Meeting Transcript, No. 43 at p. 87; CA Utilities, Public Meeting Transcript, No. 43 at pp. 89–90) CA Utilities concluded that DOE must ensure that products not intended to provide the specific utility of outdoor sign ballasts cannot be construed as outdoor sign ballasts, and that products which are intended to provide this utility are covered by the standards. (CA Utilities, No. 45 at p. 7) Universal explained that cold temperature does have an effect on efficiency and is one of several characteristics that would separate a sign ballast application from another application. GE also noted that more energy is required to strike at a cold temperature with a longer lamp and it becomes more difficult for a system to start as lamp length increases and as temperature decreases. (Universal, Public Meeting Transcript, No. 43 at pp. 84–5; GE, Public Meeting Transcript, No. 43 at pp. 86–7, 89)

Available data support the CA Utilities assertion that cold temperature is not a key factor in the description of sign ballasts. Although sign ballasts are rated to operate in cold temperature environments, often down to −20 degrees Fahrenheit, DOE surveyed the market and found that all ballast types covered by this rulemaking have product offerings that include cold temperature ratings, including 8-foot HO ballasts designed and marketed for traditional non-outdoor sign applications. While a cold-temperature rating may affect efficiency, DOE found that these cold temperature rated non-sign ballasts were among the most efficient ballasts of their respective types. Therefore, DOE agrees that the cold-temperature rating is not a descriptor specific to ballasts intended to be used in outdoor signs.

Several manufacturers described alternative characteristics for defining the sign ballast product class. Universal and Osram Sylvania (OSI) commented that a sign ballast has a much longer striking distance, which requires a much higher open circuit voltage. GE added that striking distance and open circuit voltage add to efficiency losses. (Universal, Public Meeting Transcript, No. 43 at pp. 84–5; OSI, Public Meeting Transcript, No. 43 at p. 87; GE, Public Meeting Transcript, No. 43 at pp. 86–7, 89) However, Philips pointed out that IS ballasts are not as affected by wiring distances. (Philips, Public Meeting Transcript, No. 43 at pp. 88–9) Philips also stated that outdoor sign ballasts have a different weather rating than traditional ballasts. (Philips, Public Meeting Transcript, No. 43 at pp. 88–9) GE added that many manufacturers design to higher transient ratings for protection of the ballast in its outdoor application. (GE, Public Meeting Transcript, No. 43 at pp. 86–7, 89)

In DOE's assessment of the market, electronic sign ballasts use the IS starting method and therefore may not be as affected by wiring distances and increased open circuit voltage as RS ballasts. DOE also examined the available product literature to see if the increased wiring distances led to a significant difference in open circuit voltage. Higher open circuit voltages can require different components capable of withstanding those high voltages. These components may have decreased losses due to their more rugged build. If open circuit voltage were significantly different for sign ballasts, DOE could use that voltage to define the sign ballast product class. However, because open circuit voltage information is not readily available in product specification sheets, DOE could not further specify the sign ballast product class using open circuit voltage. DOE agrees with GE that higher transient ratings might lead to increased ballast losses, but was unable to determine a typical transient rating specific to sign ballasts from product literature.

Through a review of product datasheets, DOE did find that sign ballasts have a UL Type 2 rating for the enclosure whereas regular 8-foot HO ballasts are rated for UL Type 1. Type 2 enclosures are moisture resistant and have a rust resistant coating so that the ballast can be used in plastic sign applications without a separate metal enclosure.[28] Because the UL Type 2 enclosure rating distinguishes currently commercially available sign ballasts from regular ballasts that operate 8-foot HO lamps, DOE will use this enclosure rating as a distinction in defining the sign ballast product class.

ASAP suggested that the phrase ''designed and marketed'' should be added to the product class description for sign ballasts. ASAP also commented that sign ballasts should be labeled with the designation ''for use only in outdoor signs.'' (ASAP, No. 46 at pp. 2–3) DOE agrees with ASAP that these types of descriptors should be added to strengthen the product class description. Therefore, DOE has modified the description of these products to include ''designed, labeled, and marketed for use in outdoor signs.''

In summary, in this final rule, DOE adopted the description ''ballasts with a UL Type 2 rating designed, labeled, and marketed for use in outdoor signs that operate 8-foot HO lamps'' to define the sign ballast product class. DOE finds that this description is the most specific definition that can be accurately applied to all sign ballasts. While redesign of traditional 8-foot HO ballasts to meet the definition of the sign ballast product class is possible, DOE believes this to be an unlikely scenario due to the added cost of manufacturing the UL Type 2 enclosure and resulting increased price to the end-user. Customers currently purchasing traditional 8-foot HO systems would likely not tolerate a price increase resulting from added features that are not necessary for traditional applications.

3. Starting Method

In the April 2011 NOPR, based on DOE's determination that IS and RS ballasts provide the same utility to the consumer, DOE proposed to include both of these starting methods in one product class. DOE proposed a separate product class for PS ballasts because these ballasts were less efficient yet increased lamp lifetime in frequent on/off cycling applications. NEMA commented that lower performance RS ballasts should be grouped with PS ballasts instead of IS, citing their similarity in applications and operating characteristics. (NEMA, No. 47 at p. 3, 6)

DOE acknowledges that ballasts have different operating characteristics based on starting method. For example, IS ballasts are more efficient than RS and

[27] For these same reasons, the test procedure in Subpart B of 10 CFR Part 430 Appendix Q1 specifies that a sign ballast must be tested with the maximum number of 8-foot HO (either T8 or T12) lamps it is designed to operate.

[28] Universal Lighting Technologies Inc. *The Sign Ballast Today.* 2010. *www.signasign.com/news/signindustry.html.*

PS ballasts because the latter contain extra components and use extra power to provide filament heating to the lamp, thereby increasing the lamp's lifetime. In the BLE metric, such cathode heating is counted as a loss because it does not directly contribute to the creation of light. Therefore, RS and PS ballasts will have lower BLEs than comparable IS ballasts. DOE confirmed that RS and IS ballasts were commonly used as substitutes for each other, indicating consumers find no added benefit or utility associated with RS relative to IS. Both RS and PS ballasts use cathode heating; however, only PS ballasts limit the voltage across the lamp tube to prevent glow discharge during the initial cathode heating. This prevention of glow discharge also increases lamp lifetime in frequent on/off cycling applications. DOE found PS ballasts were commonly used in conjunction with occupancy sensors (a frequent on/off cycling application). DOE determined that because of their ability to limit voltage, PS ballasts offer the user a distinct utility. As a result of this unique utility and the difference in efficiency associated with these ballasts, DOE decided to establish separate product classes for programmed start ballasts.

4. 8-Foot HO

In the April 2011 NOPR, DOE included ballasts that operate all types of 8-foot HO lamps in one product class. NEMA commented that separate product classes should be established for ballasts that operate 8-foot HO T8 lamps and those that operate 8-foot HO T12 lamps. NEMA indicated that 8-foot T8 HO ballasts are typically electronic. (NEMA, No. 47 at p. 5) Though T8 electronic ballasts are more efficient than T12 magnetic and electronic ballasts, DOE found the two ballast types were commonly used as replacements and identified no added utility associated with 8-foot T8 electronic or 8-foot T12 ballasts. Therefore, neither lamp diameter nor electronic versus magnetic ballast type justifies the creation of different product classes for 8-foot HO ballasts.

5. Summary

After evaluating potential class-setting factors, DOE has established separate product classes for programmed start ballasts, residential ballasts, ballasts that operate 8-foot HO lamps, and sign ballasts. Table V.1 summarizes the seven product classes.

TABLE V.1—FLUORESCENT LAMP BALLAST PRODUCT CLASSES

Description	Product class No.
IS and RS ballasts (not classified as residential) that operate:	1
4-foot MBP lamps	
2-foot U-shaped lamps	
8-foot slimline lamps	
PS ballasts (not classified as residential) that operate:	2
4-foot MBP lamps	
2-foot U-shaped lamps	
4-foot MiniBP SO lamps	
4-foot MiniBP HO lamps	
IS and RS ballasts (not classified as sign ballasts) that operate 8-foot HO lamps	3
PS ballasts (not classified as sign ballasts) that operate 8-foot HO lamps	4
Sign ballasts that operate 8-foot HO lamps	5
IS and RS residential ballasts that operate	6
4-foot MBP lamps	
2-foot U-shaped lamps	
8-foot slimline lamps	
PS residential ballasts that operate:.	
4-foot MBP lamps	
2-foot U-shaped lamps	7

B. Engineering Analysis

1. NOPR Approach

The engineering analysis develops cost-efficiency relationships to show the manufacturing costs of achieving increased efficiency. In the April 2011 NOPR, DOE used the following methodology to conduct its engineering analysis.

Determine Representative Product Classes and Representative Ballast Types. When multiple product classes exist, DOE selects certain classes as ''representative'' to concentrate analytical effort. The representative product classes represent the most commonly sold ballasts and the majority of the ballast shipment volume. In the April 2011 NOPR, DOE analyzed four of the then five total product classes as representative. These included, 1) IS/RS ballasts that operate 4-foot MBP and 8-foot slimline lamps; 2) PS ballasts that operate 4-foot MBP lamps, 4-foot MiniBP SO lamps, and 4-foot MiniBP HO lamps; 3) IS/RS ballasts that operate 8-foot HO lamps; 4) and ballasts that operate 8-foot HO lamps in cold temperature outdoor signs. DOE did not directly analyze PS ballasts that operate 8-foot HO lamps due to their relatively low market share.

Within each representative product class, DOE selected at least one representative ballast type for each lamp type. For the IS/RS product class, DOE analyzed ballasts that operate: Two 4-foot MBP lamps; (2) four 4-foot MBP lamps; two 8-foot slimline lamps; and two 4-foot MBP lamps in the residential sector. For the PS product class, DOE analyzed ballasts that operate: (1) Two 4-foot T5 SO lamps; two 4-foot T5 HO; two 4-foot MBP lamps; and four 4-foot MBP lamps. For the 8-foot HO IS/RS product class, DOE analyzed 2-lamp ballasts as the representative ballast type, whereas for the sign ballast product class DOE analyzed 4-lamp ballasts as representative. DOE limited its representative ballast types to include only those ballasts that exhibit a normal ballast factor [29], as this BF is most common.

Collecting and Analyzing Test Data. DOE then tested a range of ballasts from multiple manufacturers including extensive testing of the representative ballast types. DOE attempted to test

[29] DOE defines low ballast factor as being less than or equal to 0.78, normal ballast factor as being greater than 0.78 but less than 1.10, and high ballast factor as being greater than or equal to 1.10.

five [30] samples for ballasts included in the representative ballast type categories (purchased over two years) and three samples for non-representative ballast types. DOE conducted testing at two laboratories or ''labs,'' one primary lab where the majority of testing occurred and another lab to analyze possible lab-to-lab variation. DOE conducted this testing in accordance with the lamp-based ballast luminous efficiency procedure in Appendix Q1 of 10 CFR 430.

Determine Efficiency Levels. Next, using the test data, DOE empirically found a relationship between BLE and the natural logarithm or ''log'' of total lamp arc power. In general, as total lamp arc power increased, BLE increased as well. DOE's hypothesis was that this behavior was due to the fixed losses of a ballast becoming proportionally less significant at higher arc powers. DOE established efficiency levels as a natural logarithmic function of total lamp arc power based on this power-efficiency relationship.

After compiling the test data, DOE plotted BLE versus total lamp arc power for both standard and high efficiency product lines from multiple manufacturers. Based on analysis of test data for representative ballast types, DOE identified certain natural divisions in BLE. DOE then adjusted the coefficient and constant of the logarithmic power-efficiency equation to create efficiency levels that corresponded to these divisions. DOE found that the more efficient ballast product lines generally had a reduced (flatter) slope than the standard-efficiency products. To reflect this observation, DOE decreased the coefficient of the more efficient EL equations and increased the coefficient of the less efficient EL equations. In the April 2011 NOPR, DOE established three efficiency levels for each product class except for sign ballasts, for which it developed one efficiency level above the baseline level.

In developing the max tech level, DOE found that no working prototypes existed that had a distinguishably higher BLE than currently available ballasts. Therefore, DOE established TSL3 as the highest level at which a sufficient diversity of products (spanning several ballast factors, number of lamps per ballast, and types of lamps operated) was commercially available.

In the April 2011 NOPR, DOE noted that compliance certification requirements could affect the reported efficiency. The active mode test procedure requires manufacturers to report the lower of either the sample average or the value calculated by an equation intended to account for small sample sizes. DOE's analysis of its own test data showed that it was more likely that manufacturers would be reporting the compliance equation result, as it would be the lower of the two values. Thus, DOE calculated the average difference between the output of the compliance equation and the sample mean to be 0.2 percent and reduced the efficiency levels, based on average BLEs, by this value.

DOE also considered lab-to-lab variation when determining efficiency levels in the April 2011 NOPR. While DOE tested a large number of ballasts at one primary lab, DOE also tested a subset of those ballasts at a second lab to determine the magnitude of any variation. DOE found that tested efficiencies for the ballast models sent to the second lab were slightly lower (by 0.6 percent on average) than the values measured at the main test facility. DOE then applied this additional 0.6 reduction to the efficiency levels, which were based on the primary lab's test data.

Select Baseline and More Efficient Ballasts. For each representative ballast type, DOE established baseline ballasts to serve as reference points against which DOE measures changes from potential amended energy conservation standards. Generally, a baseline ballast is a commercially available ballast that just meets existing Federal energy conservation standards and provides basic consumer utility. If no standard exists for that specific ballast, the baseline ballast represents the most common ballast sold within a representative ballast type with the lowest ballast luminous efficiency. DOE selected specific characteristics such as starting method, BF, and input voltage to characterize the most common ballast. DOE also selected multiple baseline ballasts for some representative ballast types to ensure consideration of varied consumer economics. Because fluorescent lamp ballasts are designed to operate fluorescent lamps, DOE also considered properties of the entire lamp-and-ballast system. Though ballasts are capable of operating several different lamp wattages, in the April 2011 NOPR, DOE chose the fluorescent lamp most commonly used with each ballast for analysis.

DOE selected commercially available ballasts with higher BLEs as replacements for each baseline ballast by considering the design options identified in the technology assessment and screening analysis (see chapter 4 of the NOPR TSD). DOE also included two substitution cases in the engineering analysis. In the first substitution case, the consumer is not able to change the spacing of the fixture and therefore replaces one baseline ballast with a more efficient ballast. This generally represents the lighting retrofit scenario where fixture spacing is predetermined by the existing installation. In this case, light output is generally maintained to within 10 percent of the baseline system lumen output.[31] In the second substitution case, the consumer is able to change the spacing of the fixture and purchases either more or fewer ballasts to maintain light output. This represents a new construction scenario in which the consumer has the flexibility to assign fixture spacing based on the light output of the new system. In this case, DOE normalizes the light output relative to the baseline ballast.

Conduct Price Analysis. In the April 2011 NOPR, DOE developed ballast manufacturer selling prices using three main inputs: (1) Teardown data; (2) manufacturer price lists (blue books); and (3) confidential manufacturer-supplied MSPs and incremental MPC values. In general, DOE used a combination of information from teardowns and manufacturer price lists throughout the analysis and used the aggregated manufacturer-supplied MSPs for comparison purposes. DOE used ratios of online supplier retail prices to scale to ELs where data from both teardowns and manufacturer price lists were unavailable.

Scaling to Non-Representative Product Classes. DOE scales ELs from representative product classes to those product classes it did not analyze directly. In the NOPR analysis, DOE applied a two percent reduction to the efficiency levels for the 8-foot HO IS/RS representative product class to determine efficiency levels for the 8-foot HO PS product class.

Comments Received. In response to the April 2011 NOPR and subsequent NODA, DOE received comments on the available data, methodology, engineering results, and efficiency levels. All of these comments are discussed in further detail in the following sections.

[30] Because certain models were placed on backorder due to limited supply/production, only about 60 percent of representative ballast types in the April 2011 NOPR were tested with five or more samples.

[31] In some instances (*e.g.,* when switching from T12 to T8 ballasts), light output exceeds these limits.

2. Available Test Data

For the April 2011 NOPR, DOE tested more than 450 ballasts to develop proposed energy conservation standards. At the time the NOPR was published, DOE posted test data to its public Web site as Appendix 5C of the TSD. Appendix 5C contained a listing of all ballast models tested at DOE's primary lab for the April 2011 NOPR, including identifying characteristics such as lamp type operated, number of lamps operated, starting method, ballast factor, input voltage, and catalog performance value. For each ballast model, DOE also reported average [32] tested values for input power, total lamp arc power, and BLE.[33]

At the May 2011 public meeting, NEMA presented data collected from several manufacturers.[34] NEMA's data included average BLE test results from three manufacturers that were subsequently reduced by 0.8 percent to account for compliance certification requirements. Attendees of the public meeting noted that the BLE values of the most efficient ballast models tested by NEMA appeared to be less than the most efficient ballast models tested by DOE. NEMA also noted that about 60 percent of DOE's test data represented ballast models with less than four tested samples, which is not consistent with the minimum number of samples required to demonstrate compliance with DOE's standards. The CA Utilities stated that if possible, DOE should conduct testing of four or more samples to more accurately reflect the testing process that must be completed by manufacturers for certification purposes. (NEMA, No. 52 at p. 9; CA Utilities, No. 45 at p. 3)

Following the May 2011 public meeting, DOE posted to the public meeting Web site a more comprehensive set of test data used to develop the April 2011 NOPR, which specified ballasts by serial numbers, added round robin test results, and included results for each sample tested, rather than the average across several samples for each model number. DOE also purchased and tested more than 120 additional ballasts to increase tested models' sample size to a minimum of four samples consistent with compliance certification requirements in 10 CFR 429.26. Furthermore, DOE tested additional ballast models, particularly for sign ballasts and residential ballasts, to gain more market information about these products. All available test data—the NEMA-provided data, the data utilized for the April 2011 NOPR, and the results of additional testing conducted after publication of the April 2011 NOPR—were posted on DOE's Web site in conjunction with the publication of the August 2011 NODA.[35]

3. NEMA-Provided and DOE BLE Data Comparison

As described in the previous section, at the May 2011 public meeting, NEMA members presented test results for the highest efficiency NEMA Premium products. NEMA emphasized that its results represented only high efficiency products, which generally exceeded NEMA Premium efficiency requirements. Therefore the comparisons did not include hundreds of products in lower-efficiency product lines that would be eliminated at the proposed standard level. NEMA compared its results to TSL3, the proposed standard level in the April 2011 NOPR. Based on its data and analysis, NEMA determined that 88 percent of its highest efficiency products failed to meet the proposed standard level. NEMA added that these IS and PS ballasts are likely 80 to 85 percent of the total market. NEMA concluded that the implementation of the proposed standards would cause a catastrophic ballast shortage in the market. (NEMA, Public Meeting Transcript, No. 43 at pp. 25–7; NEMA, No. 98 at pp. 2, 6)

A comparison of DOE and NEMA data sets showed that BLE values reported by NEMA were consistently lower than those reported by DOE. For example, NEMA noted that its data showed no ballast with a BLE higher than 91 percent at 50 watts, while DOE's data showed a BLE as high as 94 percent at the same wattage. NEMA also found that the variation between samples of each ballast model was much smaller within manufacturer-provided data than within DOE's data. NEMA underscored the significance of its data, stating that it would submit data derived using these same methods to demonstrate compliance with new standards. (NEMA, Public Meeting Transcript, No. 43 at pp. 47–8, 50, 99; NEMA, No. 98 at p. 6)

Earthjustice, Northwest Energy Efficiency Alliance (NEEA), ASAP, NEEP, and the CA Utilities emphasized the importance of determining the cause of the differences between DOE and NEMA test data. (Earthjustice, Public Meeting Transcript, No. 43 at p. 66; NEEA, Public Meeting Transcript, No. 43 at pp. 120–1; ASAP, Public Meeting Transcript, No. 43 at pp. 46–7; NEEP, No. 49 at pp. 1, 2; CA Utilities, Public Meeting Transcript, No. 43 at p. 62; CA Utilities, No. 45 at p. 2) NEEA noted that the source of the discrepancy between DOE and NEMA data should be determined before any efficiency levels are fit to either data set. (NEEA, Public Meeting Transcript, No. 43 at pp. 138–9) Acuity Brands suggested DOE divide its test data according to manufacturer and compare it with the test data from the individual manufacturers obtained under non-disclosure agreements. (Acuity Brands, Public Meeting Transcript, No. 43 at p. 149)

ASAP suggested DOE continue to use its own data for the final rule analysis and any supplemental data provided by manufacturers should be assessed in its raw form to ensure comparability with DOE data. (ASAP, No. 46 at p. 1) CA Utilities also advised DOE to continue to use its own test results for the final rule unless it determined a specific fault with the testing process of the labs used by DOE. (CA Utilities, No. 45 at p. 4)

Following the May 2011 public meeting, under non-disclosure agreements, several manufacturers provided the model numbers and efficiencies for the ballasts included in NEMA's data set. Upon receiving this information, DOE conducted a comparative analysis between NEMA data and DOE's independently tested data. DOE published the results of its analysis in the August 2011 NODA. DOE concluded that its data collection methods were consistent with Appendix Q1 of 10 CFR 430 and that, after removing NEMA's reduction factor as discussed in section V.B.3.a, the remaining differences between the two data sets arise primarily from normal measurement variation. Subsequent comments received on the NODA reaffirmed DOE's conclusions. Therefore, for this final rule, DOE continued to use its own data and utilized NEMA-provided data for comparison. The sections below detail DOE's comparative analysis and discuss several comments by interested parties suggesting possible sources of differences between the two datasets.

a. NEMA Reduction Factor

As described above, the data contained in NEMA's presentation at

[32] The average across several samples for each model number.

[33] DOE obtained these values in accordance with the active mode test procedure in Appendix Q1 of 10 CFR 430.

[34] These test results were contained in a Power Point presentation that was subsequently posted to the public meeting Web site at: *http://www1.eere.energy.gov/buildings/appliance_standards/residential/fluorescent_ballasts_nopr_public_meeting.html.*

[35] The August 2011 NODA and accompanying data are available here: *www1.eere.energy.gov/buildings/appliance_standards/residential/notice_of_data_availability.html.*

the May 2011 public meeting represented the mean of four or five samples decreased by 0.8 percent to account for compliance certification requirements. To calculate this 0.8 reduction factor, NEMA referred DOE to an analysis NEMA submitted in a comment in response to the preliminary TSD. In that analysis, NEMA calculated the 0.8 percent reduction factor based on application of the certification equation described in 10 CFR 429.26. NEMA assumed that each sample set's three standard deviation spread was equal to five percent of the mean efficiency (2.5 percent for design variation and 2.5 percent for measurement variation). NEMA then calculated a mean efficiency adjustment factor (from sample sizes of four and five) by inserting this standard deviation into the certification equation. This adjustment factor represented NEMA's estimate of the percent difference between the sample mean and the value NEMA anticipated reporting to DOE for certification. CA Utilities commented that NEMA's reduction of its test results by 0.8 percent may have been a misinterpretation of the test procedure and could have caused the discrepancy between DOE's and NEMA's BLEs. (CA Utilities, No. 45 at p. 2) ASAP agreed that DOE should not directly compare its data to NEMA's reduced points. (ASAP, No. 46 at p. 1)

In the August 2011 NODA, DOE stated that to understand potential discrepancies between NEMA and DOE's test data, it was necessary to ensure that similar calculation methodologies had been undertaken for the two data sets. Therefore, for the purpose of comparing the efficiency data, DOE removed the 0.8 percent reduction factor from NEMA's presented ballast efficiencies, resulting in values that represented mean tested efficiencies. DOE compared these efficiency values to DOE's mean tested efficiencies presented in the April 2011 NOPR.

b. Arc Power Versus Rated Power

Due to the relationship between total lamp arc power and ballast efficiency, in the April 2011 NOPR, DOE proposed establishing efficiency levels as logarithmic equations dependent on total lamp arc power. When NEMA plotted their test data against the DOE proposed efficiency levels, however, NEMA paired their ballast efficiency test data with approximated arc powers rather than measured arc powers. CA Utilities and NEEA and NPCC noted that NEMA appeared to list a batch of products all at the same ''rated power,'' and compared the performance of all of those products against the same BLE standard. They stated that their understanding was that standards are to be calculated based on the measured lamp arc power specific to each ballast, not the rated lamp power. (NEEA and NPCC, No. 44 at p. 5; CA Utilities, No. 45 at pp. 2–3)

DOE agrees that total lamp arc power, measured in accordance with the active mode test procedure, should be used when comparing manufacturer-provided data to DOE's efficiency levels. In the August 2011 NODA, DOE noted that the lamp arc power associated with a particular ballast in NEMA's data was an approximation rather than a test result. DOE found NEMA's approximation to be higher than typical test results in DOE's data set, with differences as high as 27.6 percent. As this discrepancy could potentially cause NEMA's test data to appear to have artificially lower efficiencies relative to DOE's efficiency levels, DOE revised NEMA's approximate lamp arc powers using ANSI reference lamp arc powers to calculate total expected lamp arc power. 76 FR 52892, 52895–6 (August 24, 2011). These lamp arc powers better aligned with expected total lamp arc powers for similar ballast types. DOE used these calculated powers when comparing the efficiency levels to the manufacturer-provided data as discussed in section V.B.5.

c. Test Procedure and Lab Accreditation

NEMA commented that the difference between the data it collected and DOE's results may be due to DOE's labs not having proper accreditation. NEMA stated that all of the labs used for its testing were certified according to ANSI C82.11–2002 and DOE should only test in similarly certified labs. NEMA specifically noted that it did not believe the Lighting Research Center (LRC) was ANSI C82.11–2002 certified. (NEMA, Public Meeting Transcript, No. 43 at pp. 30, 116) GE emphasized that labs should be accredited in accordance with ISO 17025, which is a definition of laboratory performance and accreditation for test equipment and test engineers using that equipment. (GE, Public Meeting Transcript, No. 43 at p. 116) Similarly, CA Utilities suggested that the difference between NEMA's and DOE's test results could be because the BLE test procedure is new and may require clarification. (CA Utilities, No. 45 at p. 2)

DOE notes that 10 CFR 430.25 requires testing of fluorescent lamp ballasts to be performed in accordance with Appendix Q1 of 10 CFR part 430 Subpart B by test laboratories accredited by National Volunteer Laboratory Accreditation Program (NVLAP) or a NVLAP-recognized organization, Underwriter Laboratories, or Council of Canada in accordance with ISO 17025. 76 FR 25211, 25219 (May 4, 2011). ISO 17025 is an international standard that outlines general requirements for the competence of testing and calibration laboratories. NVLAP operates an accreditation system that requires applicant laboratories to be assessed against all ISO 17025 requirements.

As described in the August 2011 NODA, DOE contacted both test laboratories utilized for DOE testing and verified each is properly accredited and that all testing was conducted in accordance with the active mode test procedure in Appendix Q1. CA Utilities stated that this action greatly improved the overall credibility of DOE's dataset. (CA Utilities, No. 58 at pp. 1–2) Given the verification of data collection methods, DOE continues to use its own data in this final rule.

d. Sample Size

NEMA also commented that the number of samples tested for several ballast models was too small, potentially resulting in test data unrepresentative of the mean efficiencies of the ballast model's population. They pointed out that about 60 percent of DOE's test data represented an average efficiency calculated with fewer than four samples, which is less than the minimum number of samples required to demonstrate compliance with DOE's standards. (NEMA, No. 52 at p. 9) CA Utilities also stated that if possible, DOE should conduct testing of four or more samples to more accurately reflect the testing process that must be completed by manufacturers for compliance. (CA Utilities, No. 45 at p. 3)

Since the publication of the April 2011 NOPR, DOE has conducted additional testing to increase the sample size of selected ballast models. More than 90 percent of tested ballast models now have a minimum of four samples. Only in those cases where models have been discontinued or were unavailable for purchase was DOE unable to test a minimum of four samples. DOE posted a complete set of test data on its Web site at the time the August 2011 NODA was published.

CA Utilities and NEEA and NPCC commended DOE for conducting additional testing to increase the sample size to a minimum of four ballast samples, consistent with the certification requirements in 10 CFR 429.26. NEEA and NPCC stated that the additional testing conducted improved the dataset's accuracy and credibility, which contributed to the development of appropriate standard levels. (CA Utilities, No. 58 at p. 2; NEEA and NPCC, No. 59 at p. 2) DOE discusses how it utilized all available data in sections V.B.4 and V.B.5.

e. Measured Versus Calculated BLE

In response to the April 2011 NOPR, NEMA commented that it found several samples of DOE test data in which the measured BLE reported in appendix 5C of the NOPR TSD was not consistent with the BLE calculated by NEMA. Though some of the differences were small, NEMA provided examples of four ballast models with differences up to 8 percent. (NEMA, Public Meeting Transcript, No. 43 at pp. 28–9) DOE addressed these discrepancies in the August 2011 NODA.

For the small discrepancies identified by NEMA, DOE noted that the information provided by NEMA was consistent with calculating the BLE values by dividing the average arc power of all samples by the average input power of all samples. This method is not consistent with the active mode test procedure. In contrast, DOE's average BLE reported in appendix 5C of the TSD was determined, as required in the test procedure, by averaging the BLE of each individual sample. Based on DOE's analysis, this difference in methodology accounts for the small discrepancies observed between the values reported in appendix 5C and those calculated by NEMA.

DOE also worked to resolve the large differences cited by NEMA. DOE identified six samples with measured-versus-calculated BLE differences ranging from 7.8 to 8.0 percentage points, which included the specific examples cited by NEMA. These six samples were all magnetic ballasts; in accordance with the active mode test procedure (see Table A, Appendix Q1 of 10 CFR part 430 Subpart B), DOE calculated BLE for these samples by reducing the measured ballast efficiency (total lamp arc power divided by ballast input power) by a frequency adjustment factor (1.00 for high-frequency ballasts and values ranging from 0.93 to 0.95 for low-frequency ballasts). These larger discrepancies are consistent with NEMA not including this adjustment factor in its calculation of BLE. Thus, given the above explanation and the absence of any additional comments regarding this subject, DOE's measured BLE values are correctly calculated and consistent with the active mode test procedure.

f. Ballast Factor

NEMA also identified differences in appendix 5C of the NOPR TSD between catalog and tested values for ballast factor, in some cases as large as 10 or 15 percent. NEMA reported that based on its own tests, it would expect the average difference between catalog BF and tested BF to be 1.5 percent. (NEMA, Public Meeting Transcript, No. 43 at pp. 27–8) DOE acknowledges that there might be differences between ballast factor values reported in catalogs and DOE's test data. Catalogs generally report ballast factor using the procedure in Appendix Q of 10 CFR part 430 subpart B, which requires photometric measurements. DOE calculated ballast factor in the April 2011 NOPR using electrical measurements by measuring the lamp arc power for the test ballast and dividing it by the reference lamp arc power as specified by ANSI standards. Available information suggests that manufacturing variation, coupled with application of a different test procedure to determine BF, accounts for the difference between catalog BF and DOE measured BF. Because DOE did not establish product classes or standards using BF and the active mode test procedure final rule did not adopt a new method for its calculation, however, ballast factor is not relevant to this rulemaking.

g. Variation Within DOE's Data

Stakeholders also questioned the variation present within DOE's data and offered several suggestions on how to measure variation within the test results. Lutron and NEMA suggested DOE perform a gauge repeatability and reproducibility (R&R) analysis, a recognized technique to reconcile differences among measurements. (Lutron, Public Meeting Transcript, No. 43 at pp. 118–9; NEMA, Public Meeting Transcript, No. 43 at p. 121) Philips suggested that DOE look at the variation among each unit and among each lab, and then use the total variation to conduct a 3-sigma [36] analysis. Philips noted, however, that three samples is not a very statistically large sample size in examining this kind of variation. (Philips, Public Meeting Transcript, No. 43 at p. 113)

As described in the previous sections, DOE evaluated several factors to verify the integrity of its data. DOE has confirmed that testing was conducted in accordance with the active mode test procedure and that its calculations of BLE are accurate. Furthermore, additional testing has increased sample size such that it is consistent with compliance certification requirements. After accounting for the above items, DOE believes that variation in its data reflects expected measurement, design, and lab-to-lab variation. DOE addresses these sources of variation in the following sections.

4. Accounting for Variation and Compliance Certification Requirements

In the April 2011 NOPR, DOE accounted for lab-to-lab variation and compliance certification requirements by calculating reduction factors for each and adjusting the efficiency levels accordingly. DOE calculated a 0.6 percent reduction factor for lab-to-lab variation by comparing the data from the primary laboratory, which conducted the majority of DOE's testing, with data from its secondary laboratory, which tested a limited number of identical samples. DOE applied the 0.6 percent lab-to-lab variation reduction to the efficiency curves so that the standard level could, on average, be met by ballasts tested at the less efficient lab. To account for certification requirements, DOE calculated the difference between the output of the compliance certification equation in 10 CFR 429.26 and the sample mean of DOE's test data to be 0.2 percent. As DOE's certification requirements at 10 CFR 429.26 require manufacturers to report the lower of these two values, DOE reduced the efficiency levels, based on average BLEs, by this value.

OSI and Lutron Electronics Co., Inc. (Lutron) commented that in addition to lab-to-lab variation, both design and measurement variation need to be taken into account when setting a standard to make sure that the average of different tested samples will meet the minimum BLE requirements. OSI commented that design tolerances exist because different components are used in different production runs. OSI estimated this variation to be about two percent. (OSI, Public Meeting Transcript, No. 43 at pp. 137–8, 152; Lutron, Public Meeting Transcript, No. 43 at pp. 151–2)

NEMA submitted analyses in response to the NOPR recommending modifications to DOE's methodology of accounting for certification requirements and variation. NEMA's first analysis used an assumed design variation and measurement variation (each 2.5 percent) in the compliance certification equation to adjust each ballast efficiency data point. After analyzing the more detailed set of data posted after the May 2011 public meeting, NEMA submitted a similar analysis but used an assumed design variation and a calculated measurement variation. NEMA then suggested that

[36] 3-sigma is a statistical calculation that refers to data within three standard deviations from a mean. It is based on the rule that for a normal distribution, nearly all values lie within three standard deviations of the mean.

DOE base its efficiency levels on the adjusted data points rather than mean BLE values. Specifically, NEMA determined the mean BLE for each ballast model by averaging all tested values of that particular model. NEMA then calculated the maximum measurement variation across labs for each category of fluorescent lamp ballast (*e.g.,* 4-foot MBP, 4-foot MiniBP, or 8-foot high output). NEMA added this highest calculated measurement variation for each ballast type to a 2.5 percent assumed design tolerance to characterize the total variation. NEMA then entered these variations into the compliance equation to calculate a reduction factor based on sample size of each tested model. NEMA commented that DOE should make similar allowances in the standard levels to account for the variation present in DOE's own data. (NEMA, No. 52 at pp. 8–10)

The CA Utilities also conducted an analysis using the data DOE provided following the May 2011 public meeting. They agreed with NEMA that compliance certification requirements should be considered when assessing whether products will meet each standard level. However, they pointed out that NEMA had employed methods to characterize the certification procedures that were not consistent with the requirements specified in 10 CFR 429.26. Instead, the CA Utilities used individual samples of DOE's efficiency data to calculate both the sample mean and the value determined by the compliance certification equation in 10 CFR 429.26. Then, as directed by the compliance certification regulations, they represented the reported efficiency as the lower of the two values. They suggested that DOE base its efficiency levels on these reported values. (CA Utilities, No. 45 at pp. 3, 4–5)

Consistent with the April 2011 NOPR, DOE recognizes the importance of considering the variation present in the test data when developing efficiency levels. DOE acknowledges that due to design and measurement variation, the reported value for compliance certification may deviate from the sample mean and this difference must be accounted for. As described in the following sections, DOE has modified its approach to account for variation and compliance certification procedures based on the comments provided.

a. Design Variation and Compliance Certification Requirements

As stated earlier, 10 CFR 429.26 requires manufacturers to test a minimum of four fluorescent lamp ballasts and report the lower of either the mean efficiency of the samples or the output of a compliance certification equation based on the lower 99 percent confidence limit of the sample. The lower 99 percent confidence limit equation requires a calculation of the standard deviation of the sample set to account for measurement variation. Because over 90 percent of ballast models tested by DOE include samples obtained during two different years, the standard deviation for these models also incorporates design variation that is present in the sample set.

Both NEMA and the CA Utilities had previously commented that, in order to develop efficiency levels, DOE should adjust its mean efficiency data points to represent values similar to those manufacturers would report to DOE for compliance certification. However, their approaches differed in how they computed the standard deviation input for the compliance certification equation. The CA Utilities calculated the standard deviation among all samples of a particular ballast model tested at a single lab. NEMA, however, calculated the standard deviation by assuming a 2.5 percent design variation and then adding an additional factor based on DOE's lab-to-lab test data for each ballast category.

In the August 2011 NODA, DOE disagreed with NEMA's method of applying the compliance certification requirements. First, the compliance requirements direct manufacturers to calculate the standard deviation of the tested sample, rather than an assumed population standard deviation. Second, in practice, this calculation would likely not include data from more than one lab unless manufacturers chose to test their samples of a single ballast model at more than one location. DOE agreed that lab-to-lab variation was important, but considered accounting for it as a separate adjustment to efficiency levels as discussed below in section V.B.4.b.

The CA Utilities evaluated both the sample mean and compliance equation for each ballast model and compared the lower of the two, the reported value, to the standard level. DOE believed the CA Utilities' approach for accounting for compliance certification requirements was consistent with the procedures laid out in 10 CFR 429.26 and therefore, in the August 2011 NODA, considered using this methodology for the final rule. To facilitate this approach, as discussed earlier, DOE conducted additional testing after publication of the NOPR to increase the sample size of several ballast models in accordance with compliance certification requirements. To account for these requirements, DOE calculated a new data set that represented the reported value for all ballast models. DOE used these reported values to develop the efficiency levels described in the August 2011 NODA.

CA Utilities and NEEA and NPCC supported DOE's methodology of accounting for certification requirements when setting standard levels. They stated that the use of reported values accounts for design variation within a product line and measurement variation among multiple test runs within a single lab. These organizations also commented that this approach is more accurate than DOE's previous proposal to apply a 0.2 percent reduction to all efficiency levels. (CA Utilities, No. 58 at p. 2; NEEA and NPCC, No. 59 at p. 2)

NEMA, however, disagreed with the methodology presented in the August 2011 NODA. Specifically, NEMA claimed that the correction factor they calculated is essential to account for manufacturing and component variance. NEMA commented that because DOE's samples were acquired when market demand was low, the manufacturing variation present in DOE's test data was not representative of typical variation. They reasoned that manufacturers could be more selective when purchasing components for products manufactured during that time period. Under normal market conditions, manufacturers compete for the same component supply and often obtain parts that vary in quality and cost. NEMA commented that DOE should have tested a statistically representative sample set for each model (*i.e.,* a larger sampling from multiple productions lots, assembled over time) and that, absent this, DOE should have used a statistically derived method for determining an appropriate reduction rather than empirical data. (NEMA, No. 56 at pp. 2, 4)

As described previously, DOE believes that NEMA's recommended 0.8 percent reduction does not reflect appropriate certification procedures. As stated in 10 CFR 429.26, manufacturers are required to evaluate the certification equation using the standard deviation of the samples tested, not the expected variation in the population. Furthermore, NEMA included lab-to-lab variation when calculating its reduction factor. This calculation would likely not include data from more than one lab, however, unless manufacturers chose to test their samples of a single ballast model at more than one location. In addition, NEMA utilized a normal distribution critical value for the 99th percentile rather than the specified t-statistic for the 99th percentile in evaluating the compliance equation.[37]

As explained in the preceding paragraphs, DOE considered both design variation and certification requirements when developing efficiency levels using the methodology presented in the August 2011 NODA. DOE purchased samples over several years, encompassing more than one production lot. While NEMA states that DOE purchased samples at a time when manufacturers could easily obtain the most efficient components, DOE also purchased ballasts (for the purpose of increasing sample size) during years in which interviewed manufacturers stated that they faced component shortages. Furthermore, consistent with 10 CFR 429.26, over 90 percent of models tested had a sample size of 4 or more. For these reasons, DOE continues to use the methodology described in the August 2011 NODA in this final rule.

NEMA commented that half of all borderline but compliant products will fail to meet the standard if an adjustment factor is calculated using average empirical data, such as DOE's method described above. (NEMA, No. 56 at p. 2) DOE notes that the certification requirements do not mandate that every sample tested must meet or exceed the standard level, rather they require that the average of the tested samples meet or exceed the standard. A compliant product may still have samples that test below the standard, provided that the average BLE meets or exceeds the level adopted in this final rule. NEMA's concern may be regarding a situation where all ballast samples are selected from a production run in which lower-quality components cause all samples to test at the lower end of the expected range attributable to design variation. However, there is no requirement that all samples be selected from the same production run. In fact, 10 CFR 429.26 states that samples should be randomly chosen. Manufacturers can also choose to test more than the minimum number of samples to address concerns about a borderline product.

b. Lab-to-Lab Variation

As described in section V.B.1, DOE accounted for lab-to-lab variation in the April 2011 NOPR by comparing data from two different labs and calculating a 0.6 percent reduction factor to apply to efficiency levels. NEMA noted that DOE's data showed significant variation between labs and stressed the importance of accurately quantifying this variation. (NEMA, Public Meeting Transcript, No. 43 at pp. 140–1) NEMA pointed out that DOE typically only used one lab to make measurements rather than validating variation using multiple labs. (NEMA, No. 52 at p. 7) Philips suggested that, after evaluating data among multiple labs, DOE should apply a reduction representative of the maximum variation present in the data rather than average variation. (Philips, Public Meeting Transcript, No. 43 at p. 113–5)

In the August 2011 NODA, DOE considered revising its methodology to account for lab-to-lab variation. DOE received test data from NEMA following the May 2011 public meeting and also received test data from NEMA-member manufacturers. The information from manufacturers allowed DOE to match NEMA test data with the same ballast models tested at DOE's primary and secondary labs. Using the model-specific test data supplied by manufacturers (representative of three different manufacturer labs) and DOE's BLE data (representative of the two labs used by DOE), DOE determined that on average, the BLE test data from DOE's primary lab was 0.7 percent more efficient than the average test lab. DOE attributed this offset to systematic lab-to-lab variation and therefore considered reducing the efficiency levels by 0.7 percent so that they are representative of ballasts tested at the average test lab. This approach was slightly different than that taken in the April 2011 NOPR, which applied a 0.6 percent reduction to efficiency levels, representing the average offset between DOE's primary lab and the least efficient lab (in that case, DOE's secondary lab). DOE believed that adjusting efficiency levels so that they represent the average test lab better characterized the mean performance of products currently being sold.

CA Utilities, NEEA, and NPCC commented that DOE should not use NEMA's data to calculate lab-to-lab variation. CA Utilities stated that because NEMA provided an approximation for arc power instead of measured arc power, their data is not useful for assessing lab-to-lab variation. They suggested DOE use its own data from the primary and secondary test labs to quantify this type of variation. (CA Utilities, No. 58 at p. 2; NEEA and NPCC, No. 59 at p. 2)

DOE believes that NEMA's data reflects correct application of the active mode test procedure, given confidential data received from individual manufacturers and NEMA's description of testing provided during the public meeting. (NEMA, Public Meeting Transcript, No. 43 at p. 51) Although interested parties expressed concern that NEMA did not provide the measured lamp arc power for each model, DOE notes that its approach for calculating lab-to-lab variation does not incorporate measured lamp arc power. Rather, DOE directly compares the BLE for a given ballast model to the BLE provided by NEMA for the same model. Although some stakeholders suggested that DOE only utilize its own results, DOE believes it should incorporate all available data. By doing so, the number of labs included in the calculation increases from two to five and the number of models available for comparison between labs increases as well. Therefore, DOE maintains the methodology described in the August 2011 NODA for this final rule.

5. Efficiency Levels

a. Curve Shape

As described in section V.B.1, DOE concluded in the April 2011 NOPR that a logarithmic relationship best modeled the observed trend between total lamp arc power and BLE and therefore proposed efficiency levels using this equation form. Several manufacturers commented that, based on the test data they collected, the shape of the proposed efficiency levels was not a good fit for all commercially available products. GE commented that it found larger discrepancies between its test data and minimum BLE requirements for ballasts with lower input power than higher input power. GE reported that none of its ballasts met the proposed standard efficiency in the low power range. (GE, Public Meeting Transcript, No. 43 at p. 58) NEMA also noted that at approximately 80 W and below, very few manufacturers had products meeting the programmed start minimum BLE requirements. (NEMA, Public Meeting Transcript, No. 43 at pp. 66–7; NEMA, No. 47 at p. 6) NEMA suggested an alternative equation in which they increased the natural log constant and decreased the additive constant to increase the curvature of the proposed standard and better fit the dataset. (NEMA, Public Meeting Transcript, No. 43 at p. 59) NEMA also recommended breaking up the power ranges into separate product classes to have the formulas fit the test data better and suggested a breaking point somewhere in the 50 to 100W range. (NEMA, Public Meeting Transcript, No. 43 at pp. 75–6)

Acuity Brands expressed concern that DOE was not considering can size when

[37] The compliance equation found in 10 CFR 429.26 requires the use of a t-statistic, to calculate the reported value. NEMA used a different statistical distribution, the standard normal distribution, in the calculation of its reduction factor.

determining what types of ballasts met proposed standards. NEMA reported that consumer demand has moved the ballast market into smaller can sizes, specifically to A- and N-cans, from F-cans. NEMA stated that three representative ballast types in A-cans currently make up 80 percent of the total U.S. market, and the market is in the process of migrating to even smaller N-cans. NEMA explained that smaller ballasts enable reduced fixture size and plenum height in buildings. Not only is this convention in accordance with green building practices, but smaller can sizes allow for a reduction of gas and waste, and a 10 to 15 percent reduction of steel in the manufacturing process. NEMA and Acuity Brands added that the smaller can sizes also increase the photometric efficiency of the fixture by two to six percent (for fixtures housing an A-can compared to an F-can). The small can allows better optical control and fuller use of the reflector as the thinner ballast housing blocks less light than larger cans. The smaller ballasts are also easier to access in the event that the ballast needs replacing. The limited space constrains the technology and components used, however, limiting possible efficiency gains. NEMA argued that, given the size of A- and N-cans, industry is currently developing the highest practical efficiency with NEMA Premium products. NEMA emphasized that while ballasts in the larger F-can can have higher efficiencies, consumer demand and fixture design makes moving to larger cans unsustainable. Acuity Brands asserted that if standard levels eliminate the smaller can sizes, DOE must, in its analysis, account for the additional costs of fixture redesign, engineering time, and incremental transportation costs. (NEMA, Public Meeting Transcript, No. 43 at pp. 32–3, 35–7; Acuity Brands, Public Meeting Transcript, No. 43 at pp. 99–100, 107–9, 171–2)

CA Utilities and NEEA and NPCC commented that lower standards are not needed to accommodate ballasts of the smallest can size, and CA Utilities noted that they were not aware of any unique utility provided by N-cans. CA Utilities also stated that NEMA had not presented data demonstrating that N-cans are less efficient than A-cans or that smaller can size can reduce the use of steel. (CA Utilities, No. 45 at p. 6) NEEA and NPCC strongly urged the Department to proceed with the proposed standards unless conclusive data is presented on these issues that would suggest a different standard is warranted. (NEEA and NPCC, No. 44 at p. 8–9)

Upon analysis, NEMA's test data showed a larger efficiency decrease at lower wattages than DOE's data indicated. Although DOE and NEMA generally tested the same types of ballasts, NEMA tested more permutations of ballast factor and number of lamps for each product line, particularly at lower wattages. For example, NEMA's data contained BLE values for 1-lamp 4-foot MBP ballasts with both low and high ballast factors, whereas DOE's data included 1-lamp 4-foot MBP ballasts with only normal ballast factors. For these reasons, in the August 2011 NODA, DOE considered changing the contour of the efficiency levels to better fit all of the available data. DOE acknowledges that industry is migrating to smaller can sizes, and the methodology described below allows ballasts with small can sizes to remain on the market.

Stakeholders had provided comments on a potential new equation form during the May 2011 public meeting, when DOE presented a power law equation fit to the data provided by NEMA. Several manufacturers commented that upon initial review, the new power law equation appeared to be a better fit to the NEMA data. (Philips, Public Meeting Transcript, No. 43 at pp. 136–7, NEMA, No. 47 at p. 3 OSI, Public Meeting Transcript, No. 43 at pp. 137–8) NEMA further stated that the logarithmic equation in the April 2011 NOPR was more stringent at lower wattages relative to higher wattages. A lower wattage ballast's efficiency is more affected by fixed losses than a higher wattage ballast. The new power law equation seemed to accommodate this difference in efficiency (NEMA, No. 47 at p. 11)

NEEA and NPCC supported the use of a logarithmic equation dependent on lamp arc power and based on the data presented by DOE in the April 2011 NOPR. However, NEEA and NPCC noted that the NEMA data does have a different shape and could be better fit by the power law equation presented during the May 2011 NOPR public meeting. The CA Utilities agreed, stating that the data supported the new curve shape. (NEEA and NPCC, No. 44 at p. 4–6; CA Utilities, No. 45 at p. 5–6)

Based on an application of several equation forms for efficiency levels, DOE concluded in the August 2011 NODA that a power law equation fit both the NEMA data and DOE data better than the logarithmic relationship proposed in the April 2011 NOPR. A power law equation takes the form:

$$BLE = \frac{A}{1 + B * power^{-C}}$$

Where: *power* = average total lamp arc power.

The exponent "C" determines the shape of the equation. Because NEMA's test data included a greater number of low wattage ballasts, DOE determined the exponent "C" by fitting a power law regression to NEMA's data. For the IS/RS product class (product class 1 in Table V.1), DOE found the exponent "C" to be 0.25. The exponent 0.25 is also a quantity used in relating power to relative losses (analog of efficiency) for distribution transformers, and fluorescent lamp ballasts similarly employ transformers and inductors. The PS NEMA data, however, yielded a different exponent for ballasts that use the PS starting method. PS ballasts have proportionately higher fixed losses due to internal control circuitry and heating of lamp electrodes (cathode heating). As such losses are a larger proportion of total losses at lower powers, the PS product classes have a steeper slope across the range of wattages corresponding to a larger exponent "C" of 0.37.

Once the exponents were established for the two starting method categories, DOE fit the power law equation to the reported value data (calculated in accordance with 10 CFR 429.26 as discussed in section V.B.4) by adjusting the coefficient "B" to delineate among criteria such as different product lines, lines, ballasts that operate different lamp types, and other clusters in efficiency data. The most efficient (maximum technologically feasible) ELs approximate the April 2011 NOPR proposals for the highest wattages, but better follow product line efficiency trends at lower wattages. DOE confirmed the impacts of efficiency levels considered in the August 2011 NODA by comparing the levels to both DOE's and NEMA's data.

In subsequent comments, NEMA supported the use of a power law equation to develop efficiency levels.

(NEMA, No. 56 at p. 3) DOE received no adverse comment regarding this approach, and therefore maintains the use of this equation form for the final rule.

b. Max Tech Ballast Efficiency

As described in the April 2011 NOPR and appendix 5D of the NOPR TSD, DOE was not able to identify any working prototypes with efficiencies higher than those of commercially-available ballasts. DOE therefore established the maximum technologically feasible efficiency level as the highest level that is technologically feasible for a sufficient diversity of commercially available products (spanning several ballast factors, number of lamps per ballast, and types of lamps operated) within each product class.

NEEA and NPCC agreed that no additional information suggests that higher efficiency levels exist above the most efficient levels analyzed for each product class in the April 2011 NOPR. (NEEA and NPCC, No. 44 at p. 6) NEMA reiterated this point by commenting that there were no improvements possible over the level of efficiency proposed by DOE in the April 2011 NOPR. NEMA stated that electronic ballasts perform functions that require some fixed level of power consumption including: Switching losses related to power conversion from AC to DC and back to AC, cathode preheating, striation control, and end of life protection. NEMA commented that using lower loss switches would increase cost dramatically, and that lower loss magnetic components would necessitate an overall increase in ballast size, which the market would not accept. (NEMA, No. 47 at pp. 6–7)

The CA Utilities, NEEA and NPCC, and the second Joint Comment commented that the max tech levels could be more stringent for higher wattage ballasts such as those that operate four 4-foot MBP lamps. They noted that among the 4-lamp 4-foot MBP IS/RS ballasts tested by DOE, a high percentage met the max tech level, and there was typically a greater range of efficiency among those ballasts that met the standard. (CA Utilities, No. 45 at p. 5–6; Second Joint Comment, No. 57 at p. 1; CA Utilities, No. 58 at p. 3; NEEA and NPCC, No. 59 at p. 2)

DOE determined the max tech level for today's final rule to be the highest level that is technologically feasible for a sufficient diversity of lamp types, ballast factors, and numbers of lamps, regardless of manufacturer. DOE developed EL3 for the IS/RS product class in accordance with this criteria. For some ballast types in this class, there is only one product available at the max tech level and therefore raising this level would remove these products from the marketplace. Therefore, DOE has concluded that EL3 represents the highest level for the IS/RS product class that is technologically feasible for a sufficient diversity of products and maintains this level for the final rule. The following sections describe the impact of each efficiency level in more detail.

c. IS and RS Ballasts

DOE developed three efficiency levels for the IS/RS product class. The least efficient level (EL1) was designed to eliminate 4-foot MBP T12 ballasts while allowing 4-foot MBP T8 and 8-foot slimline ballasts to comply with energy conservation standards. EL2 corresponds to a level which allows the highest-efficiency product lines from each of the four major ballast manufacturers to comply. DOE defines a full product line as spanning a sufficient diversity of products (spanning several ballast factors, numbers of lamps per ballast, and types of lamps operated). EL3 is the maximum technologically feasible level and allows nearly two manufacturer product lines comply.

d. PS Ballasts

DOE developed three efficiency levels for the PS product class (product class number 2 in Table V.1). The least efficient level (EL1) was designed to eliminate the least efficient 4-foot MBP, 4-foot T5 standard output, and 4-foot T5 high output PS ballasts. This also corresponds to a level at which each of the four major fluorescent lamp ballast manufacturers maintain a diversity of products. EL2 allows full product lines from two major manufacturers. Finally, EL3, the maximum technologically feasible level, was designed to represent the most efficient PS ballasts tested by DOE. EL3 is the highest level that allows one full line of products to meet standards, regardless of manufacturer.

e. Eight-Foot HO Ballasts

For the 8-foot HO IS/RS product class (product class 3 in Table V.1), DOE developed three efficiency levels. For this product class, DOE tested ballasts that operate two lamps, the most common lamp-and-ballast combination. EL1 was designed to just allow the least efficient T12 electronic ballasts, eliminating magnetic ballasts. EL2 allows the least efficient T8 ballast tested and eliminates the vast majority of T12 electronic ballasts. Finally, EL3 was designed to just allow the most efficient T8 ballast tested by DOE.

f. Sign Ballasts

The sign ballast market is primarily comprised of magnetic and electronic ballasts that operate T12 HO lamps. DOE tested sign ballasts that operate up to one, two, three, four, or six 8-foot T12 HO lamps. The test data showed that sign ballasts exist at two levels of efficiency. Therefore, DOE analyzed a baseline and one efficiency level above that baseline. EL1 was designed to allow a full line of electronic sign ballasts, including ballasts that operate up to six 8-foot HO lamps.

g. Residential Ballasts

In the April 2011 NOPR, DOE had proposed that both residential and commercial ballasts could achieve similar levels of efficiency at the highest levels analyzed. Based on the similarity in efficiency, DOE included both ballast types in the same product class. However, for the final rule, DOE conducted additional testing which indicates that 4-lamp residential ballasts are not able to achieve the same levels as commercial ballasts. Therefore, DOE has established a separate product class for residential ballasts and adjusted the efficiency levels for these ballasts to reflect the new data. EL1 was designed to just allow the least efficient T8 MBP ballasts, eliminating T12 residential ballasts. EL2, the maximum technologically feasible level, is the highest level that allows a full range of T8 products (including both two- and four-lamp ballasts) to comply.

6. Representative Units

a. Baseline Ballasts

For each ballast type analyzed, DOE selected a baseline ballast from which to measure improvements in efficiency. Baseline ballasts are what DOE believes to be the most common, least efficacious ballasts for each representative ballast type. For ballasts subject to existing Federal energy conservation standards, a baseline ballast is a commercially available ballast that just meets existing standards and provides basic consumer utility. If no standard exists for that specific ballast type, the baseline ballast represents the most common ballast sold within a representative ballast type with the lowest tested ballast luminous efficiency. In cases where two types of ballasts (each operating a different lamp diameter) are included in the same representative ballast type, DOE chose multiple baseline ballasts.

NEMA commented that magnetic ballasts should not be used as baselines. (NEMA, Public Meeting Transcript, No. 43 at pp. 38–9). DOE notes that while magnetic ballasts are not appropriate baselines for the majority of ballast types, for certain ballast types they represent the most common, least efficient ballasts that meet existing energy conservation standards. For example, as most magnetic 4-foot MBP and 8-foot slimline ballasts do not meet the BEF standards set forth by the 2000 Ballast Rule and EPACT 2005, DOE chose electronic baselines for these ballast types. DOE used a magnetic ballast as a baseline for 8-foot HO ballasts, however, because a T12 magnetic ballast represents the least efficient ballast that meets existing energy conservation standards.

Consistent with projections that a significant portion of 8-foot HO ballasts sold in 2014 (the compliance year of the new and amended standards in this final rule) will be electronic T8HO ballasts, DOE analyzes a T8 electronic ballast as a second baseline for this ballast type. DOE also used a magnetic ballast as a baseline for sign ballasts, which is typical of the least efficient products that are commercially available. In addition, according to DOE's shipment estimates, magnetic ballasts constitute a significant portion of the sign ballast market. For these reasons, DOE continues to analyze both electronic and magnetic baselines for the 8-foot HO and sign representative ballast types in this final rule.

While NEAA and NPCC supported the use of T12 ballasts as an analytical baseline, EEI reasoned that due to the 2009 Lamps Rule, only T8 lamps will be able to comply with the new lamp efficacy standards. Therefore, T8 lamp-and-ballast systems will be the baseline (in terms of product availability) for all consumers as of July 2012. (NEEA and NPCC, No. 44 at p. 6; EEI, No. 48 at p. 2)

DOE has concluded that both T8 and T12 ballasts are appropriate baselines. Although many T12 lamps will not meet the standards adopted in the 2009 Lamps Rule, several manufacturers have already introduced T12 lamp models that are not covered by these standards. Therefore, DOE projects that T12 products will be offered in 2014, the compliance year for this rulemaking. For example, DOE projects that in 2014 shipments (in the base case with existing technologies), while T8 ballasts will have a 78 percent market share, T12 ballasts will still have a market share of 4 percent of covered shipments, or about 5.3 million ballasts.[38] Thus, DOE continues to use T12 ballasts as baselines in this final rule.

[38] T5 ballasts comprise the remaining market share.

b. Representative Units

DOE then selected representative units at each efficiency level with higher BLEs as replacements for each baseline ballast. Representative units are typically ballasts that just meet the EL requirements based on the representative units' lamp arc power. Because DOE revised the shape of the efficiency levels, it also reevaluated its selection of representative units. DOE selected three new representative units based on the revised EL requirements. The revised representative units included the EL3 units for 2-lamp 4-foot MBP and 2-lamp 8-foot slimline ballasts in the IS/RS product class, and the EL2 unit for 2-lamp 4-foot MBP ballasts in the residential IS/RS product class. See chapter 5 of the TSD for more details.

c. Reduced Wattage Lamps

In the April 2011 NOPR, DOE paired each ballast with a representative lamp type to develop system input power and lumen output characteristics for use in the LCC and NIA. Based on the active mode test procedure for fluorescent lamp ballasts, DOE used full wattage lamps for T8 and T5 ballasts and reduced wattage lamps for T12 ballasts. For example, for ballasts that operate 4-foot MBP lamps, DOE paired an F32T8 lamp with T8 ballasts and an F34T12 lamp with T12 ballasts. NEMA commented that due to the prevalence of energy-saving lamps in the market today, the standard 32 watt lamp is not an appropriate selection for the 4-foot MBP T8 system. (NEMA, Public Meeting Transcript, No. 43 at pp. 38–9)

DOE agrees that all ballasts do not operate full-wattage lamps and thus revised the engineering analysis to incorporate the distribution of full- and reduced-wattage lamps on the market. In the 2009 Lamps Rule, DOE estimated the distribution of lamps by wattage that would be compliant with the 2012 energy conservation standards. For this final rule, DOE used those distributions to develop weighted-average lamp wattages (*e.g.,* a rated wattage of 30.8 W for 4-foot MBP T8 lamps) to pair with T8 and T5 ballasts. In addition, DOE also updated the ballast luminous efficiency, system input power, system lumen output, lamp lifetime, and lamp price to reflect the distribution of lamp wattages. See chapter 5 of the final rule TSD for additional details.

7. Scaling to Product Classes Not Analyzed

In the April 2011 NOPR, DOE did not analyze 8-foot HO PS ballasts directly. Thus, it developed a scaling relationship for this starting method. To do so, DOE compared 4-foot MBP IS ballasts to their PS counterparts. DOE found the average reduction in BLE from IS to PS to be 2 percent and therefore applied this reduction to the efficiency levels for the 8-foot HO IS/RS product class.

P.R. China found this approach potentially lacking scientific basis and suggested DOE provide a more detailed explanation of its methodology. (P.R. China, No. 51 at p. 4) As discussed in section V.B.6, DOE identified and selected certain product classes as ''representative'' product classes where DOE would concentrate its analytical effort. DOE chose these representative product classes and the representative units within them primarily because of their high market volumes. DOE then scaled from these representative classes to those not directly analyzed. In the NOPR, DOE calculated a 2 percent reduction factor to scale between IS/RS and PS product classes. This factor was determined by comparing pairs of ballasts in which the only characteristic that differed was starting method. Absent new information, DOE continues to use the 2 percent reduction factor. However, because DOE has established different efficiency level shapes for the IS/RS versus PS product classes, DOE has revised its methodology for scaling an IS/RS efficiency level to a PS efficiency level in this final rule.

To establish residential PS and 8-foot HO PS efficiency levels, DOE input the arc power of the representative unit at each EL into the IS/RS efficiency level equation to calculate the minimum required BLE. DOE then fit an efficiency level with a PS exponent (the exponent ''C'' is 0.37 for PS ballasts) such that it passed through the minimum required BLE by adjusting the coefficient ''B''. Then, DOE applied the 2 percent reduction factor to the overall equation to account for the expected difference in efficiency between IS and PS ballasts. Because multiple representative ballast types existed in the same product class, DOE sought to match the stringency of the PS curve to the IS curve at the highest arc power within that product class.

8. Manufacturer Selling Prices

DOE received comments on the process used to develop manufacturer selling prices (MSPs). NEMA commented that published blue book values account for only a small fraction of market prices and are skewed to be higher relative to the rest of the market. (NEMA, No. 47 at p. 7) DOE recognizes that blue book values are often significantly higher than MSPs and therefore used teardown data and confidential manufacturer-supplied MSPs in combination with blue book values to determine more accurate MSPs. DOE determined these MSP values by applying manufacturer-specific ratios between blue book prices and teardown- or aggregated manufacturer-sourced MSPs to blue book prices. By applying the manufacturer-specific ratios, the blue book price was reduced to reflect more realistic MSPs.

NEMA also commented that they do not think the price analysis method employed by DOE in the April 2011 NOPR accurately accounts for manufacturing variances among companies and circuit topology. In particular, NEMA disagreed with DOE's determination that higher efficiency ballasts were less expensive to manufacture than normal efficiency ballasts. (NEMA, No. 47 at p. 5) Based on DOE's assessment, certain higher efficiency ballasts are less expensive than lower efficiency ballasts. DOE notes that these trends are consistent with confidential manufacturer cost data received during interviews. Several low efficiency ballasts are magnetic ballasts, which are comprised of materials different from electronic ballasts. The difference in materials, such as the use of larger amounts of electrical steel and copper or aluminum windings in magnetic ballasts, would account for the higher cost. Similarly, DOE found some electronic T12 ballasts to carry a higher MSP than a more efficient T8 electronic ballast. Though these electronic ballasts utilize similar components, the low demand for T12 ballasts reduces the potential for high-volume discounts leading to a higher MSP relative to the T8 ballast.

NEMA questioned DOE's statement in the April 2011 NOPR that teardown prices are independent of long term commodity prices. (NEMA, No. 47 at p. 7) DOE acknowledges that a teardown analysis may be sensitive to the dynamic nature of the electrical component market, but continues to use the teardown results given that limited pricing information is publicly available. In the April 2011 NOPR, DOE amended its teardown approach such that incremental differences between two efficiency levels were based on pricing differences between single manufacturers' ballasts rather than basing prices directly from teardowns of different manufacturers. DOE notes that the industry did not provide average incremental MPC values. Instead, some manufacturers provided confidential data on an individual basis. DOE has not identified any new information that would affect its conclusion in the April 2011 NOPR, and therefore maintains this approach for the final rule.

9. Results

In this final rule, DOE establishes efficiency levels in terms of a power law equation that relates total lamp arc power to BLE. When developing efficiency level equations, DOE plotted the reported value for each ballast model to account for certification requirements. DOE then applied a reduction factor to the efficiency level equations based on an analysis of lab-to-lab variation. Table V.2 summarizes the efficiency levels developed by DOE for each product class. Costs associated with ballasts that meet these efficiency levels are presented in chapter 5 of the TSD.

TABLE V.2—EFFICIENCY LEVELS FOR REPRESENTATIVE PRODUCT CLASSES

BLE = A/(1+B*total lamp arc power^-C) where A, B, and C are as follows:

Representative product class	Efficiency level	A	B	C
IS and RS ballasts (not classified as residential) that operate 4-foot MBP lamps 2-foot U-shaped lamps 8-foot slimline lamps	EL 1 EL 2 EL 3	0.993	0.46 0.31 0.27	0.25
PS ballasts (not classified as residential) that operate 4-foot MBP lamps 2-foot U-shaped lamps 4-foot MiniBP SO lamps 4-foot MiniBP HO lamps	EL 1 EL 2 EL 3	0.993	0.60 0.55 0.51	0.37
IS and RS ballasts (not classified as sign ballasts) that operate 8-foot HO lamps	EL 1 EL 2 EL 3	0.993	1.01 0.38 0.28	0.25
Sign ballasts that operate 8-foot HO lamps	EL 1	0.993	0.47	0.25
IS and RS residential ballasts that operate 4-foot MBP lamps 2-foot U-shaped lamps 8-foot slimline lamps	EL 1 EL 2	0.993	0.41 0.29	0.25

TABLE V.3—EFFICIENCY LEVELS FOR SCALED PRODUCT CLASSES

BLE = A/(1 + B * total lamp arc power^-C) where A, B, and C are as follows:

Scaled product class	Efficiency level	A	B	C
PS ballasts (not classified as sign ballasts) that operate 8-foot HO lamps	EL 1 EL 2 EL 3	0.973	1.86 0.70 0.52	0.37
PS residential ballast that operate 4-foot MBP lamps 2-foot U-shaped lamps	EL 1 EL 2	0.973	0.71 0.50	0.37

C. Markups to Determine Product Price

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

In response to the April 2011 NOPR, DOE received no comments regarding its markups analysis, and therefore retained this approach for this final rule. DOE's markups analysis method and results are discussed in the following sections.

1. Distribution Channels

Before it could develop markups, DOE needed to identify distribution channels (*i.e.,* how the products are distributed from the manufacturer to the end user) for the ballast designs addressed in this final rule. Most ballasts used in commercial and industrial applications pass through one of two types of distribution channels—an original equipment manufacturer (OEM) channel and a wholesaler channel. The OEM distribution channel applies to ballasts shipped in fixtures. In this distribution channel, the ballast passes from the manufacturer to a fixture OEM which in turn sells it to an electrical wholesaler (*i.e.,* distributor); from the wholesaler it passes to a contractor, and finally to the end user. The wholesaler distribution channel applies to ballasts not shipped in fixtures (*e.g.,* replacement ballasts). In this distribution channel, the ballast passes from the manufacturer to an electrical wholesaler, then to a contractor, and finally to the end user.

DOE assumed a separate home improvement retailer distribution channel for residential ballasts, because DOE could not obtain retail sales data detailing the breakdown between fixture ballasts and replacement ballasts, DOE assumed for the markups analysis that the manufacturer sells the residential ballast to a fixture OEM who in turn sells it in a fixture to a home improvement retailer, where it is purchased by the end user.

2. Estimation of Markups

Publicly-owned companies must disclose financial information regularly through filings with the U.S. Securities and Exchange Commission (SEC). Filed annually, SEC form 10–K provides a comprehensive overview of the company's business and financial conditions. To estimate OEM, wholesaler, and retailer markups, DOE used financial data from 10–K reports from publicly owned lighting fixture manufacturers, electrical wholesalers, and home improvement retailers.

DOE's markup analysis developed both baseline and incremental markups to transform the ballast MSP into an end user product price. DOE used the baseline markups to determine the price of baseline designs. Incremental markups are coefficients that relate the change in the MSP of higher-efficiency designs to the change in the OEM, wholesaler, and retailer sales prices. These markups refer to higher-efficiency designs sold under market conditions with new and amended energy conservation standards. The calculated average baseline markups for fixture OEM companies, electrical wholesalers, and home improvement retailers were 1.50, 1.23, and 1.51, respectively. The average incremental markups for OEMs, wholesalers, and home improvement retailers were 1.17, 1.05, and 1.15, respectively.

While recognizing that SEC form 10–K data is not product-specific, actual product markups are generally business-sensitive. For this rule, DOE contacted the National Association of Electrical Distributors (NAED) and received feedback from two NAED member companies, both confirming that DOE's calculated wholesaler markups were consistent with their actual markups for commercial and industrial ballast designs. DOE also contacted Home Depot and Lowe's regarding price markups for residential fluorescent lighting products, but both organizations declined to comment, citing competition concerns. Consequently, DOE based its estimated markups for commercial, industrial and residential ballast designs on financial data from 10–K reports.

For ballasts used in commercial and industrial applications, DOE adjusted the calculated average baseline and incremental markups to reflect estimated proportions of ballasts sold through the OEM and wholesaler distribution channels. DOE assumed ballasts in the fixture OEM channel represent 63 percent of the market and ballasts in the wholesaler channel represent 37 percent. These percentages are from chapter 3 (engineering analysis) of the final TSD for the 2000 Ballast Rule and were based on a comment submitted by NEMA for that rulemaking. For the current ballast rulemaking, neither NEMA nor other interested parties provided updated estimates of distribution channel proportions, or offered adverse comment regarding DOE's assumed proportions.

DOE then multiplied the resulting weighted average markups by a contractor markup of 1.13 (also from the 2000 Ballast Rule, and used in the 2009 Lamps Rule) and sales tax to develop total weighted baseline and incremental markups, which reflect all individual markups incurred in the ballast distribution channels. DOE has not identified a more recent estimate for contractor markups, and did not receive related data or estimates from interested parties in response to the ballasts preliminary TSD or April 2011 NOPR. For residential ballasts, DOE assumed that end users purchased ballasts—already installed in fixtures—directly from home improvement retailers with no contractor involvement or markup. DOE used OEM and retailer markups and sales tax to calculate total baseline and incremental markups for residential ballasts.

The sales tax represents state and local sales taxes applied to the end user equipment price. DOE derived state and local taxes from data provided by the Sales Tax Clearinghouse.[39] These data represent weighted averages that include state, county and city rates. DOE then derived population-weighted average tax values for each census

[39] The Sales Tax Clearinghouse. Available at *https://thestc.com/STRates.stm.* (Last accessed May 16, 2011.)

division and large state, and then derived U.S. average tax values using a population-weighted average of the census division and large state values. This approach provided a national average tax rate of 7.25 percent.

3. Summary of Markups

TABLE V.4—SUMMARY OF BALLAST DISTRIBUTION CHANNEL MARKUPS

	Commercial/industrial ballasts				Residential ballasts	
	OEM distribution (ballasts shipped in fixtures)		Wholesaler distribution (individual ballasts only)		Retailer distribution (ballasts shipped in fixtures)	
	Baseline	Incremental	Baseline	Incremental	Baseline	Incremental
Fixture OEM	1.50	1.17			1.50	1.17
Electrical Wholesaler (Distributor)	1.23	1.05	1.23	1.05		
Home Improvement Retailer					1.51	1.15
Contractor or Installer	1.13	1.13	1.13	1.13		
Sales Tax	1.07		1.07		1.07	
Overall	2.24	1.48	1.49	1.27	2.43	1.43
Assumed Market Percentage	63		37		100	
Overall (Weighted)	1.96 (Baseline)		1.41 (Incremental)		2.43	1.43

In response to the April 2011 NOPR, NEMA said it disagreed with DOE's incremental markups for OEMs, contractors and home improvement retailers, citing current economic conditions, price compression and commodity fluctuations. NEMA did not provide details about or suggested revisions to incremental markups. (NEMA, No. 47 at p. 7) DOE was not able to obtain confidential pricing and markups data from OEMs and home improvement retailers to validate its estimated baseline and incremental markups. Absent representative markups data, DOE retained its previously-vetted approach using SEC form 10–K financial reports to estimate markups for OEMs and home improvement retailers. Similarly, no new data to support different contractor markups were available, so DOE retained its NOPR markups for this final rule.

Using these markups, DOE generated ballast end user prices for each efficiency level it considered. Chapter 7 of the final rule TSD provides additional detail on the markups analysis.

D. Energy Use Analysis

For the energy use analysis, DOE estimated the energy use of ballasts in the field (*i.e.,* as they are actually used by consumers in commercial, industrial and residential applications). The energy use analysis provided the basis for other DOE analyses, particularly assessments of the energy savings and the savings in consumer operating costs that could result from DOE's adoption of new and amended standard levels.

To develop annual energy use estimates, DOE multiplied annual usage (in hours per year) by the lamp-and-ballast system input power (in watts). DOE characterized representative lamp-and-ballast systems in the engineering analysis, which provided measured and normalized system input power ratings (the latter used to compare baseline- and standards-case systems on an equal light-output basis). To characterize the country's average use of lamp-and-ballast systems for a typical year, DOE developed annual operating hour distributions by sector, using data published in the U.S. Lighting Market Characterization: Volume I (LMC),[40] the Commercial Building Energy Consumption Survey (CBECS),[41] the Manufacturer Energy Consumption Survey (MECS),[42] and the Residential Energy Consumption Survey (RECS).[43] DOE assumed, based on its market and technology assessment, that PS ballasts operating 4-foot MBP T8 lamps in the commercial sector were operated on occupancy sensors. Based on its survey of available literature, DOE assumed that occupancy sensors would result, on average, in a 30-percent reduction in annual operating hours.

DOE received no comments on the April 2011 NOPR regarding the energy use analysis for ballasts and retains this approach for today's final rule. Chapter 6 of the final rule TSD provides a more detailed description of DOE's energy use analysis.

E. Life-Cycle Cost and Payback Period Analyses

DOE conducted LCC and PBP analyses to evaluate the economic impacts of potential energy conservation standards for ballasts on individual consumers. For any given efficiency level, DOE measures the PBP and the change in LCC relative to an estimated baseline product efficiency level. The LCC is the total consumer expense over the life of a product, consisting of purchase, installation, and operating costs (expenses for energy use, maintenance, and repair). To compute the operating costs, DOE discounted future operating costs to the time of purchase and summed them over the 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

[40] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. *U.S. Lighting Market Characterization. Volume I: National Lighting Inventory and Energy Consumption Estimate.* 2002. Available at *http://apps1.eere.energy.gov/buildings/publications/pdfs/corporate/lmc_vol1.pdf.*

[41] U.S. Department of Energy, Energy Information Administration. *Commercial Building Energy Consumption Survey: Micro-Level Data, File 2 Building Activities, Special Measures of Size, and Multi-building Facilities.* 2003. Available at *http://www.eia.doe.gov/emeu/cbecs/public_use.html.*

[42] U.S. Department of Energy, Energy Information Administration. *Manufacturing Energy Consumption Survey, Table 1.4: Number of Establishments Using Energy Consumed for All Purpose.* 2006. Available at *http://www.eia.doe.gov/emeu/mecs/mecs2006/2006tables.html.*

[43] U.S. Department of Energy, Energy Information Administration. *Residential Energy Consumption Survey: File 1: Housing Unit Characteristics.* 2005. Available at *http://www.eia.doe.gov/emeu/recs/recspubuse05/pubuse05.html.*

change in purchase cost (normally higher) by the change in average annual operating cost (normally lower) that results from the more efficient standard.

Inputs to the calculation of total installed costs include the cost of the product—which includes MSPs, distribution channel markups, and sales taxes—and installation costs. Inputs to the calculation of operating expenses include annual energy consumption, energy prices and price projections, repair and maintenance costs, product lifetimes, discount rates, and the year that compliance with new and amended standards is required. To account for uncertainty and variability, DOE created probability distributions for inputs such as operating hours, electricity prices, discount rates and sales tax rates, and disposal costs. For example, DOE created a probability distribution of annual energy consumption in its energy use analysis based, in part, on a range of annual operating hours. The operating hour distributions capture variation across census divisions and large states, building types, and lamp-and-ballast systems for three sectors (commercial, industrial, and residential). Because ballast MSPs were specific to the representative ballast designs evaluated in DOE's engineering analysis and price markups were based on limited publicly-available financial data, DOE used discrete values instead of distributions for these inputs.

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 probability distributions of these values, performing more than 10,000 iterations per simulation run. The final rule TSD chapter 8 and its appendices provide details on the spreadsheet model and all inputs to the LCC and PBP analyses.

Table V.5 summarizes the approach and data DOE used to derive inputs to the LCC and PBP calculations for the April 2011 NOPR as well as the changes made for this final rule. The subsections that follow discuss the model inputs and DOE's changes to them.

TABLE V.5—SUMMARY OF INPUTS AND KEY ASSUMPTIONS IN THE LCC AND PBP ANALYSES *

Inputs	NOPR	Changes for the final rule
Product Cost	Derived by multiplying ballast MSPs by distribution channel markups and sales tax	No change.
Installation Cost	Derived costs using estimated labor times, and applicable labor rates from *RS Means Electrical Cost Data* (2007) and U.S. Bureau of Labor Statistics.	Updated labor rates from 2009$ to 2010$.
Annual Energy Use	Determined operating hours by associating building type-specific operating hours with regional distributions of various building types using lighting market and building energy consumption survey data: LMC (2002), CBECS (2003), MECS (2006), and RECS (2005)[44] (see section V.D).	No change (newer data unavailable).
Energy Prices	Electricity: Based on EIA's Form 826 data for 2010 Variability: Energy prices determined at state level.	No change.
Energy Price Projections	Forecasted using Annual Energy Outlook 2010 (*AEO2010*)	No change.[45]
Replacement and Disposal Costs.	Commercial/Industrial: Included labor and materials costs for lamp replacement, and disposal costs for failed lamps. Residential: Included only materials cost for lamps, with no lamp disposal costs. Variability: Assumed commercial and industrial consumers pay recycling costs in approximately 30 percent of lamp failures and 5 percent of ballast failures.	Updated labor rates from 2009$ to 2010$.
Product Lifetime	Ballasts: Lifetime based on average lifetimes from the 2000 Ballast Rule (and used in the 2009 Lamps Rule). Lamps: Assumed as 91 percent—94 percent of rated life, to account for lamp type and relamping practices.	No change.
Discount Rates	Commercial/Industrial: Estimated cost of capital to affected firms and industries; developed weighted average of the cost to the company of equity and debt financing. Residential: Estimated by examining all possible debt or asset classes that might be used to purchase ballasts. Variability: Developed a distribution of discount rates for each end-use sector.	No change.
Compliance Date of Standards.	2014	No change.
Ballast Purchasing Events.	Assessed two events: Ballast failure and new construction/renovation	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 final rule TSD.

1. Product Cost

To calculate consumer product costs, DOE multiplied the MSPs developed in the engineering analysis by the distribution channel markups described in section V.C.1 (along with sales taxes). DOE used different markups for baseline products and higher-efficiency products, because the markups estimated for incremental costs differ from those estimated for baseline models.

DOE received comments on the April 2011 NOPR questioning its product cost assumptions for residential ballasts. NEEA and NPCC noted that residential consumers would more likely replace an entire fluorescent lamp fixture upon ballast failure, and that these fixtures

[44] RECS was updated in 2009, but these updates did not address lighting usage; therefore, DOE used RECS 2005 data for this final rule.

[45] DOE continues to use *AEO2010* in its final rule analyses. The comment period on DOE's NODA, discussed previously, closed on September 14, 2011, and DOE is required by consent decree to publish the final amended standards for fluorescent lamp ballasts by October 28, 2011. (*State of New York, et al. v. Bodman et al.,* 05 Civ. 7807 (LAP) and *Natural Resources Defense Council, et al. v. Bodman, et al.,* 05 Civ. 7808 (LAP) (Nov. 3, 2006), as amended on June 20, 2011.) The additional time required for DOE to consider the comments and information submitted by interested parties did not allow sufficient time for DOE to update the final rule analyses using *AEO2011.* DOE has determined, however, that the *AEO2011* 30-year annual growth rates for energy consumption (electric power) and electricity generating capacity are almost identical to those in *AEO2010.* The forecasted near-term electricity prices in *AEO2010* are slightly higher than in *AEO2011,* and would produce slightly shorter payback periods. However, these payback periods and other LCC and NIA results are not expected to vary significantly using *AEO2010* and *AEO2011.*

would be less expensive than DOE's estimated ballast prices. (NEEA, Public Meeting Transcript, No. 43 at pp. 169–170; NPCC, Public Meeting Transcript, No. 43 at pp. 163–164; NEEA and NPCC, No. 44 at p. 6) DOE notes that fluorescent fixture and ballast price are highly variable, but maintains that its estimated residential ballast prices (approx. $10–12) are comparable with those for inexpensive fixtures (*e.g.,* shop lights) that residential consumers might replace upon ballast failure. DOE also notes that fixture price data that correspond with individual ballast efficiency levels are not readily available. Therefore, DOE retained its residential ballast product cost approach for this final rule.

On February 22, 2011, DOE published a Notice of Data Availability (NODA, 76 FR 9696) stating that DOE may consider improving regulatory analysis by addressing product and equipment price trends. DOE notes that learning curve analysis characterizes the reduction in production cost mainly associated with labor-based performance improvement and higher investment in new capital equipment at the microeconomic level. Experience curve analysis tends to focus more on entire industries and aggregates over various casual factors at the macroeconomic level: ''Experience curve'' and ''progress function'' typically represent generalizations of the learning concept to encompass behavior of all inputs to production and cost (i.e., labor, capital, and materials).'' The economic literature often uses these two terms interchangeably. The term ''learning'' is used here to broadly cover these general macroeconomic concepts.

Consistent with the February 2011 NODA, DOE examined historical producer price indices (PPI) for fluorescent ballasts and found both positive and negative real price trends depending on the specific time period examined. Therefore, in the absence of a definitive trend, DOE assumed in its price forecasts for the NOPR that the real prices of fluorescent ballasts are constant in time and that fluorescent ballast prices will trend the same way as prices in the economy as a whole. DOE is aware that there have been significant changes in both the regulatory environment and mix of fluorescent ballast and controls technologies that create analytical challenges for estimating longer-term product price trends from the product-specific PPI data. DOE performed price trends sensitivity calculations to examine the dependence of the analysis results on different analytical assumptions.

DOE received no comments on the April 2011 NOPR regarding its ballast price trend basis. For this final rule, DOE also considered adjusting ballast prices using forecasted price indices (called deflators) used by EIA to develop the *AEO.* When adjusted for inflation, the deflator-based price indices decline from 100 in 2010 to approximately 54 in 2043. The effect is diminished significantly when discounting is taken into account. Deflator-based net present value (NPV) results from the national impacts analysis (NIA) were approximately 9 percent higher than NPV values based on constant real prices for ballasts. Given this minor difference in estimated NPV, and that DOE did not receive negative comments on its constant real price basis in the NOPR, DOE retained its constant real price approach for this final rule. A more detailed discussion of price trend modeling and calculations is provided in Appendix 8B of the final rule TSD.

2. Installation Cost

The installation cost is the total cost to the consumer to install the equipment, excluding the marked-up consumer product price. Installation costs include labor, overhead, and any miscellaneous materials and parts. As detailed in the final rule TSD, DOE considered the total installed cost of a lamp-and-ballast system to be the consumer product price (including sales taxes) plus the installation cost. DOE applied installation costs to lamp-and-ballast systems installed in the commercial and industrial sectors, treating an installation cost as the product of the average labor rate and the time needed for installation. Using the same approach, DOE assumed that residential consumers must pay for the installation of a fixture containing a lamp-and-ballast system, and calculated installation price in the same manner. DOE received no comments on the April 2011 NOPR concerning its installation costs for the LCC analysis, and retained this approach for this final rule.

3. Annual Energy Use

As discussed in section V.D, DOE estimated the annual energy use of representative lamp-and-ballast systems using system input power ratings and sector operating hours. The annual energy use inputs to the LCC and PBP analyses are based on weighted average annual operating hours, whereas the Monte Carlo simulation draws on a distribution of annual operating hours to determine annual energy use.

4. Energy Prices

For the LCC and PBP, DOE derived average energy prices for 13 U.S. geographic areas consisting of the nine 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. The derivation of prices was based on data from 2010 EIA Form 826, ''Monthly Electric Utility Sales and Revenue Data.'' DOE received no comments on the April 2011 NOPR concerning its derivation of energy prices for the LCC analysis and retained this approach for this final rule.

5. Energy Price Projections

To estimate the trends in energy prices, DOE used the price forecasts in *AEO2010.* To arrive at prices in future years, DOE multiplied current average prices by the forecast of annual average price changes in *AEO2010.* Because *AEO2010* forecasts prices to 2035, DOE followed past EIA guidelines and used the average rate of change from 2020 to 2035 to estimate the price trend for electricity from 2035 to 2043. In addition, the spreadsheets that DOE used to conduct the LCC and PBP analyses allow users to select price forecasts from *AEO'*s low-growth, high-growth, and reference case scenarios to estimate the sensitivity of the LCC and PBP to different energy price forecasts. DOE received no specific comments on the April 2011 NOPR concerning its energy price forecasting method for the LCC analysis and retained this approach for this final rule.

6. Replacement and Disposal Costs

In the April 2011 NOPR, DOE addressed lamp replacements occurring within the analysis period as part of operating costs for considered lamp-and-ballast system designs. Replacement costs in the commercial and industrial sectors included the labor and materials costs associated with replacing a lamp at the end of its lifetime, discounted to 2011. For the residential sector, DOE projected that consumers would install their own replacement lamps and incur no related labor costs.

Some consumers recycle failed lamps and ballasts, thus incurring a disposal cost. For the 2009 Lamps Rule, DOE found average recycling costs of 10 cents per linear foot for GSFL and $3.50 for each ballast. DOE surveyed current online recycling cost data for this rulemaking, and determined that its 2009 recycling cost estimates were still valid. A 2004 report by the Association of Lighting and Mercury Recyclers noted that approximately 30 percent of lamps used by businesses and 2 percent of lamps in the residential sector are recycled nationwide.[46] Consistent with the 2009 Lamps Rule, DOE considered the 30-percent lamp-recycling rate to be significant and incorporated lamp recycling costs into the LCC analysis for commercial and industrial consumers. DOE was unable to obtain reliable ballast recycling rate data, but projected that the likely higher ballast recycling costs would largely discourage voluntary ballast recycling by commercial and industrial consumers. DOE therefore did not include ballast recycling costs in the LCC analysis. Given the low (2 percent) estimated lamp recycling rate in the residential sector, DOE assumed that residential consumers would be even less likely to voluntarily incur the higher recycling costs for ballasts. Therefore, DOE excluded the recycling costs for lamps or ballasts from the LCC analysis for residential ballast designs.

DOE received no comments on the April 2011 NOPR concerning these assumed recycling rates and costs, and retained this approach in the final rule LCC analysis. The Monte Carlo simulation for the final rule allowed DOE to examine variability in recycling practices; consequently, DOE assumed that commercial and industrial consumers pay recycling costs in 5 percent of ballast failures—as well as the 30 percent of lamp failures assumed in the LCC analysis. As in the LCC analysis, DOE assumed that residential lamp and ballast disposal rates were insignificant, and excluded the related disposal costs from the Monte Carlo simulation for residential ballast designs.

7. Product Lifetime

Chapter 8 of the final rule TSD details DOE's basis for its calculation of average ballast lifetimes. DOE used assumptions from the 2000 Ballast Rule and the 2009 Lamps Rule. DOE explicitly sought comment on these assumptions but received no additional information upon which to base changes to them in today's final rule. For ballasts in the commercial and industrial sectors, DOE used an average ballast lifetime of 49,054 hours that, when combined the respective average annual operating hours, yielded average ballast lifetimes of approximately 13 and 10 years in the commercial and industrial sectors, respectively. Consistent with the 2000 Ballast Rule and the 2009 Lamps Rule, DOE assumed an average ballast lifetime of approximately 15 years in the residential sector, which corresponds with 11,835 hours total on an assumed 789 hours per year operating schedule. To account for a range of relamping practices (*e.g.,* group and spot relamping, where lamps are replaced preemptively or after failure, respectively), DOE assumed that lamps operated, on average, for 91–94 percent of rated life, depending on lamp type.

DOE also assumed that ballast lifetimes can vary due to both physical failure and economic factors (*e.g.,* early replacements due to retrofits). DOE accounted for variability in lifetime in LCC and PBP via the Monte Carlo simulation (using repeated random sampling), and in the shipments and NIA analyses by assuming a Weibull distribution for lifetimes that represents failures and replacements. DOE received no adverse comments on the April 2011 NOPR concerning its product lifetime assumptions and retained this approach for this final rule.

8. Discount Rates

The discount rate is the rate at which future expenditures are discounted to estimate their present value. In the April 2011 NOPR, DOE estimated separate discount rates for commercial, industrial, and residential consumers. For both the proposed and final rules, DOE also developed a distribution of discount rates for each end-use sector from which the Monte Carlo simulation samples.

For the industrial and commercial sectors, DOE assembled data on debt interest rates and the cost of equity capital for representative firms that use ballasts. DOE determined a distribution of the weighted-average cost of capital for each class of potential owners using data from the Damodaran online financial database.[47] DOE used the same distribution of discount rates for the commercial and industrial sectors. The average discount rates, weighted by the shares of each rate value in the sectoral distributions, are 6.9 percent for commercial end users and 7.2 percent for industrial end users.

For the residential sector, DOE assembled a distribution of interest or return rates from sources including the Federal Reserve Board's ''Survey of Consumer Finances'' (SCF) in 1989, 1992, 1995, 1998, 2001, 2004 and 2007. DOE assigned weights in the distribution based on the shares of each financial instrument in household financial holdings according to SCF data. The weighted-average discount rate for residential product owners is estimated to be 5.6 percent.

DOE received no comments on the April 2011 NOPR concerning its estimated discount rates for the LCC analysis and retained this approach for this final rule.

9. Compliance Date of Standards

The compliance date is when a covered product is required to meet a new or amended standard. EPCA requires that any new or amended standards established in this rule apply to products manufactured after a date that is five years after—(i) the effective date of the previous amendment; or (ii) if the previous final rule did not amend the standards, the earliest date by which a previous amendment could have been effective; except that in no case may any amended standard apply to products manufactured within three years after publication of the final rule establishing such amended standard. (42 U.S.C. 6295(g)(7)(C)). DOE is required by a 2006 consent decree, as amended, to publish any amended standards for ballasts by October 28, 2011.[48] In accordance with 42 U.S.C. 6295(g)(7)(C), the compliance date is three years after the publication of any final new and amended standards. DOE calculated the LCC for all end users as if each one would purchase a new ballast in the year compliance with the standard is required.

10. Ballast Purchasing Events

DOE based the LCC and PBP analyses for this rulemaking on scenarios where consumers must purchase a ballast. Each of these purchasing events may involve a different set of ballast or lamp-and-ballast designs and, therefore, a different set of LCC savings for a certain efficiency level. The two scenarios are (1) ballast failure and (2) new construction/renovation. In the ballast failure scenario, DOE assumed that the consumer of the failed ballast would replace it with a standards-compliant lamp-and-ballast combination such that the system light output never drops more than 10 percent below that of the baseline system. For the ballast failure scenario, DOE used rated system input power to calculate annual energy use. For new construction/renovation, DOE assumed that consumers may design a new installation that matches the

[46] Association of Lighting and Mercury Recyclers, ''National Mercury-Lamp Recycling Rate and Availability of Lamp Recycling Services in the U.S.'' Nov. 2004.

[47] The data are available at *http://pages.stern.nyu.edu/~adamodar.*

[48] *State of New York, et al.* v. *Bodman et al.,* 05 Civ. 7807 (LAP) and *Natural Resources Defense Council, et al.* v. *Bodman, et al.,* 05 Civ. 7808 (LAP) (Nov. 3, 2006), as amended on June 20, 2011.

overall light output of the base-case system. DOE used normalized system input power, adjusted to yield equivalent light output from both the baseline and substitute new construction/renovation systems.

DOE received no comments on the April 2011 NOPR concerning its assumed ballast purchasing events for the LCC analysis and retained this approach for this final rule.

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

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

DOE used a spreadsheet model to calculate the energy savings and the national consumer costs and savings for each TSL. The TSD and other documentation for the rulemaking explain the models and how to use them, allowing interested parties to 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 and LCC analyses. 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 these four output parameters. DOE examines sensitivities in the NIA by analyzing different efficiency scenarios, such as Roll-up and Shift.

DOE evaluated the national impacts of new and amended standards for ballasts by comparing base-case projections with standards-case projections. The base-case projections characterize energy use and consumer costs for each product class in the absence of new or amended energy conservation standards. DOE compared these projections with projections characterizing the market for each product class if DOE adopted new or amended standards at specific energy efficiency levels (*i.e.,* the TSLs or standards cases) for that class. In characterizing the base and standards cases, DOE considered historical shipments, the mix of efficiencies sold in the absence of new standards, and how that mix may change over time. Additional information about the NIA spreadsheet is in final rule TSD chapter 11.

Table V.6 summarizes the approach and data DOE used to derive the inputs to the NES and NPV analyses for the April 2011 NOPR, as well as the changes to the analyses for the final rule. A discussion of selected inputs and changes follows. See chapter 11 of the final rule TSD for further details.

TABLE V.6—APPROACH AND DATA USED FOR NATIONAL ENERGY SAVINGS AND CONSUMER NET PRESENT VALUE ANALYSES

Inputs	NOPR	Changes for the final rule
Shipments	Derived annual shipments from shipments model	See Table V.7.
Compliance Date of Standard.	2014	No change.
Annual Energy Consumption per Unit.	Established in the energy use analysis (NOPR TSD chapter 6)	Energy use analysis updated using most recent available inputs.
Rebound Effect	1% in commercial and industrial sectors, 8.5% in residential sector	No change.
Electricity Price Forecast	*AEO2010*	No change.
Energy Site-to-Source Conversion Factor.	Used marginal conversion factors generated by NEMS–BT; factors held constant after 2035.	No change.
Discount Rate	3% and 7% real	No change.
Present Year	2011	No change.

1. Shipments

Product shipments are an important input to any estimate of the future impact of a standard. To develop the shipments portion of the NIA spreadsheet, DOE used a three-step process to: (1) Estimate historical shipments; (2) calculate installed ballast stock; and (3) develop annual shipment projections for the analysis period 2014–2043. Table V.7 summarizes the approach and data DOE used to derive the inputs to the shipments analysis for the April 2011 NOPR and the changes DOE made for today's final rule. A discussion of these inputs and changes follows. For details on the shipments analysis, see chapter 10 of the final rule TSD.

TABLE V.7—APPROACH AND DATA USED FOR THE SHIPMENTS ANALYSIS

Inputs	NOPR	Changes for the final rule
Historical Shipments	Used historical shipments for 1990–2005 to develop shipments and stock projections for the analysis period; changed lifetime distribution and growth assumptions, mitigating oscillations in shipment projections.	No change.
Ballast Stock	Based projections on the shipments that survive up to a given date; assumed Weibull lifetime distribution.	No change.
Growth	Used 2010 *AEO* projections for floorspace growth	Revised growth rate for residential sector.

TABLE V.7—APPROACH AND DATA USED FOR THE SHIPMENTS ANALYSIS—Continued

Inputs	NOPR	Changes for the final rule
Base Case Scenarios	Analyzed both existing technology and emerging technology scenarios	Added dimming ballast penetration rate to the emerging technology scenario; revised efficiency apportionments for commercial sector ballasts operating 4-foot MBP lamps.
Standards Case Scenarios	Analyzed Shift and Roll-up scenarios based on both existing and emerging technology cases.	No change.

a. Historical Shipments

For the April 2011 NOPR, DOE used U.S. Census Bureau Current Industrial Reports (CIR) to estimate historical (1990–2005) shipments for each representative ballast type. The census CIR data cover NEMA shipments for individual ballast designs (*e.g.,* 2-lamp F96T8), as well as aggregated shipments for multiple designs to prevent disclosing data for individual companies. For lower-volume ballast designs, the CIR withheld shipments data to avoid disclosing individual company data.

For CIR reporting years for which specific shipments data are too aggregated or unavailable, DOE estimated historical shipments using trends within the available data and/or market trends identified in ballast manufacturer interviews, the 2009 Lamps Rule, and the 2000 Ballast Rule. DOE then adjusted these estimates to account for the volume of ballasts that non-NEMA companies import or manufacture. DOE received no comments on the April 2011 NOPR regarding historical ballast shipments data and estimates. DOE also found no historical ballast shipment data to validate its NOPR shipments analysis because neither NEMA nor its member companies typically retain data of the vintage in question (1990–2005). DOE therefore concluded that census data remain the best available data for estimating historical ballast shipments and retained its approach for this final rule.

b. Ballast Stock Projections

In its shipments analysis for the April 2011 NOPR, DOE calculated the installed ballast stock using historical shipments estimated from U.S. Census Bureau CIR data (1990–2005) and projected shipments for future years. DOE estimated the installed stock during the analysis period by calculating how many ballasts will survive up to a given year based on a Weibull lifetime distribution for each ballast type. DOE received no comments on the April 2011 NOPR regarding its ballast stock projection method and retained this approach for this final rule.

c. Projected Shipments

By modeling ballast market segments (*i.e.,* purchasing events) and applying lifetime distribution, growth and emerging technologies penetration rate assumptions, and efficiency scenarios, DOE developed annual shipment projections for the analysis period (2014–2043). The following subsections address the lifetime, base-case market share apportionment, emerging technology, market trend, and efficiency scenario issues that DOE considered in its shipments analysis for the final rule.

i. Ballast Lifetime Assumptions

In its shipments analysis for the April 2011 NOPR, DOE retained the average ballast physical lifetimes used in its preliminary analysis, and combined them with Weibull distributions for lifetimes to model ballast failures and retrofits. DOE received no comments on the April 2011 NOPR regarding its assumed average ballast lifetimes and lifetime distributions and retained this approach for this final rule.

ii. Base-Case Market Share Apportionments

When choosing lighting systems, consumers consider attributes such as lifetime, efficiency, price, lumen output, rated wattage, and total system power. Therefore, within each product class, DOE developed efficiency level market share apportionments to account for the mix of system attributes that consumers select in the base case. These market share apportionments were used to estimate base case historical shipments and installed stock for each ballast design.

DOE was not able to obtain detailed historical ballast shipment data to develop percentage market shares for the analyzed ballast designs. Based on initial manufacturer interviews, however, DOE was able to develop a general assumed market-share apportionment using shipments of electronic ballasts for 4-foot T8 MBP systems. DOE then applied this general apportionment to each product class in the base case, assigning 69 percent of shipments to the baseline ballast design, and dividing the remaining 31 percent of shipments among the higher efficiency designs.

For the April 2011 NOPR, DOE received several comments regarding base case market share apportionments and their effects on estimated energy savings and economic benefits. Universal questioned DOE assigning a majority market share to baseline ballast designs, noting at least 80 percent of NEMA manufacturers' current ballast shipments are classified as NEMA Premium. (Universal, Public Meeting Transcript, No. 43 at p. 38; NEMA, No. 56 at p. 4) Philips and Universal further contended that DOE's baseline apportionments—including magnetic ballast designs—effectively underestimated the efficiency of the installed ballast stock and overestimated the resulting energy savings and economic benefits of the proposed efficiency standards. (Philips, Public Meeting Transcript, No. 43 at p. 64; Universal, Public Meeting Transcript, No. 43 at p. 38)

DOE agrees that the ballast market is shifting to higher efficiency designs, but notes that its baseline representative ballasts (excluding ballasts operating two 8-foot T12 lamps, and four-lamp sign ballasts) are electronic designs. Therefore, less-efficient magnetic baseline designs did not have a significant effect on DOE's NIA results. However, DOE reviewed the prevalence of NEMA Premium products in its tested ballasts (including baseline products), and adjusted the market share apportionments of higher efficiency level ballasts in the IS and RS, and PS product classes accordingly. DOE could not verify NEMA's estimated 80 percent market share for higher efficiency designs. Based on its review, however, DOE assigned a 64-percent market share to the higher efficiency level designs and a 36-percent market share to baseline ballast designs in these product classes in the base case for the final rule shipments analysis.

iii. Emerging Technologies Shipment Forecasts

In its previous analyses, DOE modeled separate existing and emerging technologies shipment scenarios to characterize the uncertainty in ballast market penetration by emerging solid-state lighting (SSL) technologies. The existing technologies scenario generally considers only the market penetration of technologies that are mature in terms of price and efficiency, largely excluding SSL. In the emerging technologies scenario, the shipments and installed stock of ballasts (*e.g.,* ballasts operating 4-foot MBP T8 lamps) decrease due to significant replacement by SSL. This scenario effectively lowers the energy savings of new fluorescent lamp ballast standards. DOE acknowledges both scenarios and the likelihood that actual results will fall between them by presenting the two scenarios' energy savings and economic effects as a range.

Consistent with the 2009 Lamps Rule and its current research, DOE assumed no SSL penetration for residential linear fluorescent applications. DOE stated in the April 2011 NOPR that residential energy codes will drive the market toward higher efficacy lighting systems, but that the related market growth will be greater for compact fluorescent lamp (CFL)-based fixtures than for 4-foot MBP fluorescent systems. As discussed in DOE's SSL Multi Year Program Plan (updated May 2011), the vast majority of residential sockets are dedicated to incandescent lamps, for which screw-base compact fluorescent and SSL lamps are direct replacements.[49] DOE's review of available residential fixture surveys confirms that linear fluorescent fixtures are typically relegated to utility room, laundry, and some kitchen applications. A comparison of recent California residential lighting data for 2005 and 2009 shows no significantly increased installation of linear fluorescent systems, and DOE believes that residential consumers will continue to opt for lower-first-cost fluorescent systems rather than installing more expensive SSL replacements for linear fluorescent lamps and fixtures. DOE received no adverse comments to the April 2011 NOPR for not including SSL penetration in its residential ballast shipments. Given the limited residential applications for linear fluorescent systems, DOE retained this approach for this final rule.

For the April 2011 NOPR, DOE received comments regarding how regulations requiring use of dimming ballasts could affect future shipments of fixed-output ballasts. Commenters referenced proposed regulations in California that would require controllable ballasts in non-residential applications. (ASAP, Public Meeting Transcript, No. 43 at p. 209; Lutron, Public Meeting Transcript, No. 43 at pp. 207–208; Philips, Public Meeting Transcript, No. 43 at p. 179) Philips further suggested that SSL and dimming ballasts in combination could largely eliminate the fixed-output ballast market by 2040. (Philips, Public Meeting Transcript, No. 43 at p. 187)

As part of its 2013 Title 24 updates (effective in 2014), the state of California is considering mandatory requirements for controllable light sources that could require dimming ballasts for non-residential linear fluorescent systems.[50] These proposed changes to Title 24 would build upon existing requirements for stepped lighting controls, requiring significantly increased granularity of control at the individual fixture level. It is uncertain, however, whether these proposed changes to Title 24 will be enacted. It is also not certain that other building standards, such as the American Society of Heating, Refrigerating and Air-Conditioning Engineers standard 90.1 (ASHRAE 90.1), would adopt the ballast controllability requirements being considered in California. DOE projects that a significant number of fluorescent lighting installations where dimming is not practical or possible (such as spaces without daylighting, or where occupancy/vacancy sensing can extinguish lighting) will remain, thus maintaining demand for fixed-output ballasts.

In its comments to the April 2011 NOPR, NEMA generally affirmed DOE's shipment projections, but asserted that DOE underestimated the current and future penetration of SSL in the emerging technologies scenario. (NEMA, No. 47 at pp. 8–9) NEEA stated that the emerging technologies forecast is the more likely of DOE's two shipment scenarios, and that DOE should increase the penetration of SSL and controllable lighting to lower the projected shipments of fixed-output ballasts. (NEEA and NPCC, No. 44 at p. 7)

As described previously in this section, DOE developed existing and emerging technologies shipment scenarios to investigate uncertainties in ballast market penetration by other technologies. Although dimming ballasts are an existing technology, DOE considered them an ''emerging application'' for fluorescent lighting applications and included dimming ballasts with SSL products in its emerging technologies shipments scenario for this final rule. As discussed in chapter 10 of the final rule TSD, because SSL penetration has increased since the inception of this rulemaking, DOE increased its estimated penetration rate earlier in the shipments analysis period. DOE also increased the maximum penetration of 40.6 percent (for SSL in the April 2011 NOPR) to a maximum penetration of 75 percent (for SSL and dimming ballasts combined). This increased penetration resulted in decreased shipments for affected ballast types for the lower boundary, base case shipments scenario.

iv. Anticipated Market Trends

DOE received comments on the April 2011 NOPR regarding its shipment projections for residential ballasts. NEEA and NPCC questioned whether DOE overestimated residential ballast shipments, based on the commenters' understanding of ballast lifetimes and new construction growth rates. (NEEA, Public Meeting Transcript, No. 43 at pp. 194–195; NPCC, Public Meeting Transcript, No. 43 at p. 195) DOE calculates shipments of ballasts due to new construction, retrofits and replacements for failed ballasts. After reviewing its assumptions for these three purchasing events, DOE adjusted its estimated shipments downward by approximately 30 percent for the final rule shipments analysis. See chapter 10 of the final rule TSD for additional details.

v. Efficiency Scenarios

Several of the inputs for determining NES (*e.g.,* the annual energy consumption per unit) and NPV (*e.g.,* the total annual installed cost and the total annual operating cost savings) depend on product efficiency.

For the April 2011 NOPR, DOE used two shipment efficiency scenarios: ''Roll-up'' and ''Shift.'' The Roll-up scenario is a standards case in which all product efficiencies in the base case that do not meet the standard would roll up to meet the new standard level.

[49] U.S. Department of Energy—Office of Energy Efficiency and Renewable Energy. *Solid-State Lighting Research and Development: Multi Year Program Plan.* March 2011 (Updated May 2011). Washington, DC Available at *http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/ssl_mypp2011_web.pdf.*

[50] California Energy Commission's 2013 Building Energy Efficiency Standards Rulemaking Web page. Available at *http://www.energy.ca.gov/title24/2013standards/prerulemaking/.* (Last accessed May 27, 2011.)

Consumers in the base case who purchase ballasts above the standard level are not affected as they are assumed to continue to purchase the same base-case ballast or lamp-and-ballast system. The Roll-up scenario characterizes consumers primarily driven by the first-cost of the analyzed products. In contrast, the Shift scenario models a standards case in which the standard affects all base-case consumer purchases (regardless of whether their base-case efficiency is below the standard). In this scenario, any consumer may purchase a more efficient ballast, preserving the same relationship to the baseline ballast efficiency. For example, if a consumer purchased a ballast one efficiency level above the baseline, that consumer would do the same after a standard is imposed. In this scenario, DOE assumed product efficiencies in the base case that do not meet the standard would roll up to meet the new standard level, as in a roll-up scenario. However, product efficiencies at or above the new standard level would shift to higher efficiency levels. As the standard level increases, market share incrementally accumulates at the highest standard level because it represents max tech (*i.e.,* moving beyond this efficiency level is not achievable with today's technology).

DOE received no comments on the April 2011 NOPR regarding its Roll-up and Shift efficiency scenarios and retained this approach for the final rule shipments analysis.

2. 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. 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.

For the April 2011 NOPR, DOE used annual site-to-source conversion factors based on the version of NEMS that corresponds to *AEO2010,* which provides energy forecasts through 2035. For 2036–2043, DOE used conversion factors that remain constant at the 2035 values.

Section 1802 of EPAct 2005 directed DOE to contract a study with the National Academy of Science (NAS) to examine whether the goals of energy efficiency standards are best served by measurement of energy consumed, and efficiency improvements, at the actual point-of-use or through the use of the full-fuel-cycle, beginning at the source of energy production (Pub. L. 109–58 (August 8, 2005)). NAS appointed a committee on ''Point-of-Use and Full-Fuel-Cycle Measurement Approaches to Energy Efficiency Standards'' to conduct the study, which was completed in May 2009. The NAS committee defined full-fuel-cycle energy consumption as including, in addition to site energy use, the following: 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.[51]

In evaluating the merits of using point-of-use and full-fuel-cycle measures, the NAS 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 NAS committee concluded that extended site energy consumption understates the total energy consumed to make an appliance operational at the site. As a result, the NAS committee recommended that DOE consider shifting its analytical approach over time to use a full-fuel-cycle measure of energy consumption when assessing national and environmental impacts, especially with respect to the calculation of greenhouse gas emissions. The NAS committee also recommended that DOE provide more comprehensive information to the public through labels and other means, such as an enhanced Web site. For those appliances that use multiple fuels (*e.g.,* water heaters), the NAS committee indicated that measuring full-fuel-cycle energy consumption would provide a more complete picture of energy consumed and permit comparisons across many different appliances, as well as an improved assessment of impacts.

In response to the NAS recommendations, DOE issued, on August 20, 2010, a Notice of Proposed Policy proposing to incorporate a full-fuel cycle analysis into the methods it uses to estimate the likely impacts of energy conservation standards on energy use and emissions. Specifically, DOE proposed to use full-fuel-cycle (FFC) measures of energy and GHG emissions, rather than the primary (extended site) energy measures it currently uses. Additionally, DOE proposed to work collaboratively with the FTC to make FFC energy and GHG emissions data available to the public to enable consumers to make cross-class comparisons. On October 7, 2010, DOE held an informal public meeting to discuss and receive comments on its planned approach. The Notice, a transcript of the public meeting and all public comments received by DOE are available at: *http://www.regulations.gov/search/Regs/home.html#docketDetail?R=EERE-2010-BT-NOA-0028.* Following the close of the public comment period, DOE issued a final policy statement on these subjects and will take steps to begin implementing that policy in future rulemakings and other activities. 76 FR 51281 (August 18, 2011). The Statement of Policy is available at: *http://www.gpo.gov/fdsys/pkg/FR-2011-08-18/pdf/2011-21078.pdf.*

G. Consumer Sub-Group Analysis

In analyzing the potential impact of new or amended standards on consumers, DOE evaluates the impact on identifiable sub-groups of consumers (*e.g.,* low-income households) that a national standard may disproportionately affect. DOE received no comments regarding specific sub-groups and, therefore, evaluated the same sub-groups addressed in the 2009 Lamps Rule, assuming that consumers using GSFL would share similar characteristics with ballast consumers. Specifically, DOE evaluated the following consumer sub-groups for the April 2011 NOPR: low-income households; institutions of religious worship; and institutions that serve low-income populations (*e.g.,* small nonprofits). DOE received no comments on the April 2011 NOPR regarding its choice of consumer sub-groups, and retained this approach for this final rule. The final rule TSD chapter 12 presents the consumer subgroup analysis.

[51] The National Academies, Board on Energy and Environmental Systems, Letter to Dr. John Mizroch, Acting Assistant Secretary, U.S. DOE, Office of Energy Efficiency and Renewable Energy from James W. Dally, Chair, Committee on Point-of-Use and Full-Fuel-Cycle Measurement Approaches to Energy Efficiency Standards, May 15, 2009.

H. Manufacturer Impact Analysis

DOE performed an MIA to estimate the financial impact of new and amended energy conservation standards on manufacturers of ballasts, and to calculate the impact of such standards on employment and manufacturing capacity. The MIA has both quantitative and qualitative aspects. The quantitative part of the MIA primarily relies on the GRIM, an industry cash-flow model using inputs specific to this rulemaking. The key GRIM inputs are data on the industry cost structure, product costs, shipments, and assumptions about markups and conversion expenditures. The key output is the INPV. 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 new and amended standards on manufacturers. Different sets of shipment and markup assumptions (scenarios) will produce different results. The qualitative part of the MIA addresses factors such as product characteristics, characteristics of and impacts on particular sub-groups of firms, and important market and product trends. DOE outlined its complete methodology for the MIA in the NOPR. 76 FR 20090, 20134 (April 11, 2011). Chapter 13 of the TSD outlines the complete MIA.

1. Product and Capital Conversion Costs

New and amended energy conservation standards will cause manufacturers to incur conversion costs to bring their production facilities and product designs into compliance. For the MIA, DOE classified these conversion costs into two major groups: (1) product conversion costs and (2) capital conversion costs. For the final rule, DOE converted the NOPR product and capital conversion costs to 2010$ from 2009$ using the producer price index (PPI) for the relevant industry. The PPI is disaggregated into each North American Industry Classification System (NAICS) code. For fluorescent lamp ballasts, DOE updated the conversion costs using the specific PPI index under NAICS code 335311—''Electric power and specialty transformer manufacturing'' and series ID PCU3353113353115—''Fluorescent lamp ballasts.'' DOE's estimates of the product and capital conversion costs for fluorescent lamp ballasts can be found in section VII.B.2.a, of today's final rule and in chapter 13 of the TSD.

a. Product Conversion Costs

Product conversion costs are investments in research, development, testing, marketing, and other non-capitalized costs necessary to make product designs comply with the new or amended energy conservation standard.DOE based its estimates of the product conversion costs that would be required to meet each TSL on information obtained from manufacturer interviews, the engineering analysis, the NIA shipment analysis, and market information about the number of models and stock-keeping units (SKUs) each major manufacturer supports. This methodology, described in full in the April 2011 NOPR (76 FR 20090, 20136 (April 11, 2011)), centers on an assessment of the number of models and SKUs manufacturers will need to upgrade to meet new and amended standards. DOE applied a per-model and per-SKU cost to every product currently offered by manufacturers that does not meet the analyzed standard levels.

Several stakeholders questioned this methodology, arguing that DOE's assumption that manufacturers would upgrade all models that do not currently meet existing standards leads to overstated conversion cost estimates. In reality, manufacturers would not upgrade non-compliant models in product categories where they already offer similar compliant models. (NEEA and NPCC, No. 44 at pp. 7–8; CA Utilities, No. 45 at pp. 7–8) Similarly, NEEA and NPCC stated that manufacturers may not upgrade all non-compliant product lines as they shift resources away from fluorescent lighting toward emerging technologies such as solid-state lighting. (NEEA and NPCC, No. 44 at p. 8)

In contrast, manufacturers argued that full product line upgrades would be necessary to compete. GE explained that manufacturers must upgrade non-compliant models even in categories in which compliant models currently exist because today's high efficiency products generally bundle additional premium features at a higher cost. These premium features, such as Type CC protection, cold temperature rating, case size, and lamp striation control, are detailed in the April 2011 NOPR. 76 FR 20090, 20108–9 (April 11, 2011). To remain competitive, manufacturers would need to offer compliant products stripped of these premium features to the cost-conscious OEM channels. (GE, Public Meeting Transcript, No. 43 at p. 217) Philips emphasized that manufacturers cannot simply ignore the ballast market by choosing not to make the necessary investments to meet today's standards because it represents an important part of the lighting business. (Philips, Public Meeting Transcript, No. 43 at pp. 213–4)

Although DOE's max tech efficiency levels do not preclude ballasts with premium features, DOE agrees that competition in the OEM channel would force manufacturers to offer a low-cost product at the new baseline standard level. The large fixture manufacturers that compose the OEM channel are price-sensitive, and their large orders afford them substantial buying power. Their business is valuable to the ballast industry because the manufacturers rely on these high-volume orders to improve plant utilization and lower fixed costs per unit for all models. As such, DOE does not predict that large ballast manufacturers can afford to ignore the demand for these commoditized[52] products. DOE also finds it unreasonable to assume that manufacturers would forego investment in the ballast market due to a shifting focus on emerging technologies because ballast sales currently generate significant revenue for these companies. For these reasons, DOE has not adjusted its methodology for determining the number of models that would need to be upgraded in response to standards.

b. Capital Conversion Costs

Capital conversion costs are investments in property, plant, and equipment necessary to adapt or change existing production facilities such that new product designs can be fabricated and assembled. Estimates for capital conversion costs varied greatly from manufacturer to manufacturer, as manufacturers anticipated different paths to compliance based on the modernity, flexibility, and level of automation of the equipment already existing in their factories. However, all manufacturers DOE interviewed indicated that capital costs would be relatively moderate compared to the required engineering costs. 76 FR 20090, 20136 (April 11, 2011).

2. Markup Scenarios

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 preservation of operating profit markup scenario, and (2) a two-tier markup scenario. These scenarios lead to

[52] In this final rule, we define 'commoditized' to mean that a large number of products are produced by many manufacturers, such that the products are differentiated only by price.

different markups values, which, when applied to the inputted MPCs, result in varying revenue and cash flow impacts.

The preservation of operating profit markup scenario assumes that manufacturers are able to maintain the base-case total operating profit in absolute dollars in the standards case, despite higher product costs and investment. DOE adjusted the manufacturer markups in the GRIM 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 new and amended standards as in the base case. The preservation of operating profit markup scenario represents the upper bound of industry profitability following amended energy conservation standards. Under this scenario, while manufacturers are not able to yield additional operating profit from higher production costs and the investments required to comply with the new and amended energy conservation standard, they are able to maintain the same operating profit in the standards case as in the base case.

DOE also modeled a lower bound profitability scenario with the two-tier markup scenario. In this scenario, DOE assumed that the markup on fluorescent lamp ballasts varies according to two efficiency tiers in both the base case and the standards case. DOE used information from MIA interviews to estimate markups for fluorescent lamp ballasts under a two-tier pricing strategy in the base case. In the standards case, DOE modeled the situation in which portfolio reduction squeezes the margin of higher-efficiency products as they become the new baseline, presumably high-volume products. 76 FR 20090, 20137 (April 11, 2011).

3. Other Key GRIM Inputs

Key inputs to the GRIM characterize the fluorescent lamp ballast industry cost structure, investments, shipments, and markups. For today's final rule, DOE made several updates to the GRIM to reflect changes in these inputs. These updates do not represent changes in methodology from the April 2011 NOPR. Specifically, DOE incorporated changes made in the engineering analysis and NIA, including updates to the MPCs, shipment forecasts, and shipment efficiency distributions. These updated inputs affected the values calculated for the conversion costs and markups described above, as well as the INPV results presented in section VII.B.2.

4. Other Comments From Interested Parties

The following section discusses a number of other comments DOE received on the April 2011 NOPR MIA methodology.

a. Fixture Redesigns for Ballast Can Size Changes

Several interested parties commented that new and amended standards could drive larger ballast designs, which would result in product redesign and tooling costs for fixture manufacturers because fixtures are built for a particular ballast can size. NEMA stated that increasing efficiency by employing additional circuitry to reduce variation would drive larger case sizes. (NEMA, No 47 at p. 9) At the same time, the market has trended over time toward the use of smaller can sizes (from the standard can to the A-can and, most recently, from the A-can to the N-can). Larger can sizes would reverse this trend and cost fixture manufacturers tens of millions of dollars each, according to NEMA and Acuity Brands. Accordingly, these fixture redesign costs should be included in DOE's analysis. (NEMA, Public Meeting Transcript, No. 43 at pp. 33–4, 36–7; Acuity Brands, Public Meeting Transcript, No. 43 at pp. 171–2)

DOE recognizes that the fluorescent lamp ballast market has trended over time toward the use of smaller can sizes. For today's final rule, as discussed in section V.B.5.a, DOE is not analyzing any efficiency levels that would eliminate manufacturers' ability to meet standard levels with the smaller N-cans. DOE has accounted for sources of variation and compliance certification requirements, as described in section V.B.4, and does not project that ballasts will grow in size in response to standards. As such, fixture manufacturers will not incur product redesign and tooling costs to accommodate larger ballasts.

b. Potential Benefits to Ballast Manufacturers

ASAP noted that energy conservation standards for fluorescent lamp ballasts could accelerate the adoption of emerging technologies. Because ballast manufacturers often also offer these emerging technologies and can typically command higher margins on these emerging technology products, ballast manufacturers could be less affected by standards than estimated by DOE. (ASAP, Public Meeting Transcript, No. 43 at pp. 209–11)

As addressed in response to comments in the April 2011 NOPR (76 FR 20090, 20138 (April 11, 2011)), the potential exists for the market to increasingly migrate from traditional fixed light output fluorescent lamp ballasts to alternate technologies such as LEDs and dimming ballasts. DOE therefore models the emerging technologies shipment scenario as described in section V.F.1.c and in chapter 10 of the TSD. This market shift to emerging technologies occurs in the base case. That is, the shift is not standards-induced. DOE excludes the revenue from substitute technologies earned by manufacturers who produce ballasts in the GRIM because the revenue stream would be present in both the base case and the standards case, resulting in no impact on the change in INPV.

c. Opportunity Cost of Investments

NEMA and Philips stated that the TSL proposed in the April 2011 NOPR (76 FR 20090, 20166–9 (April 11, 2011)) would have a high opportunity cost due to the limited capital for investment and R&D. Any investments incurred to meet amended ballast standards would reflect foregone investments in emerging technologies such as solid state lighting and controls, and reduced wattage lamp and ballast systems, which the industry believes offer both better prospects for market growth and greater potential for energy savings than traditional fixed-light-output fluorescent lamp ballasts. (Philips, Public Meeting Transcript, No. 43 at pp. 212–3; NEMA, Public Meeting Transcript, No. 43 at pp. 40–1; NEMA, No. 47 at pp. 9, 11) Specifically, NEMA argued that the investments necessary to meet new and amended ballast standards would be better spent developing new technologies that can save far more energy than the 2 to 3 percent additional energy savings this standard would generate. (NEMA, No. 52 at p. 10) NEMA also stated that the proposed rule provided no clear incentive for manufacturers to comply with standards by making already highly efficient products even more efficient. (NEMA, No. 47 at p. 9)

DOE recognizes that there is an opportunity cost associated with any investment, and agrees that manufacturers would need to spend capital to meet today's standard that they would not have to spend in the base case. As a result, manufacturers must determine the extent to which they will balance investment in the traditional ballast market with that in emerging technologies or other ventures. DOE includes the product and capital conversion costs necessary to meet today's standard in its analysis.

d. Component Availability

OSI stated that there are currently long lead times for many electronic components. As DOE standards push the fluorescent lamp ballast industry to higher efficiency components, manufacturers will have limited choices in what components they are able to receive from suppliers, causing longer product lead times and decreased product availability. (OSI, Public Meeting Transcript, No. 43 at p. 65)

DOE recognized this component shortage in the April 2011 NOPR (76 FR 20090, 20139 (April 11, 2011)), but DOE projects limited component availability to be a relatively short term phenomenon arising from the capacity reduction that occurred in the recent recession and that component suppliers will ultimately adjust. DOE addresses this issue again in full in section VII.B.2.c of today's notice.

e. Impact on Competition

NEMA stated that manufacturers may lose their ability to differentiate their products because they will need to remove premium features to meet price pressure and proposed standard levels. This would force all manufacturers to offer the same basic product. NEMA states that DOE should ensure that manufacturers are able to offer products above the standard in order to differentiate themselves. (NEMA, No. 47 at p. 9) NEEP, while agreeing that high efficiency ballasts may be commoditized by this standard, states that manufacturers will retain opportunities for differentiation by focusing on dimming ballasts and controls. (NEEP, No. 49 at pp. 3–4)

DOE agrees that ballast manufacturers may not be able to maintain today's margins after standards become effective, particularly in the short run, as demonstrated by the markup scenarios described in section V.H.2. DOE disagrees, however, that manufacturers will no longer be able to differentiate themselves. For some minimally compliant products, DOE agrees with manufacturers that price competition will play a large role in the market, as is currently the case. Manufacturers may continue to differentiate in domains other than price, including premium features such as Type CC protection, cold temperature rating, case size, and lamp striation control. Because of this effort to differentiate, as discussed in the section V.H.1, DOE included costs associated with upgrading non-compliant products, even when a compliant product already exists in the category. Therefore, DOE believes NEMA's concerns are accounted for in DOE's analysis.

NEMA stated that manufacturers may not be able to complete the redesigns needed to meet the max tech levels proposed in the April 2011 NOPR (76 FR 20090 (April 11, 2011)). (NEMA, No. 47 at p. 9) NEEP, however, believes that by setting efficiency levels such that a select subset of existing NEMA Premium ballasts qualify at today's standard levels, the market would not be faced with a shortage of qualifying products and major shift in R&D resources. (NEEP, No. 49 at p. 2)

At TSL 3A, the level promulgated in today's final rule, DOE projects that 38 percent of shipments already meet the standard. The reconciliation of the DOE and NEMA test data and the substantial share of shipments at the proposed level indicate that the industry will be able to meet market demand by the compliance date.

5. Manufacturer Interviews

DOE interviewed manufacturers representing more than 90 percent of fluorescent lamp ballast sales. These interviews were in addition to those DOE conducted as part of the engineering analysis. DOE outlined the key issues for the rulemaking for manufacturers in the NOPR. 76 FR 20090, 20139–40 (April 11, 2011). DOE considered the information received during these interviews in the development of the NOPR and this final rule.

6. Sub-Group Impact Analysis

During the NOPR phase, DOE identified two sub-groups for a separate impact analysis—small manufacturers and sign ballast manufacturers. DOE describes the impacts on small manufacturers in section VIII.B and the impacts on sign ballast manufacturers in section VII.B.2.d.

I. Employment Impact Analysis

DOE considers employment impacts in the domestic economy as one factor in selecting a standard. Employment impacts consist of direct and indirect impacts. Direct employment impacts are any changes in the number of employees working for manufacturers of the appliance products that are the subject of this rulemaking, their suppliers, and related service firms. The MIA addresses the direct employment impacts that concern ballast manufacturers in section VII.B.2.b. Indirect employment impacts are changes in employment within the larger economy that occur due to the shift in expenditures and capital investment caused by the purchase and operation of more efficient products, and are addressed in this section.

The indirect employment impacts of standards consist of the net jobs created or eliminated in the national economy, outside of the manufacturing sector being regulated, due to: (1) Reduced spending on energy by end users; (2) reduced spending on new energy supplies 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, and expects these shifts in spending and economic activity to affect the demand for labor in the short term.

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

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

In developing today's adopted standards, DOE estimated indirect national employment impacts using an input-output (I–O) model of the U.S. economy called Impact of Sector Energy Technologies (ImSET), version 3.1.1. 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. (Roop, J.M., 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*.) ImSET is a special purpose version of the ''U.S. Benchmark National Input-Output'' model, designed to estimate the national employment and income effects of energy-saving technologies. The ImSET software includes a computer-based I–O model with structural coefficients to characterize economic flows among the 187 sectors. ImSET's national economic I–O structure is based on a 2002 U.S. benchmark table (Stewart, R.L., J.B. Stone, and M.L. Streitwieser, ''U.S. Benchmark Input-Output Accounts, 2002,'' *Survey of Current Business* (Oct. 2007)), specially aggregated to the 187 sectors. DOE estimated changes in expenditures using the NIA spreadsheet. Using ImSET, DOE estimated the net national, indirect-employment impacts on employment by sector of the trial standard levels for ballasts.

DOE notes that ImSET is not a general equilibrium forecasting model, and understands the uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis.[4] Because ImSET does not incorporate price changes, the employment effects predicted by ImSET may over-estimate actual job impacts over the long run for this rule. Because ImSET predicts small job impacts resulting from this rule, regardless of these uncertainties, the actual job impacts are likely to be negligible in the overall economy. DOE may consider the use of other modeling approaches for examining long run employment impacts.

DOE also notes that the employment impacts estimated with ImSET for the entire economy differ from the employment impacts in the lighting manufacturing sector estimated in Chapter 13 using the Government Regulatory Impact Model (GRIM). The methodologies used and the sectors analyzed in the ImSET and GRIM models are different.

DOE received two comments on the April 2011 NOPR, inquiring whether DOE's employment analysis accounted for effects on ballast manufacturer employment, and if sector-specific results could be extracted from the ImSET model output. (Acuity Brands, Public Meeting Transcript, No. 43 at p. 229; Philips, Public Meeting Transcript, No. 43 at p. 227.) As discussed previously in this section, DOE's employment analysis models national effects on indirect employment (excluding ballast manufacturers) due to shifts in expenditures and capital investment caused by the purchase and operation of more efficient appliances. As previously noted, the MIA addresses direct employment impacts on ballast manufacturers in section VII.B.2.b.

DOE notes that the indirect employment numbers generated by ImSET are an estimate of the job impacts of the projected national energy and cost savings resulting from new or amended standards. These calculated impacts assume that the 187 sectors in the ImSET model are unchanged from the time that the I–O parameters were estimated (last updated in 2008 using year 2002 Economic Census data). As noted in the ImSET documentation, actual job creation will depend on future labor market supply conditions and macroeconomic policy.

DOE reviewed current ImSET sectoral details and identified one economic sector that corresponds with lighting product manufacturers, excluding lamp bulb and related parts (sector S111, Lighting Fixture Manufacturing). While this sector could encompass some ballast manufacturers, DOE notes that it is not exclusively representative of ballasts. Further, while ImSET can produce gross product impacts (in dollars) by sector, it does not produce sector-specific employment figures. Rather, ImSET characterizes economic flows among and interactions between 187 sectors in the model. Producing sector-specific employment figures would require DOE to artificially constrain its ImSET input data, which could reduce the meaningfulness of the results. DOE therefore did not calculate sector S111 employment figures, and retained its NOPR employment analysis approach for this final rule.

For more details on the employment impact analysis, see chapter 15 of the final rule TSD.

J. Utility Impact Analysis

The utility impact analysis includes estimates of the effects of the adopting new or amended standards on the utility industry. For this analysis, DOE used the NEMS–BT model to generate forecasts of electricity consumption, electricity generation by plant type, and electricity generating capacity by plant type that would result from each TSL. The estimated impacts of a standard are estimated to be the differences between values forecasted by NEMS–BT and the values in the *AEO2010* reference case.

In response to the April 2011 NOPR, NEEA, NPCC and NEEP commented that DOE did not consider the avoided costs of power plant construction corresponding to the avoided generation capacity from new or amended standards. By NEEA and NPCC's estimates, the present value cost of new generation capacity to supply the cumulative energy savings at TSL 3 would nearly equal DOE's cumulative NPV at TSL 3 (which excludes avoided power plant and infrastructure construction). NEEA and NPCC further suggested that DOE examine the difference in the value of total electricity sales between the NEMS–BT reference case and standards level cases, which could serve as a proxy for the economic value of the standard level to all electricity consumers. (NPCC, Public Meeting Transcript, No. 43 at p. 223; NEEA and NPCC, No. 44 at pp. 9–10) NEEP also commented that decreased demand is shown to drive energy prices down, benefiting consumers in general. (NEEP, No. 49 at p. 4)

DOE acknowledges that the aggregate economic benefits from avoided construction of new generating capacity and infrastructure are potentially large. However, there may be negative effects on some of the actors involved in electricity supply, particularly power plant providers and fuel suppliers. There is also uncertainty about the extent to which the benefits for electricity users from reduced electricity prices would be a transfer from actors involved in electricity supply to electricity consumers. DOE also takes under advisement the guidance provided by the Office of Management and Budget (OMB) to Federal agencies on identifying and measuring benefits and costs in its regulatory analyses (OMB Circular A–4, section E, September 17, 2003). Specifically, at page 38, Circular A–4 instructs that transfers should be excluded from the estimates of the benefits and costs of a regulation. DOE applied this approach for the utility impact analysis in the April 2011 NOPR, as well as in this final rule.

DOE is continuing to investigate the extent to which projected changes in electricity prices that result from standards represent a net economic gain to the nation. In response to the comments discussed in this section, DOE included the estimated effects of adopted standards on electricity prices and the cumulative NPV of resulting savings in electricity expenditures in the TSD. DOE also included in the TSD representative costs of avoided electricity generation capacity by fuel type, although these costs are provided for illustrative purposes only. For more details on the utility impact analysis, see chapter 14 of the final rule TSD.

K. Environmental Assessment

Pursuant to the National Environmental Policy Act of 1969 and the requirements of DOE Order 451.1B: NEPA Compliance Program, DOE has prepared an environmental assessment (EA) of the impacts of the new and amended standards for ballasts in this final rule, which it has included as chapter 16 of the final rule TSD. DOE found that the environmental effects associated with the standards for ballasts were not significant. Therefore, DOE is issuing a Finding of No Significant Impact (FONSI), pursuant to NEPA, the regulations of the Council on Environmental Quality (40 CFR parts 1500–1508), and DOE's regulations for compliance with NEPA (10 CFR part 1021). The FONSI is available in the docket for this rulemaking.

In the EA, DOE estimated the reduction in power sector emissions of CO_2, NO_X, and Hg using the NEMS–BT computer model. In the EA, NEMS–BT is run similarly to the AEO NEMS, except that ballast energy use is reduced by the amount of energy saved (by fuel type) due to each TSL. The inputs of national energy savings come from the NIA spreadsheet model, while the output is the forecasted physical emissions. The net benefit of each TSL in today's final rule is the difference between the forecasted emissions estimated by NEMS–BT at each TSL and the *AEO2010* Reference Case. NEMS–BT tracks CO_2 emissions using a detailed module that provides results with broad coverage of all sectors and inclusion of interactive effects.

Sulfur dioxide (SO_2) emissions from affected electricity generating units (EGUs) are subject to nationwide and regional emissions cap-and-trade programs, and DOE has preliminarily determined that these programs create uncertainty about the potential amended standards' impact on SO_2 emissions. Title IV of the Clean Air Act sets an annual emissions cap on SO_2 for affected EGUs in the 48 contiguous States and the District of Columbia (DC). SO_2 emissions from 28 eastern states and DC are also limited under the Clean Air Interstate Rule (CAIR; 70 FR 25162 (May 12, 2005)), which created an allowance-based trading program. Although CAIR was remanded to the Environmental Protection Agency (EPA) by the U.S. Court of Appeals for the District of Columbia Circuit (DC Circuit) (see *North Carolina* v. *EPA,* 550 F.3d 1176 (DC Cir. 2008)), it remained in effect temporarily, consistent with the DC Circuit's earlier opinion in *North Carolina* v. *EPA,* 531 F.3d 896 (DC Cir. 2008). On July 6, 2010, EPA issued the Transport Rule proposal, a replacement for CAIR (75 FR 45210 (Aug. 2, 2010)), and on July 6, 2011 EPA issued the final Transport Rule, entitled the Cross-State Air Pollution Rule. 76 FR 48208 (August 8, 2011). (*http://www.epa.gov/crossstaterule/*). Because the *AEO2010* NEMS used for today's final rule assumes the implementation of CAIR, DOE has not been able to take into account the effects of the Transport Rule for this rulemaking.[53]

The attainment of emissions caps is typically flexible among EGUs and is enforced through the use of emissions allowances and tradable permits. Under existing EPA regulations, any excess SO_2 emissions 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 new and amended standards resulted in a permanent increase in the quantity of unused emissions 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.

As discussed above, the *AEO2010* NEMS used for today's final rule assumes the implementation of CAIR, which established a cap on NO_X emissions in 28 eastern states and the District of Columbia. With CAIR in effect, the energy conservation standards for ballasts are expected to have little or no physical effect on NO_X emissions in those states covered by CAIR, for the same reasons that they may have little effect on SO_2 emissions. However, the adopted standards would be expected to reduce NO_X emissions in the 22 states not affected by CAIR. For these 22 states, DOE used the NEMS–BT to estimate NO_X emissions reductions from the standards considered in today's final rule.

Similar to emissions of SO_2 and NO_X, future emissions of Hg would have been subject to emissions caps. In May 2005, EPA issued the Clean Air Mercury Rule (CAMR). 70 FR 28606 (May 18, 2005). CAMR would have permanently capped emissions of Hg for new and existing coal-fired power plants in all states by 2010. However, on February 8, 2008, the DC Circuit issued a decision in *New Jersey* v. *Environmental Protection Agency,* 517 F.3d 574 (DC Cir. 2008), in which it vacated CAMR. EPA has decided to develop emissions standards for power plants under Section 112 of the Clean Air Act, consistent with the DC Circuit's opinion on CAMR. See *http://www.epa.gov/air/mercuryrule/pdfs/certpetition_withdrawal.pdf.* Pending EPA's forthcoming revisions to the rule, DOE is excluding CAMR from its environmental assessment. In the absence of CAMR, a DOE standard would likely reduce Hg emissions and DOE used NEMS–BT to estimate these reductions. However, DOE continues to review the impact of rules that reduce energy consumption on Hg emissions, and may revise its assessment of Hg emission reductions in future rulemakings.

L. Monetizing Carbon Dioxide and Other Emissions Impacts

As part of the development of this final rule, DOE considered the estimated monetary benefits likely to result from the reduced emissions of CO_2 and NO_X that are expected to result from each of the TSLs considered. In order to make this calculation similar to the calculation of the NPV of consumer benefit, DOE considered the reduced emissions expected to result over the lifetime of products shipped in the forecast period for each TSL. This section summarizes the basis for the monetary values used for each of these emissions and presents the values considered in this rulemaking.

For today's final rule, DOE is relying on a set of values for the SCC that was developed by an interagency process. A summary of the basis for these values is provided in the following sections, and a more detailed description of the methodologies used is provided as an appendix to chapter 17 of the final rule TSD.

1. Social Cost of Carbon

Under section 1(b) of Executive Order 12866, agencies must, to the extent permitted by law, ''assess both the costs

[53] DOE notes that future iterations of the NEMS–BT model will ncorporate any changes necessitated by issuance of the Transport Rule.

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

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

a. Monetizing Carbon Dioxide Emissions

The SCC is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services. Estimates of the SCC are provided in dollars per metric ton of CO_2.

When attempting to assess the incremental economic impacts of CO_2 emissions, the analyst faces a number of serious challenges. A recent report from the National Research Council [54] points out that any assessment will suffer from uncertainty, speculation, and lack of information about (1) Future emissions of greenhouse gases, (2) the effects of past and future emissions on the climate system, (3) the impact of changes in climate on the physical and biological environment, and (4) the translation of these environmental impacts into economic damages. As a result, any effort to quantify and monetize the harms associated with climate change will raise serious questions of science, economics, and ethics and should be viewed as provisional.

Despite the serious limits of both quantification and monetization, SCC estimates can be useful in estimating the social benefits of reducing CO_2 emissions. Consistent with the directive in Executive Order 12866 quoted previously in this section, the purpose of the SCC estimates presented here is to make it possible for Federal agencies to incorporate the social benefits from reducing CO_2 emissions into cost-benefit analyses of regulatory actions that have small, or ''marginal,'' impacts on cumulative global emissions. Most Federal regulatory actions can be expected to have marginal impacts on global emissions.

For such policies, the agency can estimate the benefits from reduced (or costs from increased) emissions in any future year by multiplying the change in emissions in that year by the SCC value appropriate for that year. The net present value of the benefits can then be calculated by multiplying each of these future benefits by an appropriate discount factor and summing across all affected years. This approach assumes that the marginal damages from increased emissions are constant for small departures from the baseline emissions path, an approximation that is reasonable for policies that have effects on emissions that are small relative to cumulative global CO_2 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. This concern is not applicable to this notice, and DOE does not attempt to answer that question here.

At the time of the preparation of this notice, the most recent interagency estimates of the potential global benefits resulting from reduced CO_2 emissions in 2010, expressed in 2010$, were $4.9, $22.3, $36.5, and $67.6 per metric ton avoided. For emissions 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,[55] 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 2 years or at such time as substantially updated models become available, and to continue to support research in this area. In the meantime, the interagency group will continue to explore the issues raised by this analysis and consider public comments as part of the ongoing interagency process.

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

To date, economic analyses for Federal regulations have used a wide range of values to estimate the benefits associated with reducing CO_2 emissions. In the final model year 2011 CAFE rule, the U.S. Department of Transportation (DOT) used both a ''domestic'' SCC value of $2 per ton of CO_2 and a ''global'' SCC value of $33 per ton of CO_2 for 2007 emission reductions (in 2007$), increasing both values at 2.4 percent per year.[56] DOT also included a sensitivity analysis at $80 per ton of CO_2. See *Average Fuel Economy Standards Passenger Cars and Light Trucks Model Year 2011,* 74 FR 14196 (March 30, 2009) (Final Rule); Final Environmental Impact Statement Corporate Average Fuel Economy Standards, Passenger Cars and Light Trucks, Model Years 2011–2015 at 3–90 (Oct. 2008) (Available at: *http://www.nhtsa.gov/fuel-economy*). A domestic SCC value is meant to reflect the value of damages in the United States resulting from a unit change in CO_2 emissions, while a global SCC value is meant to reflect the value of damages worldwide.

A 2008 regulation proposed by DOT assumed a domestic SCC value of $7 per ton of CO_2 (in 2006$) for 2011 emission reductions (with a range of $0–$14 for sensitivity analysis), also increasing at 2.4 percent per year. See *Average Fuel Economy Standards, Passenger Cars and Light Trucks, Model Years 2011–2015,* 73 FR 24352 (May 2, 2008) (Proposed Rule); Draft Environmental Impact Statement Corporate Average Fuel Economy Standards, Passenger Cars and Light Trucks, Model Years 2011–2015 at 3–58 (June 2008) (Available at: *http://www.nhtsa.gov/fuel-economy*). A regulation for

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

[55] It is recognized that this calculation for domestic values is approximate, provisional, and highly speculative. There is no a priori reason why domestic benefits should be a constant fraction of net global damages over time.

[56] Throughout this section, references to tons of CO_2 refer to metric tons.

packaged terminal air conditioners and packaged terminal heat pumps finalized by DOE in October of 2008 used a domestic SCC range of $0 to $20 per ton CO_2 for 2007 emission reductions (in 2007$). 73 FR 58772, 58814 (Oct. 7, 2008) In addition, EPA's 2008 Advance Notice of Proposed Rulemaking on Regulating Greenhouse Gas Emissions Under the Clean Air Act identified what it described as ''very preliminary'' SCC estimates subject to revision. 73 FR 44354 (July 30, 2008). EPA's global mean values were $68 and $40 per ton CO_2 for discount rates of approximately 2 percent and 3 percent, respectively (in 2006$ for 2007 emissions).

In 2009, an interagency process was initiated to offer a preliminary assessment of how best to quantify the benefits from reducing CO_2 emissions. To ensure consistency in how benefits are evaluated across agencies, the Administration sought to develop a transparent and defensible method, specifically designed for the rulemaking process, to quantify avoided climate change damages from reduced CO_2 emissions. The interagency group did not undertake any original analysis. Instead, it combined SCC estimates from the existing literature to use as interim values until a more comprehensive analysis could be conducted. The outcome of the preliminary assessment by the interagency group was a set of five interim values: global SCC estimates for 2007 (in 2006$) of $55, $33, $19, $10, and $5 per ton of CO_2. These interim values represent the first sustained interagency effort within the U.S. government to develop an SCC for use in regulatory analysis. The results of this preliminary effort were presented in several proposed and final rules and were offered for public comment in connection with proposed rules, including the joint EPA–DOT fuel economy and CO_2 tailpipe emission proposed rules.

c. Current Approach and Key Assumptions

Since the release of the interim values, the interagency group reconvened on a regular basis to generate improved SCC estimates, which were considered for this final rule. Specifically, the group considered public comments and further explored the technical literature in relevant fields. The interagency group relied on three integrated assessment models commonly used to estimate the SCC: the FUND, DICE, and PAGE models.[57] These models are frequently cited in the peer-reviewed literature and were used in the last assessment of the Intergovernmental Panel on Climate Change. Each model was given equal weight in the SCC values that were developed.

Each model takes a slightly different approach to model how changes in emissions result in changes in economic damages. A key objective of the interagency process was to enable a consistent exploration of the three models while respecting the different approaches to quantifying damages taken by the key modelers in the field. An extensive review of the literature was conducted to select three sets of input parameters for these models: climate sensitivity, socio-economic and emissions trajectories, and discount rates. A probability distribution for climate sensitivity was specified as an input into all three models. In addition, the interagency group used a range of scenarios for the socio-economic parameters and a range of values for the discount rate. All other model features were left unchanged, relying on the model developers' best estimates and judgments.

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 V.8.

TABLE V.8—SOCIAL COST OF CO_2, 2010–2050

[In 2007 dollars per metric ton]

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

It is important to recognize that a number of key uncertainties remain, and that current SCC estimates should be treated as provisional and revisable since they will evolve with improved scientific and economic understanding. The interagency group also recognizes that the existing models are imperfect and incomplete. As the National Research Council report mentioned in section V.L.1.a points out, 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 Federal agencies participating in the interagency process to estimate the SCC.

DOE recognizes the uncertainties embedded in the estimates of the SCC used for cost-benefit analyses. As such, DOE and others in the U.S. Government intend to periodically review and reconsider those estimates to reflect increasing knowledge of the science and economics of climate impacts, as well as

[57] The models are described in appendix 16–A of the final rule TSD.

improvements in modeling. In this context, statements recognizing the limitations of the analysis and calling for further research take on exceptional significance.

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 2010$ using the GDP price deflator. For each of the four cases specified, the values used for emissions 2010 were $4.9, $22.3, $36.5, and $67.6 per metric ton avoided (values expressed in 2010$).[58] To monetize the CO_2 emissions reductions expected to result from new and amended standards for ballasts, 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 17A of the final rule TSD, appropriately adjusted to 2010$. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the four cases using the specific discount rate that had been used to obtain the SCC values in each case.

2. Valuation of Other Emissions Reductions

DOE investigated the potential monetary benefit of reduced NO_X emissions from the TSLs it considered. As noted in the previous section, DOE has taken into account how new or amended energy conservation standards would reduce NO_X emissions in those 22 states that are not affected by the CAIR. DOE estimated the monetized value of NO_X emissions reductions resulting from the standard levels considered for today's final rule based on environmental damage estimates found in the relevant scientific 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 $450 to $4,623 per ton in 2010$).[59] In accordance with guidance from the U.S. Office of Management and Budget (OMB), 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.[60]

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

VI. Other Issues for Discussion

A. Proposed Standard Levels in April 2011 NOPR

In the April 2011 NOPR, DOE proposed to adopt the max tech level, which represented the highest level that was technologically feasible for a sufficient diversity of products (spanning several ballast factors, numbers of lamps per ballast, and types of lamps operated). DOE received several comments supporting the proposed standard levels. NEEP commented that assuming the test data discrepancy between DOE's and NEMA's data is resolved, the proposed standards would greatly benefit the Northeast region of the United States where energy prices are typically higher than the rest of the country, increasing the magnitude of life cycle cost savings for those consumers. They also observed that locking in strong efficiency levels for ballasts would complement the strong fluorescent lamp standards that are set to take effect on July 14, 2012. NEEP added that the NOPR proposal would help the Northeast region meet its energy savings and emission reduction goals including those set forward in Massachusetts' Global Warming Solutions Act of 2008. (NEEP, No. 49 at pp. 2–4)

EEI also supported the proposed standards and agreed they would be cost effective for the vast majority of commercial consumers based on the analysis and data put forward in the April 2011 NOPR. (EEI, No. 48 at p. 1)

In addition to the above feedback, DOE also received several comments that disagreed with the proposed standard levels. These comments are discussed in more detail in the following paragraphs.

NEMA disagreed with DOE's proposal to adopt the max tech efficiency levels. NEMA stated that, even when using DOE data, very few products met the proposed minimum BLE requirements. For example, only one residential, T5SO, and T5HO ballast met DOE's proposed standard levels. NEMA commented that the DOE is therefore using only one product to develop a rule. (NEMA, Public Meeting Transcript, No. 43 at p. 29–32) NEMA analyzed its own dataset and suggested an alternative level that allowed the majority of manufacturers' NEMA Premium products, which represent their most efficient product offerings. NEMA noted that although it is not shown in the submitted data, several products they manufacture are not NEMA Premium products and therefore would not meet their proposal. At a minimum, NEMA requested that two manufacturers' complete product lines be able to meet the standard levels. NEMA also added that they would support a proposal that does not create limited availability, disruption in the market, or extreme R&D redesign costs. (NEMA, Public Meeting Transcript, No. 43 at p. 41–5; NEMA, No. 47 at p. 6)

ASAP disagreed with NEMA's recommendation that all manufacturers' high efficiency products should meet the highest level. ASAP noted that based on the DOE data, there were two products that were compliant in each class. ASAP therefore approved of DOE's decision to adopt the max tech level. (ASAP, Public Meeting Transcript, No. 43 at p. 50–1; ASAP, No. 46 at p. 1) NEEP agreed and supported the result that only a subset of NEMA Premium products met the proposed standard. (NEEP, No. 49 at p. 1–2) CA Utilities also agreed that all products with a NEMA Premium designation should not meet the proposed standard because NEMA Premium covers a range of efficiency with some ballasts only meeting TSL1 or TSL2 as analyzed in the April 2011 NOPR. They noted that they reviewed the data and found that there is at least one product for each specific utility that meets the standard, though all manufacturers may not have an offering for each utility. (CA Utilities, Public Meeting Transcript, No. 43 at p. 62–3; CA Utilities, No. 45 at p. 4; CA Utilities, No. 58 at p. 3)

In response to the August 2011 NODA, NEMA recommended adopting lower efficiency levels for several of the product classes. NEMA recommended adopting EL2 instead of EL3 for the IS/RS and PS product classes because the incremental cost of product redesign at EL3 is not outweighed by the incremental energy savings between EL2 and EL3. NEMA added that at EL2, manufacturers would focus on retiring non-compliant products and improving existing product lines rather than redesigning a large number of models. (NEMA, No. 56 at p. 3)

For the same reasons, NEMA recommended adopting EL2 for the 8-foot HO IS/RS product class. They noted

[58] Table A1 presents SCC values through 2050. For DOE's calculation, it derived values after 2050 using the 3-percent per year escalation rate used by the interagency group.

[59] For additional information, refer to U.S. Office of Management and Budget, Office of Information and Regulatory Affairs, *2006 Report to Congress on the Costs and Benefits of Federal Regulations and Unfunded Mandates on State, Local, and Tribal Entities,* Washington, DC.

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

that the energy savings at EL2 are similar to those achieved at EL3 (the level proposed in the April 2011 NOPR), but EL3 imposes much greater costs on manufacturers. (NEMA, No. 56 at p. 3)

Finally, NEMA recommended EL1 as the standard level for residential ballasts because linear fluorescent technology is more efficient and cost-effective than other traditional technologies and therefore it does not make sense to increase the cost burden on this price-sensitive market. (NEMA, No. 47 at p. 4; NEMA, No. 56 at p. 3) EEI also commented on residential ballasts, stating that although they generally agreed with the proposed standard levels, they were concerned about the impacts of the standards on some residential consumers. EEI noted that according to the NOPR proposal, relative to the T8 baseline, 100 percent of consumers have increased life-cycle costs. 76 FR 20090, 20146 (April 11, 2011). (EEI, No. 48 at p. 2)

DOE determines efficiency levels as described in section V.B.5, and then assesses the impacts, including those on manufacturers and industry competition. DOE acknowledges that conversion costs increase at higher efficiency levels, but also notes that higher levels result in increased energy savings and NPV for the nation and increased LCC savings for consumers. Although each efficiency level may not allow a full product line from every manufacturer, DOE has concluded that, for the levels it is adopting in this final rule, the benefits outweigh the burdens. See section VII.C.2 for more details.

B. Universal Versus Dedicated Input Voltage

NEMA also expressed concern that the proposed standards may eliminate universal voltage ballasts from the market. NEMA commented that although dedicated voltage ballasts are more efficient, consumers demand universal voltage instead of dedicated voltage products. NEMA stated that manufacturers may need to shift back to the more efficient dedicated voltage products to meet the proposed standards. This shift away from universal voltage would go against industry and consumer demand. (NEMA, Public Meeting Transcript, No. 43 at p. 36) NEEA and NPCC commented that their data assessment strongly suggested ballast efficiency does not vary consistently by input voltage, and that universal voltage ballasts can be as efficient as, or more efficient than, fixed input voltage ballasts in any individual product class and utility category. (NEEA and NPCC, No. 44 at p. 3) CA Utilities also stated that based on experience and review of DOE's test data, they found no indication that universal voltage ballasts are consistently less efficient than dedicated voltage ballasts and that therefore universal and dedicated voltage ballasts should be held to the same standard levels. (NEMA, No. 56 at p. 3; CA Utilities, No. 45 at p. 6)

DOE agrees with the CA Utilities that test data shows universal voltage ballasts to be as efficient or more efficient than dedicated input voltage ballasts. DOE also recognizes that there is significant market demand for universal voltage fluorescent lamp ballasts. In both the April 2011 NOPR and this final rule, DOE's max tech efficiency levels are met by universal voltage ballasts. For the IS/RS product class, 80 percent (37 out of 46) of ballasts that meet the proposed standard are universal voltage ballasts; for the PS product class, over 95 percent (20 out of 21) are universal voltage ballasts. Therefore, DOE does not believe the final rule prohibits the manufacture and sale of universal voltage products.

C. Implementation of Adopted Standard Levels

In the April 2011 NOPR, DOE proposed that standards for all covered ballasts require compliance three years following publication of the final rule in the **Federal Register**. P.R. China noted that, for several product classes, DOE proposed increasing efficiency requirements by a large percentage and that adapting to the proposed standards could create a large burden on manufacturers. P.R. China suggested that DOE gradually phase in standards, transitioning from the lowest considered efficiency level through the higher efficiency levels to reach the proposed standard. P.R. China stated that this approach is internationally accepted and would ease the initial burden placed on manufacturers. (P.R. China, No. 51 at p. 3)

DOE acknowledges that for certain ballast types the standards adopted represent a large increase in efficiency relative to existing standards or the analyzed baseline. However, as described in section *VII.C.2,* DOE analyzed the burden on manufacturers pursuant to 42 U.S.C. 6295(o) and determined that it was outweighed by the benefits of the rule to consumers and the nation.

VII. Analytical Results and Conclusions

A. Trial Standard Levels

DOE analyzed the benefits and burdens of the TSLs developed for today's final rule. Table VII.1 presents the trial standard levels and the corresponding product class efficiency levels for all product classes. See the engineering analysis in section V.B.5 of this final rule for a more detailed discussion of the efficiency levels.

TABLE VII.1—TRIAL STANDARD LEVELS

Product class	TSL 1	TSL 2	TSL 3A	TSL 3B
IS and RS ballasts (not classified as residential) that operate 4-foot MBP lamps 2-foot U-shaped lamps 8-foot slimline lamps	EL1	EL2	EL3	EL3
PS ballasts (not classified as residential) that operate 4-foot MBP lamps 2-foot U-shaped lamps 4-foot MiniBP SO lamps 4-foot MiniBP HO lamps	EL1	EL2	EL3	EL3
IS and RS ballasts (not classified as sign ballasts) that operate: 8-foot HO lamps	EL1	EL2	EL2	EL3
PS ballasts (not classified as sign ballasts) that operate: 8-foot HO lamps	EL1	EL2	EL2	EL3
Sign ballasts that operate: 8-foot HO lamps	EL1	EL1	EL1	EL1
IS and RS residential ballasts that operate 4-foot MBP lamps 2-foot U-shaped lamps 8-foot slimline lamps	EL1	EL1	EL1	EL2
PS residential ballasts that operate	EL1	EL1	EL1	EL2

TABLE VII.1—TRIAL STANDARD LEVELS—Continued

Product class	TSL 1	TSL 2	TSL 3A	TSL 3B
4-foot MBP lamps 2-foot U-shaped lamps				

In this section, DOE presents the analytical results for the TSLs of the product classes that DOE analyzed directly (the ''representative product classes''). DOE scaled the standards for these representative product classes to create standards for other product classes that were not directly analyzed (the 8-foot HO PS and residential PS product classes), as set forth in chapter 5 of the final rule TSD.

TSL 1, which would set energy conservation standards at EL1 for all product classes, would eliminate the majority of currently available 4-foot MBP T12 RS (commercial and residential), low-efficiency 4-foot MBP T8 PS, magnetic 8-foot HO, and magnetic sign ballasts. Based on these impacts, TSL 1 would likely cause a migration from 4-foot MBP T12 RS ballasts (both commercial and residential) to 4-foot MBP T8 IS ballasts. TSL 1 also prevents inefficient T5 standard output and high output ballasts from becoming prevalent in future years. DOE would not anticipate any impact of TSL 1 on consumers of 8-foot slimline ballasts.

TSL 2 would establish energy conservation standards at EL2 for the IS/RS, PS, and 8-foot HO IS/RS product classes. This level would likely eliminate low efficiency two-lamp 4-foot MBP T8 IS commercial ballasts and the least efficient T12 8-foot slimline ballasts, causing a migration toward high efficiency two lamp 4-foot MBP T8 IS ballasts and 8-foot T8 slimline ballasts. DOE does not anticipate any impact of TSL 2 on four-lamp 4-foot MBP T8 IS ballast consumers. For PS ballasts, high-efficiency 4-foot MBP T8 ballasts and high-efficiency T5 standard output and high output ballasts are required at TSL 2. For the 8-foot HO IS/RS product class, this level would likely result in the elimination of the majority of current T12 electronic ballasts, but can be met with T8 electronic ballasts. As with TSL 1, TSL 2 would continue to use EL1 for the residential IS/RS product class, eliminating currently available 4-foot MBP T12 RS ballasts, but allowing higher efficiency T8 residential ballasts. In addition, the sign ballast efficiency level remains unchanged from TSL1.

TSL 3A would establish energy conservation standards at the maximum technologically feasible level for all product classes except for residential and 8-foot HO IS/RS product classes. As with TSL 2, the 8-foot HO IS/RS product class at TSL 3A results in the elimination of current T12 electronic ballasts, but can be met with T8 electronic ballasts. Consistent with TSLs 1 and 2, TSL 3A also requires EL1 for the residential IS/RS product class. This TSL represents the most stringent efficiency requirements where a positive LCC savings for each representative product class is maintained.

TSL 3B represents the maximum technologically feasible level for all product classes. This level would establish energy conservation standards at EL1 for sign ballasts, EL2 for residential IS/RS product classes, and EL3 for the commercial IS/RS and PS, and 8-foot HO IS/RS product classes. TSL 3B represents the highest EL analyzed in all representative product classes and is the max tech TSL. Ballasts that meet TSL 3B represent the most efficient models tested by DOE in their respective representative product classes.

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. Generally, these effects on individual consumers are best summarized by changes in LCCs and by the payback period. DOE calculated the LCC and PBP values for the potential standard levels considered in this rulemaking to provide key inputs for each TSL. These values are reported by product class in Table VII.12 through Table VII.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), or increase (net cost) relative to the baseline case. In limited cases, a more efficient (*i.e.,* higher BLE) ballast will have a higher total LCC and lower LCC savings than a less efficient ballast (*e.g.,* EL3 versus EL2 in Table VII.9). This is because the higher-EL ballast has a higher BF and system input power, resulting in higher operating costs than for the lower-EL ballast. The last column in each table contains the median PBPs for the consumer purchasing a design compliant with the TSL. Negative PBP values indicate a reduction of both operating costs and installed costs (*i.e.,* there is no purchase price increment for the consumer to recover). Entries of ''N/A'' indicate standard levels that do not reduce operating costs, which prevents the consumer from recovering the increased purchase cost. This scenario did not occur at any of the standard levels adopted by DOE in today's final rule.

The results for each TSL are presented relative to the energy use distribution in the base case (no amended standards), based on energy consumption under conditions of actual product use. The rebuttable presumption PBP is based on test values under conditions prescribed by the DOE test procedure, as required by EPCA. (42 U.S.C. 6295(o)(2)(B)(iii))

TABLE VII.2—PRODUCT CLASS 1—IS AND RS BALLASTS THAT OPERATE TWO 4-FOOT MBP LAMPS (COMMERCIAL, T12 BASELINE): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings			Median payback period* *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Event I: Replacement								
	Baseline	64	247	311				
1	1	57	225	282	29	0	100	−3.35
2	2	59	218	277	34	0	100	−1.66
3A, 3B	3	60	214	274	37	0	100	−1.30
Event II: New Construction/Renovation								
	Baseline	67	247	314				
1	1	59	222	281	32	0	100	−2.97
2	2	62	213	275	39	0	100	−1.43
3A, 3B	3	62	211	273	40	0	100	−1.19

*Negative PBP values indicate standards that reduce operating costs and installed costs.

TABLE VII.3—PRODUCT CLASS 1—IS AND RS BALLASTS THAT OPERATE TWO 4-FOOT MBP LAMPS (COMMERCIAL, T8 BASELINE): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings			Median payback period* *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Event I: Replacement								
1	Baseline/1	56	225	281				
2	2	59	218	277	5	0	100	3.62
3A, 3B	3	59	214	273	8	0	100	2.86
Event II: New Construction/Renovation								
1	Baseline/1	58	225	283				
2	2	61	216	277	7	0	100	2.76
3A, 3B	3	62	214	275	8	0	100	2.74

TABLE VII.4—PRODUCT CLASS 1—IS AND RS BALLASTS THAT OPERATE FOUR 4-FOOT MBP LAMPS: LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings			Median payback period *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Event I: Replacement								
1, 2	Baseline/2	78	412	490				
3A, 3B	3	81	403	484	7	0	100	2.65
Event II: New Construction/Renovation								
1, 2	Baseline/2	81	412	493				
3A, 3B	3	83	406	490	3	0	100	4.43

TABLE VII.5—PRODUCT CLASS 1—IS AND RS BALLASTS THAT OPERATE TWO 8-FOOT SLIMLINE LAMPS (T12 BASELINE): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings			Median payback period* *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Event I: Replacement								
1	Baseline/1	90	457	547				
2	2	90	432	521	26	0	100	−0.12
3A, 3B	3	90	425	514	33	0	100	0.01
Event II: New Construction/Renovation								
1	Baseline/1	92	457	549				
2	2	92	440	532	17	0	100	−0.17
3A, 3B	3	92	435	527	22	0	100	0.01

* Negative PBP values indicate standards that reduce operating costs and installed costs.

TABLE VII.6—PRODUCT CLASS 1—IS AND RS BALLASTS THAT OPERATE TWO 8-FOOT SLIMLINE LAMPS (T8 BASELINE): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings			Median payback period *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Event I: Replacement								
1, 2	Baseline/2	90	432	522				
3A, 3B	3	91	425	515	7	0	100	0.46
Event II: New Construction/Renovation								
1, 2	Baseline/2	93	432	524				
3A, 3B	3	93	426	519	5	0	100	0.61

TABLE VII.7—PRODUCT CLASS 2—PS BALLASTS THAT OPERATE TWO 4-FOOT MBP LAMPS: LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings			Median payback period *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Event I: Replacement								
	Baseline	59	205	263				
1, 2	2	60	191	251	12	0	100	1.09
3A, 3B	3	60	188	249	15	0	100	1.25
Event II: New Construction/Renovation								
	Baseline	61	205	266				
1, 2	2	62	191	253	13	0	100	1.09
3A, 3B	3	63	189	252	14	0	100	1.26

TABLE VII.8—PRODUCT CLASS 2—PS BALLASTS THAT OPERATE FOUR 4-FOOT MBP LAMPS: LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings			Median payback period *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Event I: Replacement								
	Baseline	77	375	452				
1	1	81	373	454	−2	100	0	20.52
2, 3A, 3B	3	83	363	446	6	1	99	6.00
Event II: New Construction/Renovation								
	Baseline	79	2375	454				
1	1	83	342	425	29	0	100	1.43
2, 3A, 3B	3	85	334	419	35	0	100	1.76

TABLE VII.9—PRODUCT CLASS 2—PS BALLASTS THAT OPERATE TWO 4-FOOT MINIBP SO LAMPS: LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings			Median payback period *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Event I: Replacement								
	Baseline	64	268	332				
1	1	64	251	315	18	0	100	0.05
2	2	66	240	306	27	0	100	0.55
3A, 3B	3	70	252	322	10	0	100	3.82
Event II: New Construction/Renovation								
	Baseline	66	268	335				
1	1	67	251	317	18	0	100	0.05
2	2	68	248	316	18	0	100	0.78
3A, 3B	3	73	242	315	19	0	100	2.41

TABLE VII.10—PRODUCT CLASS 2—PS BALLASTS THAT OPERATE TWO 4-FOOT MINIBP HO LAMPS: LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings			Median payback period *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Event I: Replacement								
	Baseline	64	357	421				
1	1	68	326	395	26	0	100	1.05
2	2	71	318	389	32	0	100	1.40
3A, 3B	3	74	319	393	28	0	100	2.03
Event II: New Construction/Renovation								
	Baseline	67	357	423				
1	1	71	326	397	26	0	100	1.05
2	2	74	323	397	26	0	100	1.63
3A, 3B	3	77	321	397	26	0	100	2.13

TABLE VII.11—PRODUCT CLASS 3—IS AND RS BALLASTS THAT OPERATE TWO 8-FOOT HO LAMPS (T12 BASELINE): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings			Median payback period* *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience: Net cost	Percent of consumers that experience: Net benefit	
Event I: Replacement								
	Baseline	116	631	747				
1	1	111	571	682	65	0	100	−0.66
2, 3A	2	97	420	517	230	0	100	−0.69
3B	3	101	413	514	233	0	100	−0.53
Event II: New Construction/Renovation								
	Baseline	119	631	750				
1	1	114	590	704	46	0	100	−0.98
2, 3A	2	99	517	616	134	0	100	−1.26
3B	3	103	513	616	134	0	100	−0.97

* Negative PBP values indicate standards that reduce operating costs and installed costs.

TABLE VII.12—PRODUCT CLASS 3—IS AND RS BALLASTS THAT OPERATE TWO 8-FOOT HO LAMPS (T8 BASELINE): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings			Median payback period *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience: Net cost	Percent of consumers that experience: Net benefit	
Event I: Replacement								
1, 2, 3A	Baseline/2	94	420	514				
3B	3	98	413	511	3	3	97	4.57
Event II: New Construction/Renovation								
1, 2, 3A	Baseline/2	96	420	517				
3B	3	100	417	517	−1	84	16	9.50

TABLE VII.13—PRODUCT CLASS 5—SIGN BALLASTS THAT OPERATE FOUR 8-FOOT HO LAMPS: LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings			Median payback period* *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience: Net cost	Percent of consumers that experience: Net benefit	
Event I: Replacement								
	Baseline	164	1,483	1,646				
1, 2, 3A, 3B	1	157	1,086	1,244	403	0	100	−0.16
Event II: New Construction/Renovation								
	Baseline	166	1,483	1,649				
1, 2, 3A, 3B	1	160	1,239	1,398	251	0	100	−0.26

* Negative PBP values indicate standards that reduce operating costs and installed costs.

TABLE VII.14—PRODUCT CLASS 6—IS AND RS BALLASTS THAT OPERATE TWO 4-FOOT MBP LAMPS (RESIDENTIAL, T12 BASELINE): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings			Median payback period* *years*
		Installed cost	Discounted operating cost	LCC*	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Event I: Replacement								
	Baseline	53	71	124				
1, 2, 3A	1	46	56	102	21	0	100	−5.46
3B	2	47	58	105	19	0	100	−4.92
Event II: New Construction/Renovation								
	Baseline	55	71	126				
1, 2, 3A	1	48	63	111	15	0	100	−9.45
3B	2	49	61	110	16	0	100	−6.35

* Negative PBP values indicate standards that reduce operating costs and installed costs.

TABLE VII.15—PRODUCT CLASS 6—IS AND RS BALLASTS THAT OPERATE TWO 4-FOOT MBP LAMPS (RESIDENTIAL, T8 BASELINE): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings			Median payback period* *years*
		Installed cost	Discounted operating cost	LCC*	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Event I: Replacement								
1, 2, 3A	Baseline/1	45	56	101				
3B	2	46	58	104	−2	100	0	N/A
Event II: New Construction/Renovation								
1, 2, 3A	Baseline/1	47	56	104				
3B	2	49	55	103	1	27	73	8.18

* Entries of "N/A" indicate standard levels that do not reduce operating costs.

b. Consumer Sub-Group Analysis

Using the LCC spreadsheet model, DOE determined the impact of the trial standard levels on the following consumer sub-groups: low-income consumers, institutions of religious worship, and institutions that serve low-income populations. Representative ballast designs used in the industrial sector (*e.g.,* ballasts operating HO lamps) are not typically used by the identified sub-groups, and were not included in the sub-group analysis. Similarly, DOE assumed that low-income consumers use residential ballasts only, and did not include commercial ballast designs in the LCC analysis for this sub-group. DOE assumed that institutions of religious worship and institutions that serve low-income populations use commercial ballasts only, and did not include residential ballast designs in the sub-group analysis.

DOE adjusted inputs to the LCC model to reflect conditions faced by the identified subgroups. For low-income consumers, DOE adjusted electricity prices to represent rates typically paid by consumers living below the poverty line. DOE assumed that institutions of religious worship have lower annual operating hours than the commercial sector average used in the main LCC analysis. For institutions serving low-income populations, DOE assumed that the majority of these institutions are small nonprofits, and used a higher discount rate of 10.7 percent (versus 6.9 percent for the main commercial sector analysis).

Table VII.16 through Table VII.25 shows the LCC impacts and payback periods for identified sub-groups that purchase ballasts. Negative PBP values indicate standards that reduce operating costs and installed costs. Entries of ''N/A'' indicate standard levels that do not reduce operating costs. In general, the average LCC savings for the identified sub-groups at the considered efficiency levels exhibited the same trends and relationships as the averages for all consumers.

TABLE VII.16—PRODUCT CLASS 1—IS AND RS BALLASTS THAT OPERATE TWO 4-FOOT MBP LAMPS (COMMERCIAL, T12 BASELINE): LCC AND PBP SUB-GROUP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings *			Median payback period ** *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Sub-Group: Institutions of Religious Worship								
Event I: Replacement								
	Baseline	64	195	260				
1	1	57	178	235	25	0	100	−5.81
2	2	59	173	232	28	0	100	−2.89
3A, 3B	3	60	170	230	30	0	100	−2.26
Event II: New Construction/Renovation								
	Baseline	67	195	262				
1	1	59	176	235	27	0	100	−5.16
2	2	62	169	231	32	0	100	−2.48
3A, 3B	3	62	167	229	33	0	100	−2.06
Sub-Group: Institutions Serving Low-Income Populations								
Event I: Replacement								
	Baseline	64	209	273				
1	1	57	191	247	26	0	100	−3.35
2	2	59	185	244	29	0	100	−1.66
3A, 3B	3	60	181	241	32	0	100	−1.30
Event II: New Construction/Renovation								
	Baseline	67	209	276				
1	1	59	188	247	28	0	100	−2.97
2	2	62	180	242	34	0	100	−1.43
3A, 3B	3	62	179	241	35	0	100	−1.19

* See Table VII.2 for average LCC savings for all consumers.
** Negative PBP values indicate standards that reduce operating costs and installed costs.

TABLE VII.17—PRODUCT CLASS 1—IS AND RS BALLASTS THAT OPERATE TWO 4-FOOT MBP LAMPS (COMMERCIAL, T8 BASELINE): LCC AND PBP SUB-GROUP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings*			Median payback period *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Sub-Group: Institutions of Religious Worship								
Event I: Replacement								
1	Baseline/1	56	178	234				
2	2	59	173	231	3	1	99	6.28
3A, 3B	3	59	170	229	6	0	100	4.96
Event II: New Construction/Renovation								
1	Baseline/1	58	178	237				
2	2	61	171	232	5	0	100	4.79
3A, 3B	3	62	169	231	6	0	100	4.75
Sub-Group: Institutions Serving Low-Income Populations								
Event I: Replacement								
1	Baseline/1	56	191	246				
2	2	59	185	243	3	1	99	3.62
3A, 3B	3	59	181	240	6	0	100	2.86

TABLE VII.17—PRODUCT CLASS 1—IS AND RS BALLASTS THAT OPERATE TWO 4-FOOT MBP LAMPS (COMMERCIAL, T8 BASELINE): LCC AND PBP SUB-GROUP RESULTS—Continued

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings*			Median payback period *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Event II: New Construction/Renovation								
1	Baseline/1	58	191	249				
2	2	61	183	244	5	0	100	2.76
3A, 3B	3	62	181	242	7	0	100	2.74

* See Table VII.3 for average LCC savings for all consumers.

TABLE VII.18—PRODUCT CLASS 1—IS AND RS BALLASTS THAT OPERATE FOUR 4-FOOT MBP LAMPS: LCC AND PBP RESULTS: LCC AND PBP SUB-GROUP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings*			Median payback period *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Sub-Group: Institutions of Religious Worship								
Event I: Replacement								
1, 2	Baseline/2	78	326	405				
3A, 3B	3	81	319	400	5	0	100	4.61
Event II: New Construction/Renovation								
1, 2	Baseline/2	81	326	407				
3A, 3B	3	83	322	405	2	10	90	7.69
Sub-Group: Institutions Serving Low-Income Populations								
Event I: Replacement								
1, 2	Baseline/2	78	349	427				
3A, 3B	3	81	341	422	5	0	100	2.65
Event II: New Construction/Renovation								
1, 2	Baseline/2	81	349	429				
3A, 3B	3	83	344	427	2	4	96	4.43

* See Table VII.4 for average LCC savings for all consumers.

TABLE VII.19—PRODUCT CLASS 1—IS AND RS BALLASTS THAT OPERATE TWO 8-FOOT SLIMLINE LAMPS (T12 BASELINE): LCC AND PBP SUB-GROUP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings*			Median payback period** *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Sub-Group: Institutions of Religious Worship								
Event I: Replacement								
1	Baseline/1	90	362	452				
2	2	90	342	431	20	0	100	−0.20
3A, 3B	3	90	336	426	26	0	100	−0.01

TABLE VII.19—PRODUCT CLASS 1—IS AND RS BALLASTS THAT OPERATE TWO 8-FOOT SLIMLINE LAMPS (T12 BASELINE): LCC AND PBP SUB-GROUP RESULTS—Continued

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings *			Median payback period ** *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Event II: New Construction/Renovation								
1	Baseline/1	92	362	454				
2	2	92	348	441	14	0	100	−0.30
3A, 3B	3	92	344	436	18	0	100	−0.02
Sub-Group: Institutions Serving Low-Income Populations								
Event I: Replacement								
1	Baseline/1	90	387	477				
2	2	90	365	455	22	0	100	−0.12
3A, 3B	3	90	359	449	28	0	100	0.01
Event II: New Construction/Renovation								
1	Baseline/1	92	387	479				
2	2	92	372	465	15	0	100	−0.17
3A, 3B	3	92	368	460	19	0	100	0.01

* See Table VII.5 for average LCC savings for all consumers.
** Negative PBP values indicate standards that reduce operating costs and installed costs.

TABLE VII.20—PRODUCT CLASS 1—IS AND RS BALLASTS THAT OPERATE TWO 8-FOOT SLIMLINE LAMPS (T12 BASELINE): LCC AND PBP SUB-GROUP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings *			Median payback period *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Sub-Group: Institutions of Religious Worship								
Event I: Replacement								
1, 2	Baseline/2	90	342	432				
3A, 3B	3	91	336	427	5	0	100	0.80
Event II: New Construction/Renovation								
1, 2	Baseline/2	93	342	434				
3A, 3B	3	93	337	430	4	0	100	1.05
Sub-Group: Institutions Serving Low-Income Populations								
Event I: Replacement								
1, 2	Baseline/2	90	365	456				
3A, 3B	3	91	359	450	6	0	100	0.46
Event II: New Construction/Renovation								
1, 2	Baseline/2	93	365	458				
3A, 3B	3	93	361	454	4	0	100	0.61

* See Table VII.6 for average LCC savings for all consumers.

TABLE VII.21—PRODUCT CLASS 2—PS BALLASTS THAT OPERATE TWO 4-FOOT MBP LAMPS: LCC AND PBP SUB-GROUP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings*			Median payback period *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Sub-Group: Institutions of Religious Worship								
Event I: Replacement								
	Baseline	59	149	208	....	....	....	....
1, 2	2	60	139	199	9	0	100	1.90
3A, 3B	3	60	137	198	10	0	100	2.16
Event II: New Construction/Renovation								
	Baseline	61	149	210	....	....	....	....
1, 2	2	62	139	201	9	0	100	1.89
3A, 3B	3	63	137	200	10	0	100	2.19
Sub-Group: Institutions Serving Low-Income Populations								
Event I: Replacement								
	Baseline	59	163	222	....	....	....	....
1, 2	2	60	152	212	10	0	100	1.09
3A, 3B	3	60	150	211	11	0	100	1.25
Event II: New Construction/Renovation								
	Baseline	61	163	225	....	....	....	....
1, 2	2	62	152	215	10	0	100	1.09
3A, 3B	3	63	151	213	11	0	100	1.26

* See Table VII.7 for average LCC savings for all consumers.

TABLE VII.22—PRODUCT CLASS 2—PS BALLASTS THAT OPERATE FOUR 4-FOOT MBP LAMPS: LCC AND PBP SUB-GROUP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings*			Median payback period *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Sub-Group: Institutions of Religious Worship								
Event I: Replacement								
	Baseline	77	273	350	....	....	....	....
1	1	81	272	352	−2	100	0	35.63
2, 3A, 3B	3	83	265	347	3	80	20	10.41
Event II: New Construction/Renovation								
	Baseline	79	273	353	....	....	....	....
1	1	83	249	332	20	0	100	2.48
2, 3A, 3B	3	85	243	329	24	0	100	3.06
Sub-Group: Institutions Serving Low-Income Populations								
Event I: Replacement								
	Baseline	77	299	376	....	....	....	....
1	1	81	298	378	−2	100	0	20.52
2, 3A, 3B	3	83	290	373	4	19	81	6.00
Event II: New Construction/Renovation								
	Baseline	79	299	379	....	....	....	....
1	1	83	273	356	22	0	100	1.43

TABLE VII.22—PRODUCT CLASS 2—PS BALLASTS THAT OPERATE FOUR 4-FOOT MBP LAMPS: LCC AND PBP SUB-GROUP RESULTS—Continued

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings*			Median payback period *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
2, 3A, 3B	3	85	267	352	27	0	100	1.76

* See Table VII.8 for average LCC savings for all consumers.

TABLE VII.23—PRODUCT CLASS 2—PS BALLASTS THAT OPERATE TWO 4-FOOT MINIBP SO LAMPS: LCC AND PBP SUB-GROUP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings*			Median payback period *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Sub-Group: Institutions of Religious Worship								
Event I: Replacement								
	Baseline	64	212	276				
1	1	64	198	263	14	0	100	0.09
2	2	66	190	256	21	0	100	0.95
3A, 3B	3	70	199	270	7	1	99	6.63
Event II: New Construction/Renovation								
	Baseline	66	212	279				
1	1	67	198	265	14	0	100	0.09
2	2	68	197	265	14	0	100	1.35
3A, 3B	3	73	192	265	14	0	100	4.19
Sub-Group: Institutions Serving Low-Income Populations								
Event I: Replacement								
	Baseline	64	227	291				
1	1	64	212	276	15	0	100	0.05
2	2	66	203	269	22	0	100	0.55
3A, 3B	3	70	213	284	7	2	98	3.82
Event II: New Construction/Renovation								
	Baseline	66	227	294				
1	1	67	212	279	15	0	100	0.05
2	2	68	210	278	15	0	100	0.78
3A, 3B	3	73	205	278	15	0	100	2.41

* See Table VII.9 for average LCC savings for all consumers.

TABLE VII.24—PRODUCT CLASS 6—IS AND RS BALLASTS THAT OPERATE TWO 4-FOOT MBP LAMPS (RESIDENTIAL, T12 BASELINE): LCC AND PBP SUB-GROUP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings*			Median payback period** *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Sub-Group: Low-Income Consumers								
Event I: Replacement								
	Baseline	53	71	124				
1, 2, 3A	1	46	57	102	21	0	100	−5.46
3B	2	47	58	105	19	0	100	−4.92

TABLE VII.24—PRODUCT CLASS 6—IS AND RS BALLASTS THAT OPERATE TWO 4-FOOT MBP LAMPS (RESIDENTIAL, T12 BASELINE): LCC AND PBP SUB-GROUP RESULTS—Continued

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings *			Median payback period ** *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Event II: New Construction/Renovation								
	Baseline	55	71	126				
1, 2, 3A	1	48	63	111	15	0	100	−9.45
3B	2	49	61	110	16	0	100	−6.35

* See Table VII.14 for average LCC savings for all consumers.
** Negative PBP values indicate standards that reduce operating costs and installed costs.

TABLE VII.25—PRODUCT CLASS 6—IS AND RS BALLASTS THAT OPERATE TWO 4-FOOT MBP LAMPS (RESIDENTIAL, T8 BASELINE): LCC AND PBP SUB-GROUP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2010$			Life-cycle cost savings *			Median payback period ** *years*
		Installed cost	Discounted operating cost	LCC	Average savings *2010$*	Percent of consumers that experience		
						Net cost	Net benefit	
Sub-Group: Low-Income Consumers								
Event I: Replacement								
1, 2, 3A	Baseline/1	45	57	101				
3B	2	46	58	104	−2	100	0	N/A
Event II: New Construction/Renovation								
1, 2, 3A	Baseline/1	47	57	104				
3B	2	49	55	103	1	27	73	8.18

* See Table VII.15 for average LCC savings for all consumers.
** Entries of "N/A" indicate standard levels that do not reduce operating costs.

c. Rebuttable Presumption Payback

As discussed in section IV.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. DOE's LCC and PBP analyses generate values for calculating the payback period for consumers affected by potential energy conservation standards. This includes, but is not limited to, the 3-year payback period contemplated under the rebuttable presumption test discussed in section IV.D.2. DOE, however, routinely conducts an economic analysis that considers the full range of impacts—including those on consumers, manufacturers, the Nation, and the environment—as required under 42 U.S.C. 6295(o)(2)(B)(i).

For this final rule, DOE calculated a rebuttable presumption payback period for each TSL. DOE used discrete values rather than distributions for inputs and, as required by EPCA, made the calculations using the applicable DOE test procedures for ballasts. DOE then calculated a single rebuttable presumption payback value, rather than a distribution of payback periods, for each TSL. Table VII.26 shows the rebuttable presumption payback periods that are less than 3 years. Negative PBP values indicate standards that reduce operating costs and installed costs.

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

Table VII.26 Ballast Efficiency Levels With Rebuttable Payback Period Less Than Three Years

Product Class	Efficiency Level	Mean Payback Period* years	
		Event I: Replacement	Event II: New Construction / Renovation
IS and RS ballasts (not classified as residential) that operate:			
Two 4-foot MBP lamps (T12 baseline)	1	-3.19	-2.82
	2	-1.57	-1.34
	3	-1.22	-1.11
Two 4-foot MBP lamps (T8 baseline)	2		2.55
	3	2.64	2.53
Four 4-foot MBP lamps	3	2.46	
Two 8-foot slimline lamps (T12 baseline)	2	-0.11	-0.16
	3	0.01	0.01
Two 8-foot slimline lamps (T8 baseline)	3	0.43	0.56
PS ballasts (not classified as residential) that operate:			
Two 4-foot MBP lamps	1, 2	1.01	1.01
	3	1.15	1.17
Four 4-foot MBP lamps	1		1.32
	3		1.63
Two 4-foot MiniBP SO lamps	1	0.05	0.05
	2	0.50	0.72
	3		2.23
Two 4-foot MiniBP HO lamps	1	1.07	1.07
	2	1.42	1.66
	3	2.06	2.17
IS and RS ballasts (not classified as sign ballasts) that operate:			
Two 8-foot HO lamps (T12 baseline)	1	-0.67	-1.00
	2	-0.72	-1.32
	3	-0.55	-1.01
Sign Ballasts that operate:			
Four 8-foot HO lamps	1, 2, 3	-0.15	-0.24
IS and RS residential ballasts that operate:			
Two 4-foot MBP lamps (T12 baseline)	1	-5.14	-8.98
	2	-4.63	-6.01

* Negative PBP values indicate standards that reduce operating costs and installed costs.

2. Economic Impacts on Manufacturers

For the MIA in the April 2011 NOPR, DOE used changes in INPV to compare the direct financial impacts of different TSLs on manufacturers. 76 FR 20090, 20156–61 (April 11, 2011). DOE used the GRIM to compare the INPV of the base case (no new or amended energy conservation standards) to that of each TSL. The INPV is the sum of all net cash flows discounted by the industry's cost of capital (discount rate) to the base year. The difference in INPV between the base case and the standards case is an estimate of the economic impacts that implementing that standard level would have on the entire fluorescent ballast industry. For today's final rule, DOE continues to use the methodology presented in the NOPR (76 FR 20090, 20134–5 (April 11, 2011)) and in section V.H.

a. Industry Cash-Flow Analysis Results

Table VII.27 and Table VII.28 depict the financial impacts on manufacturers (represented by changes in INPV) and the conversion costs DOE estimates manufacturers would incur at each TSL. The two tables show two sets of INPV impacts: Table VII.27 reflects the lower (less severe) bound of impacts and Table VII.28 represents the upper bound. To evaluate this range of cash-flow impacts on the fluorescent lamp ballast 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 (*i.e.,* where new and amended energy conservation standards apply). Each of the two scenarios results in a unique set of cash flows and corresponding industry value at each TSL. The April 2011 NOPR (76 FR 20090, 20156 (April 11, 2011)) discusses each of these scenarios in full, and they are also presented in chapter 13 of the TSD.

TABLE VII.27—MANUFACTURER IMPACT ANALYSIS FOR FLUORESCENT LAMP BALLASTS—PRESERVATION OF OPERATING PROFIT MARKUP, EXISTING TECHNOLOGIES, AND SHIFT SHIPMENT SCENARIO

	Units	Base case	Trial standard level			
			1	2	3A	3B
INPV	(2010$ millions)	1,219	1,199	1,176	1,144	1,141
Change in INPV	(2010$ millions)		(19.6)	(42.4)	(74.5)	(77.6)
	(%)		−1.6%	−3.5%	−6.1%	−6.4%
Product Conversion Costs.	(2010$ millions)		5	18	46	48
Capital Conversion Costs.	(2010$ millions)		11	20	28	29
Total Conversion Costs.	(2010$ millions)		17	38	74	78

TABLE VII.28—MANUFACTURER IMPACT ANALYSIS FOR FLUORESCENT LAMP BALLASTS—TWO-TIER MARKUP, EMERGING TECHNOLOGIES, AND ROLL-UP SHIPMENT SCENARIO

	Units	Base case	Trial standard level			
			1	2	3A	3B
INPV	(2010$ millions)	733	616	545	464	431
Change in INPV	(2010$ millions)		(116.4)	(188.0)	(268.6)	(301.2)
	(%)		−15.9%	−25.7%	−36.7%	−41.1%
Product Conversion Costs.	(2010$ millions)		5	18	46	48
Capital Conversion Costs.	(2010$ millions)		11	20	28	29
Total Conversion Costs.	(2010$ millions)		17	38	74	78

TSL 1 represents EL1 for all five representative product classes. At TSL 1, DOE estimates impacts on INPV to range from −$19.6 million to −$116.4 million, or a change in INPV of −1.6 percent to −15.9 percent. At this level, industry free cash flow[61] is estimated to decrease by approximately 12 percent to $43.4 million, compared to the base-case value of $49.3 million in the year leading up to the energy conservation standards.

The INPV impacts at TSL 1 are relatively minor, in part because the vast majority of shipments already meet EL1. DOE estimates that in 2014, the year in which compliance with the new and amended standards will be required, over 99 percent of the IS/RS product class shipments, 73 percent of the PS product class shipments, 98 percent of the 8-foot HO IS/RS product class shipments, 64 percent of the sign ballast product class shipments, and 96 percent of the residential IS/RS product class shipments would meet EL1 or higher in the base case. The majority of shipments at baseline efficiency levels that would need to be converted at TSL 1 are 2-lamp and 4-lamp 4ft MBP PS ballasts, 4-lamp sign ballasts, and 2-lamp 4-foot MBP IS/RS residential ballasts.

Because most fluorescent lamp ballast shipments already meet the efficiency levels analyzed at TSL 1, DOE expects conversion costs to be small compared to the industry value. DOE estimates product conversion costs of $5 million due to the research, development, testing, and certification costs needed to upgrade product lines that do not meet TSL 1. For capital conversion costs, DOE estimates $11 million for the industry, largely driven by the cost of converting all magnetic sign ballast production lines to electronic sign ballast production lines.

Under the preservation of operating profit markup scenario, impacts on manufacturers are marginally negative because, while manufacturers earn the same operating profit as is earned in the base case for 2015 (the year following the compliance date of amended standards), they face $17 million in conversion costs. INPV impacts on manufacturers are not as significant under this scenario as in other scenarios because most shipments already meet TSL 1 and the shift shipment scenario moves products beyond the eliminated baseline to higher-price (and higher gross profit) levels. This results in a shipment-weighted average MPC increase of 6 percent applied to a

[61] Industry free cash flow is the operating cash flow minus capital expenditures.

growing market over the analysis period.

Shipments under the existing technologies scenario are nearly three and a half times greater than shipments under the emerging technologies scenario by the end of the analysis period. At TSL 1, the moderate price increase applied to a large quantity of shipments lessens the impact of the minor conversion costs estimated at TSL 1, resulting in slightly negative impacts at TSL 1 under the preservation of operating profit markup scenario.

Under the two-tier markup scenario, manufacturers are not able to fully pass on additional costs to consumers and are not guaranteed base-case operating profit levels. Rather, products that once earned a higher-than-average markup at EL1 become commoditized once baseline products are eliminated at TSL 1. Thus, the average markup drops below the base-case average markup (which is equal to the flat manufacturer markup of 1.4). Because shipments above the baseline do not shift to higher efficiencies with greater costs under the roll-up scenario, the shipment-weighted average MPC does not significantly increase. A lower average markup of 1.38 and $17 million in conversion costs results in more negative impacts at TSL 1 under the two-tier markup scenario. These impacts increase on a percentage basis under the emerging technologies scenario relative to the existing technologies scenario because the base-case INPV against which changes are compared is nearly 40 percent lower.

TSL 2 represents EL1 for the sign ballast and residential IS/RS product classes. For the IS/RS, PS, and 8-foot HO IS/RS product classes, TSL 2 represents EL2. At TSL 2, DOE estimates impacts on INPV to range from −$42.4 million to −$188.0 million, or a change in INPV of −3.5 percent to −25.7 percent. At this level, industry free cash flow is estimated to decrease by approximately 26 percent to $36.6 million, compared to the base-case value of $49.3 million in the year leading up to the energy conservation standards.

Because the sign ballast and residential IS/RS product classes remain at EL1 at TSL 2, the additional impacts at TSL 2 relative to TSL 1 result only from increasing the IS/RS, PS, and 8-foot HO IS/RS product classes to EL2. At TSL 2, DOE estimates that 63 percent of the IS/RS product class shipments, 19 percent of the PS product class shipments, and 89 percent of the 8-foot HO IS/RS product class shipments would meet EL2 or higher in the base case. Since the 8-foot HO IS/RS product class represents only 0.1 percent of the fluorescent lamp ballast market, the vast majority of impacts at TSL 2 relative to TSL 1 result from changes in the IS/RS and PS product classes.

At TSL 2, conversion costs remain small compared to the industry value. Product conversion costs increase to $18 million due to the increase in the number of product lines within the IS/RS and PS product classes that would need to be redesigned at TSL 2. Capital conversion costs grow to $20 million at TSL 2 because manufacturers would need to invest in additional testing equipment and convert some production lines.

Under the preservation of operating profit markup scenario, INPV impacts are negative because manufacturers are not able to fully pass on higher product costs to consumers. The shipment-weighted average MPC increases by 9 percent compared to the baseline MPC, but this increase does not generate enough cash flow to outweigh the $38 million in conversion costs at TSL 2, resulting in a −3.5 percent change in INPV at TSL 2 compared to the base case.

Under the two-tier markup scenario, more products are commoditized to a lower markup at TSL 2. The impact of this lower average markup of 1.36 outweighs the impact of a 6 percent increase in shipment-weighted average MPC, resulting in a negative change in INPV at TSL 2. The $38 million in conversion costs further erodes profitability, and the lower base case INPV against which the change in INPV is compared under the emerging technologies scenario increases INPV impacts on a percentage basis.

TSL 3A represents EL1 for the sign ballasts and residential IS/RS product classes, EL2 for the 8-foot HO IS/RS product class, and EL3 for the IS/RS and PS product classes. At TSL 3A, DOE estimates impacts on INPV to range from −$74.5 million to −$268.6 million, or a change in INPV of −6.1 percent to −36.7 percent. At this level, industry free cash flow is estimated to decrease by approximately 48 percent to $25.8 million, compared to the base-case value of $49.3 million in the year leading up to the energy conservation standards.

Because the sign ballast and residential IS/RS product classes remain at EL1 and the 8-foot HO IS/RS product class remains at EL2 for TSL 3A, the additional impacts at TSL 3A relative to TSL 2 result only from increasing the IS/RS and PS product classes to EL3. At TSL 3A, DOE estimates that 21 percent of the IS/RS product class shipments and 7 percent of the PS product class shipments would meet the efficiency levels contained in TSL 3A or higher in the base case.

At TSL 3A, product conversion costs increase to $46 million because far more product lines within the IS/RS, and PS product classes would need to be redesigned at TSL 3A than TSL 2. Capital conversion costs rise to $28 million at TSL 3A because manufacturers would need to invest in equipment such as surface-mount device placement machinery and solder machines to convert production lines for the manufacturing of more efficient ballasts.

Under the preservation of operating profit markup scenario, INPV decreases by 6.1 percent at TSL 3A compared to the base case. The shipment-weighted average MPC increases by 17 percent, but manufacturers are not able to pass on the full amount of these higher costs to consumers. This MPC increase is outweighed by the $74 million in conversion costs at TSL 3A.

Under the two-tier markup scenario, at TSL 3A, products are commoditized to a lower markup to an even greater extent than under the preservation of operating profit markup scenario. The impact of this lower average markup of 1.33 outweighs the impact of a 15 percent increase in shipment-weighted average MPC, resulting in a negative change in INPV at TSL 3A compared to TSL 2. Profitability is further reduced by the $74 million in conversion costs and the lower base-case INPV over which change in INPV is compared under the emerging technologies scenario.

TSL 3B represents EL1 for the sign ballast product class, EL2 for the residential IS/RS product class, and EL3 for the IS/RS, PS, and 8-foot HO IS/RS product classes. At TSL 3B, DOE estimates impacts on INPV to range from −$77.6 million to −$301.2 million, or a change in INPV of −6.4 percent to −41.1 percent. At this level, industry free cash flow is estimated to decrease by approximately 50 percent to $24.7 million, compared to the base-case value of $49.3 million in the year leading up to the energy conservation standards.

Because the sign ballast product class remains at EL1 and the IS/RS and PS product classes remain at EL3 for TSL 3B, the additional impacts at TSL 3B relative to TSL 3A result only from increasing the 8-foot HO IS/RS product class to EL3 and the residential IS/RS product class to EL2. At TSL 3B, DOE estimates that 2 percent of the 8-foot HO IS/RS product class shipments and 23 percent of the residential IS/RS product class shipments would meet the efficiency levels contained in TSL 3B in the base case.

At TSL 3B, conversion costs are slightly greater compared to TSL 3A. Product and capital conversion costs increase to $48 million and $29 million, respectively, because more product lines would need to be redesigned and upgraded at TSL 3B.

Under the preservation of operating profit markup scenario, INPV decreases by 6.4 percent at TSL 3B compared to the base case, which is slightly greater than the percentage impact at TSL 3A. The shipment-weighted average MPC increases by over 17 percent, but manufacturers are not able to pass on the full amount of these higher costs to consumers. This slight MPC increase is outweighed by the $78 million in conversion costs at TSL 3B.

Under the two-tier markup scenario, at TSL 3B, products are commoditized to a lower markup to the greatest extent of any TSL analyzed. The impact of this lower average markup of 1.33 outweighs the impact of a 17 percent increase in shipment-weighted average MPC, resulting in a negative change in INPV at TSL 3B compared to TSL 3A. Profitability is further reduced by the $78 million in conversion costs and the lower base-case INPV over which change in INPV is compared under the emerging technologies scenario.

b. Impacts on Employment

DOE typically presents modeled quantitative estimates of the potential changes in production employment that could result from new and amended energy conservation standards. However, for this rulemaking, DOE determined that none of the major manufacturers, which comprise more than 90 percent of the market, have domestic fluorescent lamp ballast production. Although a few niche manufacturers have relatively limited domestic production, based on interviews, DOE has identified very few domestic production employees in the United States. Because many niche manufacturers did not respond to interview requests or submit comments on domestic employment impacts, DOE is unable to fully quantify domestic production employment impacts. Therefore, while DOE qualitatively discusses potential employment impacts below, DOE did not model direct employment impacts explicitly because the results would not be meaningful given the very low number of domestic production employees.

Based on interviews, DOE projects that significant direct employment impacts would occur only in the event that one or more businesses exit the market due to new standards. Discussions with manufacturers indicated that, at the highest efficiency levels (TSL 3A and TSL 3B), some small manufacturers will be faced with the decision of whether or not to make the investments necessary to remain in the market based on their current technical capabilities. In general, however, DOE projects that TSL 3A, the level adopted in today's final rule, will not have significant adverse impacts on domestic employment because achieving these levels is within the expertise of most manufacturers, including small manufacturers, due to the lack of intellectual property restrictions and similarity of products among manufacturers.

In summary, given the low number of production employees and the low likelihood that manufacturers would exit the market at the efficiency levels adopted in today's final rule, DOE does not expect a significant impact on direct employment following new and amended energy conservation standards.

DOE notes that the direct employment impacts discussed here are independent of the indirect employment impacts from the broader U.S. economy, which are documented in chapter 15, Employment Impact Analysis, of the TSD.

c. Impacts on Manufacturing Capacity

Manufacturers stated that new and amended energy conservation standards could harm manufacturing capacity due to the current component shortage discussed in the April 2011 NOPR (76 FR 20090, 20139 (April 11, 2011)). At present, manufacturers are struggling to produce enough fluorescent lamp ballasts to meet demand because of a worldwide shortage of electrical components. The components most affected by this shortage are premium high-efficiency parts, for which demand would increase even more following new and amended energy conservation standards. In the near term this increased demand might exacerbate the component shortage, thereby impacting manufacturing capacity. While DOE recognizes that the component shortage is currently a significant issue for manufacturers, DOE projects it to be a relatively short-term phenomenon to which component suppliers will ultimately adjust. According to manufacturers, suppliers have the ability to ramp up production to meet ballast component demand by the compliance date of new and amended standards, but those suppliers have hesitated to invest in additional capacity due to economic uncertainty and skepticism about the sustainability of demand. The state of the macroeconomic environment through 2014 will likely affect the duration of the component shortage. Mandatory standards, however, could create more certainty for suppliers about the eventual demand for these components. Additionally, the components at issue are not new technologies; rather, they have simply not historically been demanded in large quantities by ballast manufacturers. DOE received no comments or additional information indicating that its conclusions related to the component shortage issue were incorrect and therefore reiterates these conclusions for today's final rule.

d. Impacts on Sub-Groups of Manufacturers

As discussed in the April 2011 NOPR (76 FR 20090, 20135 (April 11, 2011)), using average cost assumptions to develop an industry cash-flow estimate may be inadequate to assess differential impacts among manufacturer sub-groups. DOE used the results of the industry characterization to group ballast manufacturers exhibiting similar characteristics. DOE identified two sub-groups that would experience differential impacts: Small manufacturers and sign ballast manufacturers, many of whom are also small manufacturers. For a discussion of the impacts on the small manufacturer sub-group, see the Regulatory Flexibility Analysis in section VIII.B and chapter 13 of the TSD.

DOE is not presenting results under the two-tier markup scenario for sign ballasts because it did not observe a two-tier effect in the sign ballast market. Electronic ballasts at EL1 command neither a higher price nor a higher markup in the base case. Additionally, roll-up and shift scenarios do not have separate impacts for sign ballasts because there are no higher ELs above the new baseline to which products could potentially shift in the standards case. As such, Table VII.29 and Table VII.30 present the cash-flow analysis results under the preservation of operating profit markup and roll-up shipment scenarios with existing or emerging technologies for sign ballast manufacturers.

TABLE VII.29—MANUFACTURER IMPACT ANALYSIS FOR SIGN BALLASTS—PRESERVATION OF OPERATING PROFIT MARKUP, EXISTING TECHNOLOGIES, AND ROLL-UP SHIPMENT SCENARIO

	Units	Base case	Trial standard level			
			1	2	3A	3B
INPV	(2010$ millions)	142	138	138	138	138
Change in INPV	(2010$ millions)		(4.2)	(4.2)	(4.2)	(4.2)
	(%)		−2.9%	−2.9%	−2.9%	−2.9%
Product Conversion Costs	(2010$ millions)		2	2	2	2
Capital Conversion Costs	(2010$ millions)		6	6	6	6
Total Conversion Costs	(2010$ millions)		8	8	8	8

TABLE VII.30—MANUFACTURER IMPACT ANALYSIS FOR SIGN BALLASTS—PRESERVATION OF OPERATING PROFIT MARKUP, EMERGING TECHNOLOGIES, AND ROLL-UP SHIPMENT SCENARIO

	Units	Base case	Trial standard level			
			1	2	3A	3B
INPV	(2010$ millions)	116	111	111	111	111
Change in INPV	(2010$ millions)		(5.1)	(5.1)	(5.1)	(5.1)
	(%)		−4.4%	−4.4%	−4.4%	−4.4%
Product Conversion Costs	(2010$ millions)		2	2	2	2
Capital Conversion Costs	(2010$ millions)		6	6	6	6
Total Conversion Costs	(2010$ millions)		8	8	8	8

For the sign ballast product class, DOE analyzed only one efficiency level; thus, the results are the same at each TSL. TSLs 1 through 3B represent EL1 for the sign ballast product class. At TSLs 1 through 3B, DOE estimates impacts on INPV to range from −$4.2 million to −$5.1 million, or a change in INPV of −2.9 percent to −4.4 percent. At these levels, industry free cash flow is estimated to decrease by approximately 38 percent to $4.9 million, compared to the base-case value of $7.9 million in the year leading up to the energy conservation standards.

As shown by the results, DOE expects sign ballast manufacturers overall to face small negative impacts under TSLs 1 through 3B. DOE estimates that 64 percent of the sign ballast product class shipments would meet EL1 in the base case. Many manufacturers already produce electronic sign ballasts, which is the design option represented by EL1. Many other manufacturers, however, produce only magnetic T12 sign ballasts and therefore would face significant capital exposure in moving from magnetic to electronic ballasts to meet TSLs 1 through 3B. For that reason, DOE estimates relatively high capital conversion costs of $6 million for sign ballast manufacturers. Product redesign and testing costs are expected to total $2 million for sign ballasts. DOE notes that small sign ballast manufacturers, particularly those who would be required to move from magnetic to electronic sign ballasts as a result of today's standards, may apply to DOE for an exemption from the standard pursuant to 42 U.S.C. 6295(t). The process applicants must follow to request an exemption and DOE's process for making a decision on a particular request are set forth in DOE's regulations at 10 CFR 430 Subpart E.

Unlike most product classes, sign ballasts are expected to decrease rather than increase in price moving from baseline to EL1 by a shipment-weighted average decrease in MPC of over 4 percent. This is because electronic ballasts are a cheaper alternative to magnetic ballasts, even though the industry has not yet fully moved toward electronic production. During interviews, manufacturers stated that consumers were reluctant to convert to electronic ballasts even though there were no technical barriers to doing so. Under the preservation of operating profit markup scenario, however, manufacturers are able to maintain the base-case operating profit for the year following the compliance date of new and amended standards despite lower production costs, so the average markup increases slightly to 1.41 to account for the decrease in MPC. Despite this markup increase, revenue is lower at TSLs 1 through 3B than in the base case because of the lower average unit price and the $8 million in conversion costs. When the preservation of operating profit markup is combined with the existing technologies scenario rather than the emerging technologies scenario, the impact of this maximized revenue per unit is greatest because it is applied to a larger total quantity of shipments.

e. Cumulative Regulatory Burden

While any one regulation may not impose a significant burden on manufacturers, the combined effects of recent or impending regulations may have serious consequences for some manufacturers, groups of manufacturers, or an entire industry. Assessing the impact of a single regulation may overlook this cumulative regulatory burden. In addition to energy conservation standards, other regulations can significantly affect manufacturers' financial operations. Multiple regulations affecting the same manufacturer can strain profits and lead companies to abandon product lines or markets with lower expected future returns than competing products. For these reasons, DOE conducts an analysis of cumulative regulatory burden as part of its rulemakings pertaining to appliance efficiency.

During previous stages of this rulemaking, DOE identified a number of requirements, in addition to new and amended energy conservation standards for ballasts, that manufacturers of these products will face for products and equipment they manufacture within approximately 3 years prior to and 3 years after the anticipated compliance date of the new and amended standards. DOE discusses these and other requirements, including the energy conservation standards for lamps that take effect beginning in 2012 (74 FR 34080 (July 14, 2009) and U.S.C. 6295 (i)(1)(A)), in its full cumulative regulatory burden analysis in chapter 13 of the TSD.

In written comments on the NOPR, NEMA expressed concern that DOE has not accounted for other legislation that would increase costs. (NEMA, No. 47 at p. 9) While it is not clear to which other legislation NEMA is referring, DOE does take into account the cost of compliance with other published Federal energy conservation standards, such as the 2009 lamps rule. DOE does not include the impacts of standards that have not yet been finalized, however, because any impacts of such standards would be speculative. The cumulative regulatory impact analysis is discussed in more detail in chapter 13 of the TSD. In response to the September 2011 NODA, NEMA also noted that President Obama stated an objective in a September 8, 2011 speech of reducing regulatory burden on manufacturers. (NEMA, No. 56 at p. 3) DOE acknowledges the President's objective of reducing regulatory burden and, as required by EPCA, ensures that each of its energy conservation standards is economically justified. DOE has analyzed the various TSLs considered in this rulemaking and believes that the burdens of today's rulemaking are outweighed and justified by the benefits of the rule, as described in section VII.C.2.

3. National Impact Analysis

a. Significance of Energy Savings

To estimate the energy savings through 2043 attributable to potential energy conservation standards for ballasts, DOE compared the energy consumption of these products under the base case to their anticipated energy use under each TSL. Table VII.31 presents DOE's forecasts of the national energy savings for each TSL, for the existing and emerging technologies shipment scenarios that represent the maximum and minimum energy savings resulting from all the scenarios analyzed. Chapter 11 of the final rule TSD describes these estimates in more detail.

TABLE VII.31—SUMMARY OF CUMULATIVE NATIONAL ENERGY SAVINGS FOR BALLASTS

[2014–2043]

Trial standard level	Product class	National energy savings *quads*	
		Existing technologies, shift	Emerging technologies, roll-up
1	IS and RS ballasts (not classified as residential) that operate:		
	Two 4-foot MBP lamps	1.19	0.001
	Four 4-foot MBP lamps	0	0
	Two 8-foot slimline lamps	0	0
	PS ballasts (not classified as residential) that operate:		
	Two 4-foot MBP lamps	0.27	0.13
	Four 4-foot MBP lamps	0.27	0.10
	Two 4-foot MiniBP SO lamps	0.43	0.16
	Two 4-foot MiniBP HO lamps	0.25	0.23
	IS and RS ballasts (not classified as sign ballasts) that operate:		
	Two 8-foot HO lamps	0.04	0.04
	Sign ballasts that operate:		
	Four 8-foot HO lamps	0.92	0.69
	IS and RS residential ballasts that operate:		
	Two 4-foot MBP lamps	0.13	0.01
	Total (TSL1)	3.50	1.36
2	IS and RS ballasts (not classified as residential) that operate:		
	Two 4-foot MBP lamps	1.19	0.42
	Four 4-foot MBP lamps	0	0
	Two 8-foot slimline lamps	0.02	0.001
	PS ballasts (not classified as residential) that operate:		
	Two 4-foot MBP lamps	0.27	0.13
	Four 4-foot MBP lamps	0.33	0.13
	Two 4-foot MiniBP SO lamps	0.78	0.25
	Two 4-foot MiniBP HO lamps	0.43	0.39
	IS and RS ballasts (not classified as sign ballasts) that operate:		
	Two 8-foot HO lamps	0.04	0.04
	Sign ballasts that operate:		
	Four 8-foot HO lamps	0.92	0.69
	IS and RS residential ballasts that operate:		
	Two 4-foot MBP lamps	0.13	0.01
	Total (TSL2)	4.10	2.05
3A	IS and RS ballasts (not classified as residential) that operate:		
	Two 4-foot MBP lamps	1.44	0.55
	Four 4-foot MBP lamps	0.31	0.12
	Two 8-foot slimline lamps	0.02	0.02
	PS ballasts (not classified as residential) that operate:		
	Two 4-foot MBP lamps	0.30	0.14
	Four 4-foot MBP lamps	0.33	0.13
	Two 4-foot MiniBP SO lamps	1.51	0.51
	Two 4-foot MiniBP HO lamps	0.56	0.52

TABLE VII.31—SUMMARY OF CUMULATIVE NATIONAL ENERGY SAVINGS FOR BALLASTS—Continued

[2014–2043]

Trial standard level	Product class	National energy savings *quads*	
		Existing technologies, shift	Emerging technologies, roll-up
	IS and RS ballasts (not classified as sign ballasts) that operate:		
	Two 8-foot HO lamps	0.04	0.04
	Sign ballasts that operate:		
	Four 8-foot HO lamps	0.92	0.69
	IS and RS residential ballasts that operate:		
	Two 4-foot MBP lamps	0.13	0.01
	Total (TSL3A)	5.55	2.74
3B	IS and RS ballasts (not classified as residential) that operate:		
	Two 4-foot MBP lamps	1.44	0.55
	Four 4-foot MBP lamps	0.31	0.12
	Two 8-foot slimline lamps	0.02	0.02
	PS ballasts (not classified as residential) that operate:		
	Two 4-foot MBP lamps	0.30	0.14
	Four 4-foot MBP lamps	0.33	0.13
	Two 4-foot MiniBP SO lamps	1.51	0.51
	Two 4-foot MiniBP HO lamps	0.56	0.52
	IS and RS ballasts (not classified as sign ballasts) that operate:		
	Two 8-foot HO lamps	0.04	0.04
	Sign ballasts that operate:		
	Four 8-foot HO lamps	0.92	0.69
	IS and RS residential ballasts that operate:		
	Two 4-foot MBP lamps	0.13	0.12
	Total (TSL3B)	5.56	2.86

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 ballasts. 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 to private capital in the U.S. economy, and reflects the returns to real estate and small business capital as well as corporate capital. DOE used this discount rate to approximate the opportunity cost of capital in the private sector, because recent OMB analysis has found the average rate of return to capital to be near this rate. In addition, DOE used the 3-percent rate to capture the potential effects of standards on private consumption (*e.g.,* through higher prices for products and the purchase of reduced amounts of energy). This rate represents the rate at which society discounts future consumption flows to their present value. This rate can be approximated by the real rate of return on long-term government debt (*i.e.,* yield on Treasury notes minus annual rate of change in the Consumer Price Index), which has averaged about 3 percent on a pre-tax basis for the last 30 years.

Table VII.32 shows the consumer NPV results for each TSL DOE considered for ballasts, using both a 7-percent and a 3-percent discount rate. This table presents the results of the two shipment scenarios that represent the maximum and minimum NPV resulting from all the scenarios analyzed. Zero values indicate product types with zero energy savings at a particular TSL, *i.e.,* the corresponding efficiency level is a baseline design. See chapter 11 of the final rule TSD for more detailed NPV results.

TABLE VII.32—SUMMARY OF CUMULATIVE NET PRESENT VALUE FOR BALLASTS (2014–2043)

Trial standard level	Product class	Net present value *billion 2010$*			
		Existing technologies, shift		Emerging technologies, roll-up	
		7 Percent discount rate	3 Percent discount rate	7 Percent discount rate	3 Percent discount rate
1	IS and RS ballasts (not classified as residential) that operate:				
	Two 4-foot MBP lamps	2.33	5.20	0.01	0.01
	Four 4-foot MBP lamps	0	0	0	0
	Two 8-foot slimline lamps	0	0	0	0
	PS ballasts (not classified as residential) that operate:				
	Two 4-foot MBP lamps	0.77	1.40	0.51	0.78
	Four 4-foot MBP lamps	0.61	1.35	0.30	0.58

TABLE VII.32—SUMMARY OF CUMULATIVE NET PRESENT VALUE FOR BALLASTS (2014–2043)—Continued

Trial standard level	Product class	Net present value billion 2010$			
		Existing technologies, shift		Emerging technologies, roll-up	
		7 Percent discount rate	3 Percent discount rate	7 Percent discount rate	3 Percent discount rate
	Two 4-foot MiniBP SO lamps	1.11	2.45	0.57	1.02
	Two 4-foot MiniBP HO lamps	0.42	0.88	0.42	0.88
	IS and RS ballasts (not classified as sign ballasts) that operate two 8-foot HO lamps.	0.11	0.12	0.10	0.12
	Sign ballasts that operate four 8-foot HO lamps	2.94	5.55	2.52	4.62
	IS and RS residential ballasts that operate two 4-foot MBP lamps.	0.22	0.49	0.16	0.27
	Total (TSL1)	8.52	17.43	4.59	8.28
2	IS and RS ballasts (not classified as residential) that operate:				
	Two 4-foot MBP lamps	2.33	5.20	1.08	2.15
	Four 4-foot MBP lamps	0	0	0	0
	Two 8-foot slimline lamps	0.05	0.10	0.01	0.01
	PS ballasts (not classified as residential) that operate:				
	Two 4-foot MBP lamps	0.77	1.40	0.51	0.78
	Four 4-foot MBP lamps	0.73	1.61	0.37	0.72
	Two 4-foot MiniBP SO lamps	1.33	3.09	0.68	1.31
	Two 4-foot MiniBP HO lamps	0.42	0.94	0.43	0.94
	IS and RS ballasts (not classified as sign ballasts) that operate two 8-foot HO lamps.	0.11	0.13	0.11	0.13
	Sign ballasts that operate four 8-foot HO lamps	2.94	5.55	2.52	4.62
	IS and RS residential ballasts that operate two 4-foot MBP lamps.	0.22	0.49	0.16	0.27
	Total (TSL2)	8.91	18.50	5.85	10.92
3A	IS and RS ballasts (not classified as residential) that operate:				
	Two 4-foot MBP lamps	2.83	6.31	1.44	2.86
	Four 4-foot MBP lamps	0.46	1.06	0.25	0.52
	Two 8-foot slimline lamps	0.05	0.10	0.05	0.10
	PS ballasts (not classified as residential) that operate:				
	Two 4-foot MBP lamps	0.84	1.54	0.56	0.87
	Four 4-foot MBP lamps	0.73	1.61	0.37	0.72
	Two 4-foot MiniBP SO lamps	1.52	3.89	0.85	1.87
	Two 4-foot MiniBP HO lamps	0.36	0.87	0.36	0.87
	IS and RS ballasts (not classified as sign ballasts) that operate two 8-foot HO lamps.	0.11	0.13	0.11	0.13
	Sign ballasts that operate four 8-foot HO lamps	2.94	5.55	2.52	4.62
	IS and RS residential ballasts that operate two 4-foot MBP lamps.	0.22	0.49	0.16	0.27
	Total (TSL3A)	10.06	21.55	6.67	12.84
3B	IS and RS ballasts (not classified as residential) that operate:				
	Two 4-foot MBP lamps	2.83	6.31	1.44	2.86
	Four 4-foot MBP lamps	0.46	1.06	0.25	0.52
	Two 8-foot slimline lamps	0.05	0.10	0.05	0.10
	PS ballasts (not classified as residential) that operate:				
	Two 4-foot MBP lamps	0.84	1.54	0.56	0.87
	Four 4-foot MBP lamps	0.73	1.61	0.37	0.72
	Two 4-foot MiniBP SO lamps	1.52	3.89	0.85	1.87
	Two 4-foot MiniBP HO lamps	0.36	0.87	0.36	0.87
	IS and RS ballasts (not classified as sign ballasts) that operate two 8-foot HO lamps.	0.11	0.13	0.11	0.13
	Sign ballasts that operate four 8-foot HO lamps	2.94	5.55	2.52	4.62
	IS and RS residential ballasts that operate two 4-foot MBP lamps.	0.23	0.50	0.23	0.50
	Total (TSL3B)	10.06	21.56	6.73	13.07

c. Impacts on Employment

DOE estimated the indirect employment impacts of potential standards on the economy in general, assuming that energy conservation standards for ballasts would reduce energy bills for ballast users and the resulting net savings would be redirected to other forms of economic activity. DOE used an I–O model of the U.S. economy to estimate these effects including the demand for labor as described in section V.I .

The I–O model results suggest that today's adopted standards are likely to increase the net labor demand. The gains, however, would most likely be small relative to total national employment, and neither the BLS data nor the input/output model DOE uses includes the quality or wage level of the jobs. As discussed in section VII.B.2.b, the major manufacturers interviewed for this rulemaking indicate they have no domestic ballast production. New and amended standards for ballasts therefore will not have a significant impact on the limited number of production workers directly employed by ballast manufacturers in the U.S.

Table VII.33—presents the estimated net indirect employment impacts from the TSLs that DOE considered in this rulemaking. See chapter 15 of the final rule TSD for more detailed results.

TABLE VII.33–NET CHANGE IN JOBS FROM INDIRECT EMPLOYMENT EFFECTS UNDER BALLAST TSLS

Analysis period year	Trial standard level	Net national change in jobs (thousands)	
		Existing technologies, shift	Emerging technologies, roll-up
2020	1	2.5	1.9
	2	2.3	2.1
	3A	2.2	2.1
	3B	2.2	2.2
2043	1	52.2	17.2
	2	57.1	24.2
	3A	73.8	30.7
	3B	73.9	34.3

4. Impact on Utility or Performance of Products

As presented in section IV.D.1.d of this final rule, DOE concluded that none of the TSLs considered in this final rule would reduce the utility or performance of the products under consideration in this rulemaking. Furthermore, manufacturers of these products currently offer ballasts that meet or exceed the adopted standards. (42 U.S.C. 6295(o)(2)(B)(i)(IV))

5. Impact of Any Lessening of Competition

As discussed in the April 2011 NOPR, and in section IV.D.1.e of this final rule, DOE considers any lessening of competition likely to result from standards; the Attorney General determines the impact, if any, of any such lessening of competition.

DOJ concluded that the standards contained in the proposed rule could possibly impact competition. Depending on the investment required and the opportunity for business expansion, DOJ found it is not clear how quickly current manufacturers could comply with new standards. DOE considered these comments and notes that TSL 3A, the level adopted in today's rule, would impact manufacturers to a lesser extent than the TSL 3 proposed in the April 2011 NOPR. Specifically, TSL 3A contains lower standards for residential and 8-foot HO product classes than the previously proposed TSL 3. Therefore, DOE does not expect that TSL 3A will raise competitive issues. For all product classes analyzed, DOE found that multiple manufacturers offered products at TSL 3A and any product modifications needed to reach TSL 3A do not require proprietary technology.

6. Need of the Nation To Conserve Energy

An improvement in the energy efficiency of the products subject to this final rule is likely to improve the security of the nation's energy system by reducing overall demand for energy. Reduced electricity demand may also improve the reliability of the electricity system. As a measure of this reduced demand, Table VII.34 presents the estimated reduction in generating capacity in 2043 for the TSLs that DOE considered in this rulemaking.

TABLE VII.34—ESTIMATED REDUCTION IN ELECTRICITY GENERATING CAPACITY IN 2043 UNDER BALLAST TSLS

Trial standard level	Reduction in electric generating capacity *Gigawatts*	
	Existing technologies, shift	Emerging technologies, roll-up
1	3.8	1.4
2	4.6	2.2
3A	6.4	3.0
3B	6.4	3.1

Energy savings from new and amended standards for ballasts could also produce environmental benefits in the form of reduced emissions of air pollutants and GHGs associated with electricity production. Table VII.35 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 the environmental assessment of in chapter 16 the final rule TSD.

TABLE VII.35—SUMMARY OF EMISSIONS REDUCTION ESTIMATED FOR BALLAST TSLS (CUMULATIVE FOR 2014 THROUGH 2043)

Trial standard level	Cumulative reduction in emissions (2014 through 2043)					
	Existing technologies, shift			Emerging technologies, roll-up		
	CO_2 *Mt*	NO_X *kt*	Hg *t*	CO_2 *Mt*	NO_X *kt*	Hg *t*
1	64	23	0.88	13	10	0.18
2	76	28	1.05	20	16	0.29
3A	106	39	1.47	27	22	0.40
3B	106	39	1.47	29	23	0.42

As discussed in section V.K, 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.

As part of the analysis for this final 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 V.L.1, DOE used values for the SCC developed by an interagency process. The four values for CO_2 emissions reductions resulting from that process (for emissions in 2010, expressed in 2010$) are $4.9/ton (the average value from a distribution that uses a 5-percent discount rate), $22.3/ton (the average value from a distribution that uses a 3-percent discount rate), $36.5/ton (the average value from a distribution that uses a 2.5-percent discount rate), and $67.6/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. For each TSL, DOE calculated the global present values of CO_2 emissions reductions, 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.

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 final rule the most recent values and analyses resulting from the ongoing interagency review process.

DOE also estimated a range for the cumulative monetary value of the economic benefits associated with NO_X and Hg emissions reductions anticipated to result from amended ballast standards. Estimated monetary benefits for CO_2, NO_X and Hg emission reductions are detailed in chapter 17 of the final rule TSD.

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 VII.36 shows an example of the calculation of the combined NPV including benefits from emissions reductions for the case of TSL 3A for ballasts. The CO_2 values used in the table correspond to the four scenarios for the valuation of CO_2 emission reductions presented in section V.L.1.

TABLE VII.36—ADDING NET PRESENT VALUE OF CONSUMER SAVINGS TO PRESENT VALUE OF MONETIZED BENEFITS FROM CO_2 AND NO_X EMISSIONS REDUCTIONS AT TSL 3A FOR BALLASTS

[Existing Technologies, Shift]

Category	Present value *billion 2010$*	Discount rate %
Benefits		
Operating Cost Savings	15.1	7
	31.5	3
CO_2 Reduction Monetized Value (at $4.9/Metric Ton)*	0.40	5
CO_2 Reduction Monetized Value (at $22.3/Metric Ton)*	2.01	3
CO_2 Reduction Monetized Value (at $36.5/Metric Ton)*	3.38	2.5
CO_2 Reduction Monetized Value (at $67.6/Metric Ton)*	6.12	3
NO_X Reduction Monetized Value (at $2,537/Ton)*	0.03	7
	0.06	3
Total Monetary Benefits **	17.1	7

TABLE VII.36—ADDING NET PRESENT VALUE OF CONSUMER SAVINGS TO PRESENT VALUE OF MONETIZED BENEFITS FROM CO_2 AND NO_X EMISSIONS REDUCTIONS AT TSL 3A FOR BALLASTS—Continued

[Existing Technologies, Shift]

Category	Present value *billion 2010$*	Discount rate %
	33.5	3
Costs		
Total Incremental Installed Costs	5.05 9.91	7 3
Net Benefits/Costs		
Including CO_2 and NO_X**	12.1 23.6	7 3

* The CO_2 values represent global monetized values (in 2010$) of the social cost of CO_2 emissions in 2010 under several scenarios. The values of $4.9, $22.3, and $36.5 per metric ton are the averages of SCC distributions calculated using 5-percent, 3-percent, and 2.5-percent discount rates, respectively. The value of $67.6/t represents the 95th percentile of the SCC distribution calculated using a 3-percent discount rate. The value for NO_X (in 2010$) is the average of the low and high values used in DOE's analysis. See section V.L.2 for details.

** Total Benefits for both the 3-percent and 7-percent cases are derived using the SCC value calculated at a 3-percent discount rate, which is $22.3/t in 2010 (in 2010$).

Although adding the value of consumer savings to the values of emission reductions would provide a valuable perspective, the following should be considered: (1) the national consumer savings are domestic U.S. consumer monetary savings found in market transactions, while the values of emissions reductions are based on estimates of marginal social costs, which, in the case of CO_2, are based on a global value; and (2) the assessments of consumer savings and emission-related benefits are performed with different computer models, leading to different timeframes for analysis. For ballasts, the present value of national consumer savings is measured for the period in which units shipped (2014–2043) continue to operate. However, the time frames of the benefits associated with the emission reductions differ. For example, the value of CO_2 emissions reductions reflects the present value of all future climate-related impacts due to emitting a ton of CO_2 in that year, out to 2300. Chapter 17 of the final rule TSD presents calculations of the combined NPV including benefits from emissions reductions for each TSL.

C. Conclusions

EPCA requires that any new or amended energy conservation standard for any type (or class) of covered product 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 after considering, to the greatest extent practicable, the seven statutory factors discussed previously. (42 U.S.C. 6295(o)(2)(B)(i)) The new or amended standard must also result in a significant conservation of energy. (42 U.S.C. 6295(o)(3)(B))

DOE considered the impacts of standards at each trial standard level, beginning with the maximum technologically feasible level, to determine whether that level met the evaluation criteria. If the max tech level was not justified, DOE then considered the next most efficient level and undertook the same evaluation until it reached the highest efficiency level that is both technologically feasible and economically justified and saves a significant amount of energy.

DOE discusses the benefits and/or burdens of each trial standard level in the following sections. DOE bases its discussion on quantitative analytical results for each trial standard level (presented in section VII.A) such as national energy savings, net present value (discounted at 7 and 3 percent), emissions reductions, industry net present value, life-cycle cost, and consumers' installed price increases. Beyond the quantitative results, DOE also considers other burdens and benefits that affect economic justification, including how technological feasibility, manufacturer costs, and impacts on competition may affect the economic results presented.

To aid the reader as DOE discusses the benefits and burdens of each trial standard level, DOE has included the following tables that present a summary of the results of DOE's quantitative analysis for each TSL. These include the impacts on identifiable subgroups of consumers, specifically low-income households, institutions of religious worship, and institutions that serve low-income populations, who may be disproportionately affected by an amended national standard. Section VII.B.1 presents the estimated impacts of each TSL for these subgroups.

TABLE VII.37—SUMMARY OF RESULTS FOR BALLASTS

[Existing Technologies, Shift]

Category	TSL 1	TSL 2	TSL 3A	TSL 3B
National Energy Savings (quads)	3.50	4.10	5.55	5.56
NPV of Consumer Benefits (2010$ billion)				
3% discount rate	17.43	18.50	21.55	21.56

TABLE VII.37—SUMMARY OF RESULTS FOR BALLASTS—Continued

[Existing Technologies, Shift]

Category	TSL 1	TSL 2	TSL 3A	TSL 3B
7% discount rate	8.52	8.91	10.06	10.06
Industry Impacts				
Industry NPV (2010$ million)	1,199	1,176	1,144	1,141
Industry NPV (% change)	−1.6%	−3.5%	−6.1%	−6.4%
Cumulative Emissions Reduction				
CO_2 (Mt)	64	76	106	106
NO_X (kt)	23	28	39	39
Hg (t)	0.88	1.05	1.47	1.47
Value of Cumulative Emissions Reduction				
CO_2 (2010$ billion)*	0.24 to 3.68	0.29 to 4.40	0.40 to 6.12	0.40 to 6.13
NO_X—3% discount rate (2010$ million)	35	41	58	58
NO_X—7% discount rate (2010$ million)	18	22	31	31
Mean LCC Savings (replacement event, per ballast) (2010$)**				
IS and RS ballasts (not classified as residential) that operate: Two 4-foot MBP lamps. Four 4-foot MBP lamps. Two 8-foot slimline lamps.	29	5 to 34	7 to 37	7 to 37
PS ballasts (not classified as residential) that operate: Two 4-foot MBP lamps. Four 4-foot MBP lamps. Two 4-foot MiniBP SO lamps. Two 4-foot MiniBP HO lamps.	−2 to 26:	6 to 32	6 to 28	6 to 28
IS and RS ballasts (not classified as sign ballasts) that operate two 8-foot HO lamps	65	230	230	3 to 233
Sign ballasts that operate four 8-foot HO lamps	403	403	403	403
IS and RS residential ballasts that operate two 4-foot MBP lamps	21	21	21	−2 to 19
Median PBP (replacement event)* (years)**				
IS and RS ballasts (not classified as residential) that operate: Two 4-foot MBP lamps. Four 4-foot MBP lamps. Two 8-foot slimline lamps.	−3.35	−1.66 to 3.62	−1.30 to 2.86	−1.30 to 2.86
PS ballasts (not classified as residential) that operate: Two 4-foot MBP lamps. Four 4-foot MBP lamps. Two 4-foot MiniBP SO lamps. Two 4-foot MiniBP HO lamps.	0.05 to 20.52	0.55 to 6.00	1.25 to 6.00	1.25 to 6.00
IS and RS ballasts (not classified as sign ballasts) that operate two 8-foot HO lamps.	−0.66	−0.69	−0.69	−0.53 to 4.57
Sign ballasts that operate four 8-foot HO lamps	−0.16	−0.16	−0.16	−0.16
IS and RS residential ballasts that operate two 4-foot MBP lamps	−5.46	−5.46	−5.46	−4.92
Distribution of Consumer LCC Impacts (see Table VII.16 through Table VII.23)				
Generation Capacity Reduction (GW)†	3.82	4.56	6.35	6.35
Employment Impacts				
Indirect Domestic Jobs (thousands) †	52	57	74	74

* 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.
*** For PBPs, negative values indicate standards that reduce operating costs and installed costs; ''N/A'' indicates standard levels that do not reduce operating costs.
† Changes in 2043.

TABLE VII.38—SUMMARY OF RESULTS FOR BALLASTS

[Emerging Technologies, Roll-up]

Category	TSL 1	TSL 2	TSL 3A	TSL 3B
National Energy Savings (quads)	1.36	2.05	2.74	2.86

TABLE VII.38—SUMMARY OF RESULTS FOR BALLASTS—Continued

[Emerging Technologies, Roll-up]

Category	TSL 1	TSL 2	TSL 3A	TSL 3B
NPV of Consumer Benefits (2010$ billion)				
3% discount rate	8.28	10.92	12.84	13.07
7% discount rate	4.59	5.85	6.67	6.73
Industry Impacts				
Industry NPV (2010$ million)	616	545	464	431
Industry NPV (% change)	−15.9%	−25.7%	−36.7%	−41.1%
Cumulative Emissions Reduction				
CO_2 (Mt)	13	20	27	29
NO_X (kt)	10	16	22	23
Hg (t)	0.18	0.29	0.40	0.42
Value of Cumulative Emissions Reduction				
CO_2 (2010$ billion) *	0.06 to 0.80	0.09 to 1.27	0.12 to 1.75	0.13 to 1.84
NO_X–3% discount rate (2010$ million)	13	21	29	30
NO_X–7% discount rate (2010$ million)	6	10	13	14
Mean LCC Savings (replacement event, per ballast) ** (2010$)				
IS and RS ballasts (not classified as residential) that operate Two 4-foot MBP lamps. Four 4-foot MBP lamps. Two 8-foot slimline lamps.	29	5 to 34	7 to 37	7 to 37
PS ballasts (not classified as residential) that operate Two 4-foot MBP lamps. Four 4-foot MBP lamps. Two 4-foot MiniBP SO lamps. Two 4-foot MiniBP HO lamps.	−2 to 26	6 to 32	6 to 28	6 to 28
IS and RS ballasts (not classified as sign ballasts) that operate Two 8-foot HO lamps.	65	230	230	3 to 233
Sign ballasts that operate Four 8-foot HO lamps	403	403	403	403
IS and RS residential ballasts that operate Two 4-foot MBP lamps	21	21	21	−2 to 19
Median PBP (replacement event)* (years)**				
IS and RS ballasts (not classified as residential) that operate Two 4-foot MBP lamps. Four 4-foot MBP lamps. Two 8-foot slimline lamps.	−3.35	−1.66 to 3.62	−1.30 to 2.86	−1.30 to 2.86
PS ballasts (not classified as residential) that operate Two 4-foot MBP lamps. Four 4-foot MBP lamps. Two 4-foot MiniBP SO lamps. Two 4-foot MiniBP HO lamps.	0.05 to 20.52	0.55 to 6.00	1.25 to 6.00	1.25 to 6.00
IS and RS ballasts (not classified as sign ballasts) that operate Two 8-foot HO lamps.	−0.66	−0.69	−0.69	−0.53 to 4.57
Sign ballasts that operate Four 8-foot HO lamps	−0.16	−0.16	−0.16	−0.16
IS and RS residential ballasts that operate Two 4-foot MBP lamps	−5.46	−5.46	−5.46	−4.92
Distribution of Consumer LCC Impacts (see Table VII.16 through Table VII.23)				
Generation Capacity Reduction (GW) †	1.37	2.18	2.99	3.14
Employment Impacts				
Indirect Domestic Jobs (thousands)†	17	24	31	34

* 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.
*** For PBPs, negative values indicate standards that reduce operating costs and installed costs; ''N/A'' indicates standard levels that do not reduce operating costs.
† Changes in 2043.

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 undervalue energy efficiency improvements. This undervaluation suggests that regulation that promotes energy efficiency can produce significant net private gains (as well as producing social gains by, for example, reducing pollution). There is evidence that consumers undervalue future energy savings as a result of: (1) A lack of information, (2) a lack of sufficient salience of the long-term or aggregate benefits, (3) a lack of sufficient savings to warrant delaying or altering purchases (*e.g.,* an inefficient ventilation fan in a new building or the delayed replacement of a water pump), (4) excessive focus on the short term, in the form of inconsistent weighting of future energy cost savings relative to available returns on other investments, (5) computational or other difficulties associated with the evaluation of relevant tradeoffs, and (6) a divergence in incentives (*e.g.,* renter versus owner; builder versus purchaser). Other literature indicates that with less than perfect foresight and a high degree of uncertainty about the future, consumers may trade off investments in efficiency at a higher than expected rate between current consumption and uncertain future energy cost savings.

In its current regulatory analysis, DOE includes potential changes in the benefits and costs of a regulation due to changes in consumer purchase decisions in two ways. First, if consumers forego a purchase of a product in the standards case, it decreases sales for product manufacturers and the cost to manufacturers is included in the MIA. Second, DOE accounts for energy savings attributable only to products used by consumers in the standards case; if a regulatory option decreases the number of products used by consumers, this decreases the potential energy savings from an energy conservation standard. DOE provides detailed estimates of shipments and changes in the volume of product purchases under standards in chapter 10 of the TSD. However, DOE's current analysis does not explicitly control for differences in consumer preferences, preferences across subcategories of products or specific features, or consumer price sensitivity varying with household income (Reiss and White 2004).

While DOE is not prepared at present to provide a fuller quantifiable framework for estimating the benefits and costs of changes in consumer purchase decisions due to an energy conservation standard, DOE has posted a paper that discusses the issue of consumer welfare impacts of appliance energy efficiency standards, and potential enhancements to the methodology by which these impacts are defined and estimated in the regulatory process.[62] DOE is committed to developing a framework that can support empirical quantitative tools for improved assessment of the consumer welfare impacts of appliance standards. DOE welcomes comments on how to more fully assess the potential impact of energy conservation standards on consumer choice and how to quantify this impact in its regulatory analysis in future rulemakings.

1. Trial Standard Level 3B

DOE first considered the most efficient level, TSL 3B, which would save an estimated 2.9 to 5.6 quads of energy through 2043. For the nation as a whole, TSL 3B would have a net savings of $6.7 billion–$10.1 billion at a 7-percent discount rate, and $13.1 billion–$21.6 billion at a 3-percent discount rate. The emissions reductions at TSL 3B are estimated at 29–106 million metric tons (Mt) of CO_2, 23–39 kilotons (kt) of NO_X, and 0.42–1.47 tons of Hg. Total generating capacity in 2043 is estimated to decrease compared to the reference case by 3.14–6.35 gigawatts under TSL 3B. As seen in section VII.B.1, while consumers of most representative ballast types have available ballast designs which result in positive LCC savings, ranging from $2.77–$402.86, some consumers experience negative LCC savings at TSL 3B. Consumers that experience negative LCC savings, ranging from −$1 to −$2, are those that currently have a 2-lamp 8-foot HO T8 ballast (for the new construction/renovation event) or a 2-lamp 4-foot MBP T8 ballast in the residential sector (for the replacement event). The projected change in industry value would range from a decrease of $77.6 million to a decrease of $301.2 million, or a net loss of 6.4 percent to a net loss of 41.1 percent in INPV.

DOE based TSL 3B on the most efficient commercially available products for each representative ballast type analyzed. This TSL represents the highest efficiency level that is technologically feasible for a diversity of products (spanning several ballast factors, number of lamps per ballast, and types of lamps operated) within each product class.

After carefully considering the analysis and weighing the benefits and burdens of TSL 3B, the Secretary has reached the following conclusion: At TSL 3B, the benefits of energy savings, emissions reductions (both in physical reductions and the monetized value of those reductions), and the positive net economic savings to the nation would be outweighed by the economic burden on consumers (of residential T8 ballasts and 8-foot HO T8 ballasts) and the large product and capital conversion costs that could result in a large reduction in INPV for manufacturers. Consequently, the Secretary has concluded that trial standard level 3B is not economically justified.

2. Trial Standard Level 3A

DOE next considered TSL 3A, which would save an estimated 2.7 to 5.6 quads of energy through 2043—a significant amount of energy. For the nation as a whole, TSL 3A would have a net savings of $6.7 billion–$10.1 billion at a 7-percent discount rate, and $12.8 billion–$21.6 billion at a 3-percent discount rate. The emissions reductions at TSL 3A are estimated at 27–106 Mt of CO_2, 22–39 kt of NO_X, and 0.40–1.47 tons of Hg. Total generating capacity in 2043 is estimated to decrease compared to the reference case by 2.99–6.35 gigawatts under TSL 3A. As seen in section VII.B.1, TSL 3A results in positive LCC savings for all representative ballast types, ranging from $6–$403. The projected change in industry value would range from a decrease of $74.5 million to a decrease of $268.6 million, or a net loss of 6.1 percent to a net loss of 36.7 percent in INPV.

DOE based TSL 3A on the most efficient commercially available products for each representative ballast type analyzed except for IS/RS ballasts in the residential sector and 8-foot HO ballasts. This TSL represents the highest efficiency level for a diversity of products (spanning several ballast factors, number of lamps per ballast, and types of lamps operated) at which consumers of all ballasts types, including those consumers with T8 residential or 8-foot HO systems, experience positive LCC savings.

After considering the analysis, comments on the analysis, and the benefits and burdens of TSL 3A, the Secretary has reached the following conclusion: TSL 3A offers the maximum improvement in efficiency that is technologically feasible and economically justified, and will result in significant conservation of energy. The Secretary has reached the conclusion that the benefits of energy savings, emissions reductions (both in physical reductions and the monetized value of those reductions), the positive net economic savings to the nation, and

[62] Alan Sanstad, Notes on the Economics of Household Energy Consumption and Technology Choice. Lawrence Berkeley National Laboratory. 2010. *http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/consumer_ee_theory.pdf.*

positive life-cycle cost savings would outweigh the reduction in INPV for manufacturers. Therefore, DOE adopts the energy conservation standards for ballasts at TSL 3A.

D. Backsliding

As discussed in section II.A, EPCA contains what is commonly known as an ''anti-backsliding'' provision, which mandates that the Secretary not prescribe any amended standard that either increases the maximum allowable energy use or decreases the minimum required energy efficiency of a covered product. (42 U.S.C. 6295(o)(1)) Because DOE is evaluating amended standards in terms of ballast luminous efficiency, DOE converted the existing BEF standards to BLE to verify that the adopted standards did not constitute backsliding. The following describes how DOE completed this comparison.

Ballast efficacy factor is defined as ballast factor divided by input power times 100. Ballast factor, in turn, is currently defined as the test system light output divided by a reference system light output. As mentioned in section IV.A, the active mode test procedure SNOPR proposed a new method for calculating ballast factor. 75 FR 71570, 71577–8 (November 24, 2010). The new methodology entails measuring the lamp arc power of the test system and dividing it by the lamp arc power of the reference system. Because this new method calculates a ballast factor equivalent to the existing method, DOE finds that this definition can be incorporated into the equation for BEF. After this substitution, BEF can be converted to BLE by dividing by 100 and multiplying by the appropriate reference arc power. Table VII.39 contains the existing standard in terms of BEF, the existing standard in terms of BLE, and the adopted standard in terms of BLE.

TABLE VII.39—EXISTING FEDERAL BEF STANDARDS AND THE CORRESPONDING BLE

Application for operation of	BEF Standard	*Equivalent BLE*		*Adopted BLE*
		Low freq	*High freq*	*Standard**
One F40T12 lamp	2.29	0.831	0.832	0.875
Two F40T12 lamps	1.17	0.849	0.850	0.899
Two F96T12 lamps	0.63	0.888	0.897	0.918
Two F96T12/HO lamps	0.39	0.777	0.780	0.886
One F34T12 lamp	2.61	0.777	0.778	0.809
Two F34T12 lamps	1.35	0.804	0.805	0.841
Two F96T12/ES lamps	0.77	0.876	0.884	0.913
Two F96T12/HO/ES lamps	0.42	0.711	0.713	0.881

* For ballast types that could be in more than one product class, this table presents the lowest standard the ballast would be required to meet. For example, 8-foot HO ballasts can have a PS starting method in addition to IS or RS. Therefore, DOE presents the standard for the PS product class as it is the lowest.

As seen in Table VII.39, the standards adopted in this final rule are higher than the existing standards, regardless of low or high frequency operation. As such, the adopted standards do not decrease the minimum required energy efficiency of the covered products and therefore do not violate the anti-backsliding provision in EPCA.

VIII. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866 and 13563

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 lighting 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 fluorescent lamp ballasts 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 OMB review this rule. DOE presented to OIRA for review the draft rule and other documents prepared for this rulemaking, including the RIA, and has included these documents in the rulemaking record. The assessments prepared pursuant to Executive Order 12866 can be found in the technical support document for this rulemaking.

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

DOE emphasizes as well that Executive Order 13563 requires agencies ''to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible.'' In its guidance, the Office of Information and Regulatory Affairs has emphasized that such techniques may include ''identifying changing future compliance costs that might result from technological innovation or anticipated behavioral changes.'' For the reasons stated in the preamble, DOE finds that today's final rule is consistent with these principles, including the requirement that, to the extent permitted by law, agencies adopt a regulation only upon a reasoned determination that its benefits justify its costs and select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits.

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) requires preparation of an initial regulatory flexibility analysis (IRFA) for any rule that by law must be proposed for public comment, and a final regulatory flexibility analysis (FRFA) for any such rule that an agency adopts as a final rule, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by Executive Order 13272, ''Proper Consideration of Small Entities in Agency Rulemaking,'' 67 FR 53461 (August 16, 2002), DOE published procedures and policies on February 19, 2003, to ensure that the potential impacts of its rules on small entities are properly considered during the rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of the General Counsel's Web site (*http://www.gc.doe.gov*). DOE reviewed the April 2011 NOPR and today's final rule under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003.

As presented and discussed in the following sections, the FRFA describes potential impacts on small manufacturers associated with the required product and capital conversion costs at each TSL and discusses alternatives that could minimize these impacts. Chapter 13 of the TSD contains more information about the impact of this rulemaking on manufacturers.

1. Statement of the Need for, and Objectives of, the Rule

The reasons why DOE is establishing the standards in today's final rule and the objectives of these standards are provided elsewhere in the preamble and not repeated here.

2. Summary of and Responses to the Significant Issues Raised by the Public Comments, and a Statement of Any Changes Made as a Result of Such Comments

This FRFA incorporates the IRFA and public comments received on the IRFA and the economic impacts of the rule. DOE provides responses to these comments in the discussion below on the compliance impacts of the rule and elsewhere in the preamble. DOE modified the standards adopted in today's final rule in response to comments received, including those from small businesses, as described in the preamble.

3. Description and Estimated Number of Small Entities Regulated

a. Methodology for Estimating the Number of Small Entities

For manufacturers of fluorescent lamp ballasts, the Small Business Administration (SBA) has set a size threshold, which defines those entities classified as ''small businesses'' for the purposes of the statute. DOE used the SBA's small business size standards to determine whether any small entities would be subject to the requirements of the rule. 65 FR 30836, 30848 (May 15, 2000), as amended at 65 FR 53533, 53544 (Sept. 5, 2000) and codified at 13 CFR part 121. The size standards are listed by NAICS code and industry description and are available at *http://www.sba.gov/idc/groups/public/documents/sba_homepage/serv_sstd_tablepdf.pdf*. Fluorescent lamp ballast manufacturing is classified under NAICS 335311, ''Power, Distribution and Specialty Transformer Manufacturing.'' The SBA sets a threshold of 750 employees or less for an entity to be considered as a small business for this category.

In the April 2011 NOPR, DOE identified approximately 10 small businesses that produce covered products and can be considered small business manufacturers. 76 FR 20090, 20171 (April 11, 2011). Radionic disagreed with this estimate, stating that they are the only domestic ballast manufacturer, and noted that they were not contacted by DOE. (Radionic, No. 36 at p. 1) During its analysis for the NOPR, DOE identified Radionic as a small business manufacturer that could potentially be affected by new or amended standards. Radionic was included in DOE's estimate of ten small manufacturers, which also includes U.S. manufacturers with foreign production. DOE contacted Radionic and received a survey response during the NOPR analysis period. Two other small businesses consented to being interviewed during the MIA interviews. DOE also obtained information about small business impacts while interviewing large manufacturers.

b. Fluorescent Lamp Ballast Industry Structure

Four major manufacturers with non-domestic production supply the vast majority of the marketplace. None of the four major manufacturers is considered a small business. The remaining market share is held by foreign manufacturers and several smaller domestic companies with very small market shares. Even for these U.S.-operated firms, most production is outsourced to overseas vendors or captive overseas manufacturing facilities. Some very limited production takes place in the United States—mostly magnetic ballasts for specialty applications. DOE is unaware of any fluorescent lamp ballast companies, small or large, that produce only domestically. See chapter 3 of the final rule TSD for further details on the fluorescent lamp ballast market.

c. Comparison Between Large and Small Entities

The four large manufacturers typically offer a much wider range of designs of covered ballasts than small manufacturers. Ballasts can be designed, or optimized, to operate different lamp lengths and numbers of lamps under various start methods, often in combination with various additional features. Large manufacturers typically offer many SKUs per product line to meet this wide range of potential specifications. Generally, one product family shares some fundamental characteristic (*i.e.,* lamp diameter, number of lamps, etc.) and hosts a large number of SKUs that are manufactured with minor variations on the same product line. Some product lines, such as the 4-foot MBP IS ballast, are manufactured in high volumes, while other products may be produced in much lower volumes but can help manufacturers meet their customers' specific needs and provide higher margin opportunities. For their part, small manufacturers generally do not have the volume to support as wide a range of products.

Beyond variations in ballast types and features, the large manufacturers also offer multiple tiers of efficiency, typically including a baseline efficiency product and a high-efficiency product within the same family. On the other hand, some small manufacturers frequently only offer one efficiency level in a given product class to reduce the number of SKUs and parts they must maintain. This strategy is important to small-scale manufacturers because many product development costs (*e.g.,* testing, certification, and marketing) are relatively fixed per product line.

Small manufacturers are able to compete in the fluorescent lamp ballast industry despite the dominance of the four major manufacturers due, in large part, to the fragmented nature of the fixture industry. The largest four fixture manufacturers comprise about 60 percent of the industry, while as many as 200 smaller fixture manufacturers have the remaining share. Many small ballast manufacturers have developed relationships with these small fixture manufacturers, whose production volumes may not be attractive to the larger players. The same structure applies to the electrical distributor market—while small ballast manufacturers often cannot compete for the business of the largest distributors, they are able to successfully target small distributors, often on a regional basis.

Lastly, like the major manufacturers, small manufacturers usually offer products in addition to those fluorescent lamp ballasts covered by this rulemaking, such as dimming ballasts, LED drivers, and compact fluorescent ballasts.

4. Description and Estimate of Compliance Requirements

Several manufacturers commented on the potential impacts of energy conservation standards on small fluorescent lamp ballast manufacturers. Radionic noted that small manufacturers would be burdened because they have fewer engineering resources and less capital to deploy toward redesign and UL testing compared to large manufacturers and suggested that consideration for exemption be given to small manufacturers. (Radionic, No. 36 at p. 1) In contrast, Lutron stated that they believe that the impacts of new and amended standards for fluorescent lamp ballasts would be negligible for small manufacturers because small manufacturers would concentrate in areas such as emerging technologies—where there is potential for growth and high margins—rather than try to compete with large manufacturers in a high-volume, traditional ballast market. (Lutron, Public Meeting Transcript, No. 43 at p. 207) Philips agreed that small manufacturers do not have a significant presence in the traditional ballast market. Philips noted, however, that many sign ballast manufacturers, who are also small manufacturers, may be adversely affected by the switch from magnetic to electronic sign ballasts driven by proposed standards, which may force sign ballast manufacturers to source their ballasts. (Philips, Public Meeting Transcript, No. 43 at pp. 208–9)

Small manufacturers have the potential to be significantly affected by this rule for the reasons suggested by Radionic. Most small ballast manufacturers, however, would be able to remain viable by focusing on niche markets or emerging technologies. DOE details its conclusions on the impacts on and expected responses of small manufacturers below.

Additionally, because sign ballast manufacturers may be differentially impacted by today's standards, DOE analyzed sign ballasts as a manufacturer subgroup in section VII.B.2.d. DOE made several attempts to contact sign ballast manufacturers for interviews but was unable to speak directly to any of the manufacturers who specialize in sign ballasts. As such, DOE's subgroup analysis was developed based on information obtained from interviews with large manufacturers and from manufacturer Web sites.

At TSL3A, the level adopted in today's final rule, DOE estimates capital conversion costs of $0.3 million and product conversion costs of $1.0 million for a typical small manufacturer, compared to capital and product conversion costs of $6.3 million and $9.7 million, respectively, for a typical large manufacturer. These costs and their impacts are described in detail in the following sections.

a. Capital Conversion Costs

Those small manufacturers DOE interviewed did not expect increased capital conversion costs to be a major concern because most of them source all or the majority of their products from Asia. Those that source their products would likely not make the direct capital investments themselves. Small manufacturers experience the impact of sourcing their products through a higher cost of goods sold, and thus a lower operating margin, as compared to large manufacturers. The capital costs estimated are largely associated with those small manufacturers producing magnetic ballasts. DOE estimates capital costs of approximately $0.3 million for a typical small manufacturer at TSL 3A, based on the cost of converting magnetic production lines, such as sign ballasts, to electronic production lines.

Another challenge facing the industry is the component shortage discussed in the section V.H.4.d. As with large manufacturers, the component shortage is a significant issue for small manufacturers, but some small manufacturers stated that the shortage does not differentially impact them. At times, they actually can obtain components more easily than large manufacturers. Because their volumes are lower, they generally pay higher prices for parts than their larger competitors, which incentivizes suppliers to fill small manufacturers' orders relatively quickly. The lower-volume orders also allow small manufacturers to piggyback off the orders for certain components that are used throughout the consumer electronics industry.

b. Product Conversion Costs

While capital conversion costs were not a large concern to the small manufacturers DOE interviewed, product conversion costs could adversely impact small manufacturers at TSL 3A, the level adopted in today's final rule. To estimate the differential impacts of the adopted standard on small manufacturers, DOE compared their cost of compliance with that of the major manufacturers. First, DOE examined the number of basic models and SKUs available from each manufacturer to determine an estimate for overall compliance costs. The number of basic models and SKUs attributed to each manufacturer is based on information obtained during manufacturer interviews and an examination of the different models advertised by each on company Web sites. DOE assumed that the product conversion costs required to redesign basic models and test and certify all SKUs to meet the standard levels presented in today's final rule would be lower per model and per SKU for small manufacturers, as detailed below. (A full description of DOE's methodology for developing product conversion costs is found in section V.H.1.a and in chapter 13 of the final rule TSD.) Table VIII.1 compares the estimated product conversion costs of a typical small manufacturer as a percentage of their annual R&D expense to those of a typical large manufacturer.

TABLE VIII.1—COMPARISON OF A TYPICAL SMALL AND LARGE MANUFACTURER'S PRODUCT CONVERSION COSTS TO ANNUAL R&D EXPENSE

	Large manufacturer		Small manufacturer	
	Product conversion costs for a typical large manufacturer (2010$ millions)	Product conversion costs as a percentage of annual R&D expense	Product Conversion costs for a typical small manufacturer (2010$ millions)	Product Conversion costs as a percentage of annual R&D expense
Baseline	$0.00	0	$0.00	0
TSL 1	1.41	16	0.14	38
TSL 2	6.15	71	0.63	163
TSL 3A	9.68	111	0.99	257
TSL 3B	12.53	144	1.28	333

Based on discussions with manufacturers, DOE estimated that the cost to fully redesign every ballast model for large manufacturers is approximately $120,000 per model and the cost to test and certify every SKU is approximately $20,000 per SKU. A typical major manufacturer offers approximately 80 basic covered models and 300 SKUs. Based on DOE's GRIM analysis, a typical major manufacturer has an annual R&D expense of $8.7 million. Because not all products would need to be redesigned at TSL 3A, DOE estimates $9.7 million in product conversion costs for a typical major manufacturer at TSL 3A (compared to $15.6 million if all products had to be fully redesigned), which represents 111 percent of its annual R&D expense. This means that a typical major manufacturer could redesign its products in just over a year if it were to devote its entire R&D budget for fluorescent lamp ballasts to product redesign and could retain the engineering resources.

DOE's research indicated that a typical small manufacturer offers approximately 50 basic covered models and 100 SKUs. However, based on manufacturer interviews, DOE does not believe that small manufacturers would incur the same level of costs per model and SKU as large manufacturers. Small manufacturers would not be as likely to redesign models in-house as large manufacturers. Instead, they would source and rebrand products from overseas manufacturers who supply their ballasts. As a result, DOE assumed a lower R&D investment, in absolute dollars, per model. Because their products are effectively sourced, DOE projects smaller manufacturers would face a higher level of cost of goods sold (*i.e.,* a higher MPC). Therefore, in a competitive environment, small manufacturers would earn a lower markup than their larger peers and consequently operate at lower margins. Small manufacturers would also have to test and certify every SKU they offer, but they would not conduct the same extent of pilot runs and internal testing as large manufacturers because less production takes place in internal factories. As such, DOE estimates that small manufacturers' testing and certification costs are expected to be $10,000 per SKU for UL and other certifications. Thus, the product conversion costs for a typical small manufacturer could total $1.6 million. Because not all products would need to be fully redesigned at TSL 3A, however, DOE estimates product conversion costs of $1.0 million at TSL 3A. Based on scaling GRIM results to an average small-manufacturer market share of 1.0 percent, DOE assumed that a small manufacturer has an annual R&D expense of $0.4 million, so the estimated product conversion costs at TSL 3A would represent 257 percent of its annual R&D expense. This means that a typical small manufacturer could redesign its products within the three year compliance period if it were to devote its entire R&D budget for fluorescent lamp ballasts to product redesign and could retain the engineering resources.

c. Summary of Compliance Impacts

Although the conversion costs required can be considered substantial for all companies, the impacts could be relatively greater for a typical small manufacturer because of much lower production volumes and the relatively fixed nature of the R&D resources required per model. Table VIII.2 compares the total conversion costs of a typical small manufacturer as a percentage of annual revenue and earnings before interest and taxes (EBIT) to those of a typical large manufacturer.

TABLE VIII.2—COMPARISON OF A TYPICAL SMALL AND LARGE MANUFACTURER'S TOTAL CONVERSION COSTS TO ANNUAL REVENUE AND EBIT

	Large Manufacturer			Small Manufacturer		
	Total conversion costs for a typical large mfr. (2010$ millions)	Total conversion costs as a percentage of annual revenue	Total conversion costs as a percentage of annual EBIT	Total conversion costs for a typical small mfr. (2010$ millions)	Total conversion costs as a percentage of annual revenue	Total conversion costs as a percentage of annual EBIT
Baseline	$0.00	0	0	$0.00	0	0
TSL 1	3.99	2	21	0.26	2	37
TSL 2	10.68	5	55	0.83	8	119
TSL 3A	16.02	7	82	1.27	12	182
TSL 3B	19.14	8	99	1.58	15	226

As seen in Table VIII.2, the impacts for a typical small manufacturer are relatively greater than for a large manufacturer at TSL 3A. Total conversion costs represent 182 percent of annual EBIT for a typical small manufacturer compared to 82 percent of annual EBIT for a typical large manufacturer. DOE believes these estimates reflect a worst-case scenario because they assume small manufacturers would redesign all proprietary models immediately, and not take advantage of the industry's supply chain dynamics or take other steps to mitigate the impacts. DOE anticipates, however, that small manufacturers would take several steps to mitigate the costs required to meet new and amended energy conservation standards.

At TSL 3A, it is more likely that ballast manufacturers would temporarily reduce the number of SKUs they offer as in-house designs to keep their product conversion costs at manageable levels in the years preceding the compliance date. As noted previously, the typical small manufacturer business model is not predicated on the supply of a wide range of models and specifications. Small manufacturers frequently either focus on a few niche markets or on customers seeking only basic, low-cost solutions. They therefore can satisfy the needs of their customers with a smaller product portfolio than large manufacturers who often compete on brand reputation and the ability to offer a full product offering. As such, DOE believes that under the adopted standards small businesses would likely selectively upgrade existing product lines to offer products that are in high demand or offer strategic advantage. Small manufacturers could then spread out further investments over a longer time period by upgrading some product lines prior to the compliance date while sourcing others until resources allow—and the market supports—in-house design. Furthermore, while the initial redesign costs are relatively large, the estimates assume small manufacturers would bring compliant ballasts to market in concert with large manufacturers. There is a possibility some small manufacturers would conserve resources by waiting to upgrade certain products until new compliant baseline designs become available or their in-house development is less resource-intensive. The commonality of many consumer electronics components, designs, and products fosters considerable sharing of experience throughout the electronics supply chain, particularly when unrestricted by proprietary technologies. DOE did not find any intellectual property restrictions that would prevent small manufacturers from making the technologies necessary to meet today's adopted levels.

5. Steps Taken to Minimize Impacts on Small Entities and Reasons Why Other Significant Alternatives to Today's Final Rule Were Rejected

DOE modified the standards established in today's final rule from those proposed in the April 2011 NOPR as discussed previously and based on comments and additional test data received from interested parties. These modifications include a separate product class for residential ballasts, which establishes less stringent standards for these ballasts than the NOPR, and new standard equations for all product classes.

The previous discussion also analyzes impacts on small businesses that would result from the other TSLs DOE considered. Though TSLs lower than the adopted TSL are expected to reduce the impacts on small entities, DOE is required by EPCA to establish standards that achieve the maximum improvement in energy efficiency that are technically feasible and economically justified, and result in a significant conservation of energy. Thus DOE rejected the lower TSLs.

In addition to the other TSLs being considered, the TSD includes a regulatory impact analysis in chapter 18. For fluorescent lamp ballasts, this report discusses the following policy alternatives: (1) No standard, (2) consumer rebates, (3) consumer tax credits, (4) manufacturer tax credits, and (5) early replacement. DOE does not intend to consider these alternatives further because they are either not feasible to implement, or not expected to result in energy savings as large as those that would be achieved by the standard levels under consideration. Thus, DOE rejected these alternatives and is adopting the standards set forth in this rulemaking.

DOE notes that small manufacturers, particularly those small sign ballast manufacturers who would be required to move from magnetic to electronic sign ballasts as a result of today's standards, may apply to DOE for an exemption from the standard pursuant to 42 U.S.C. 6295(t). The process applicants must follow to request an exemption and DOE's process for making a decision on a particular request are set forth in DOE's regulations at 10 CFR 430 Subpart E.

C. Review Under the Paperwork Reduction Act

Manufacturers of fluorescent lamp ballasts must certify to DOE that their products comply with any applicable energy conservation standards. In certifying compliance, manufacturers must test their products according to the DOE test procedures for fluorescent lamp ballasts, including any amendments adopted for those test procedures. DOE has established regulations for the certification and recordkeeping requirements for all covered consumer products and commercial equipment, including fluorescent lamp ballasts. (76 FR 12422 (March 7, 2011). The collection-of-information requirement for the certification and recordkeeping is subject to review and approval by OMB under the Paperwork Reduction Act (PRA). This requirement has been approved by OMB under OMB control number 1910–1400. Public reporting burden for the certification is estimated to average 20 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the PRA, unless that collection of information displays a currently valid OMB Control Number.

D. Review Under the National Environmental Policy Act of 1969

DOE prepared an EA of the impacts of the new and amended rule pursuant to the National Environmental Policy Act of 1969 (42 U.S.C. 4321 *et seq.*), the regulations of the Council on Environmental Quality (40 CFR parts 1500–1508), and DOE's regulations for compliance with the National Environmental Policy Act of 1969 (10 CFR part 1021). This assessment includes an examination of the potential effects of emission reductions likely to result from the rule in the context of global climate change, as well as other types of environmental impacts. The EA has been incorporated into the final rule TSD as chapter 16. Before issuing this final rule for fluorescent lamp ballasts, DOE considered public comments and issued a FONSI as part of a final EA.

E. Review Under Executive Order 13132

Executive Order 13132, ''Federalism.'' 64 FR 43255 (Aug. 10, 1999) imposes certain requirements on Federal agencies formulating and implementing policies or regulations that preempt State law or that have Federalism implications. The Executive Order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the

States and to carefully assess the necessity for such actions. The Executive Order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have Federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of today's final rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297) No further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of Executive Order 12988, ''Civil Justice Reform,'' imposes on Federal agencies the general duty to adhere to the following requirements: (1) Eliminate drafting errors and ambiguity; (2) write regulations to minimize litigation; and (3) provide a clear legal standard for affected conduct rather than a general standard and promote simplification and burden reduction. 61 FR 4729 (Feb. 7, 1996). Section 3(b) of Executive Order 12988 specifically requires that Executive agencies make every reasonable effort to ensure that the regulation: (1) Clearly specifies the preemptive effect, if any; (2) clearly specifies any effect on existing Federal law or regulation; (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction; (4) specifies the retroactive effect, if any; (5) adequately defines key terms; and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of Executive Order 12988 requires Executive agencies to review regulations in light of applicable standards in section 3(a) and section 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, this final rule meets the relevant standards of Executive Order 12988.

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA) requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Public Law 104–4, sec. 201 (codified at 2 U.S.C. 1531). For a new or amended regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a ''significant intergovernmental mandate,'' and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect small governments. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820. DOE's policy statement is also available at *http://www.gc.doe.gov*.

DOE has concluded that this final rule would likely require expenditures of $100 million or more on the private sector. Such expenditures may include: (1) Investment in research and development and in capital expenditures by fluorescent lamp ballasts manufacturers in the years between the final rule and the compliance date for the new standards, and (2) incremental additional expenditures by consumers to purchase higher-efficiency fluorescent lamp ballasts, starting at the compliance date for the applicable standard.

Section 202 of UMRA authorizes a Federal agency to respond to the content requirements of UMRA in any other statement or analysis that accompanies the final 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 final rulemaking and the ''Regulatory Impact Analysis'' section of the TSD for this final rule respond to those requirements.

Under section 205 of UMRA, DOE 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(g), today's final rule would establish energy conservation standards for fluorescent lamp ballasts 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 final rule.

H. Review Under the Treasury and General Government Appropriations Act, 1999

Section 654 of the Treasury and General Government Appropriations Act, 1999 (Pub. L. 105–277) requires Federal agencies to issue a Family Policymaking Assessment for any rule that may affect family well-being. This rule would not have any impact on the autonomy or integrity of the family as an institution. Accordingly, DOE has concluded that it is not necessary to prepare a Family Policymaking Assessment.

I. Review Under Executive Order 12630

DOE has determined, under Executive Order 12630, ''Governmental Actions and Interference with Constitutionally Protected Property Rights'' 53 FR 8859 (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 Federal agencies to review most disseminations of information to the public under guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (Feb. 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). DOE has reviewed today's final rule under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

Executive Order 13211, ''Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use'' 66 FR 28355 (May 22, 2001), requires Federal agencies to prepare and submit to OIRA at OMB, a Statement of Energy Effects for any significant energy action. A ''significant energy action'' is defined as any action by an agency that promulgates or is expected to lead to promulgation of a final rule, and that: (1) Is a significant regulatory action under Executive Order 12866, or any successor order; and (2) is likely to have a significant adverse effect on the supply, distribution, or use of energy, or (3) is designated by the Administrator of OIRA as a significant energy action. For any significant energy action, the agency must give a detailed statement of any adverse effects on energy supply, distribution, or use should the proposal be implemented, and of reasonable alternatives to the action and their expected benefits on energy supply, distribution, and use.

DOE has concluded that today's regulatory action, which sets forth energy conservation standards for fluorescent lamp ballasts, is not a significant energy action because the new and amended standards are not likely to have a significant adverse effect on the supply, distribution, or use of energy, nor has it been designated as such by the Administrator at OIRA. Accordingly, DOE has not prepared a Statement of Energy Effects on the final rule.

L. Review Under the Information Quality Bulletin for Peer Review

On December 16, 2004, OMB, in consultation with the Office of Science and Technology Policy, issued its Final Information Quality Bulletin for Peer Review (the Bulletin). 70 FR 2664 (Jan. 14, 2005). The Bulletin establishes that certain scientific information shall be peer reviewed by qualified specialists before it is disseminated by the Federal Government, including influential scientific information related to agency regulatory actions. The purpose of the bulletin is to enhance the quality and credibility of the Government's scientific information. Under the Bulletin, the energy conservation standards rulemaking analyses are ''influential scientific information,'' which the Bulletin defines as ''scientific information the agency reasonably can determine will have or does have a clear and substantial impact on important public policies or private sector decisions.'' 70 FR 2667.

In response to OMB's Bulletin, DOE conducted formal in-progress peer reviews of the energy conservation standards development process and analyses and has prepared a Peer Review Report pertaining to the energy conservation standards rulemaking analyses. Generation of this report involved a rigorous, formal, and documented evaluation using objective criteria and qualified and independent reviewers to make a judgment as to the technical/scientific/business merit, the actual or anticipated results, and the productivity and management effectiveness of programs and/or projects. The ''Energy Conservation Standards Rulemaking Peer Review Report'' dated February 2007 has been disseminated and is available at the following Web site: *http://www1.eere.energy.gov/buildings/appliance_standards/peer_review.html.*

M. Congressional Notification

As required by 5 U.S.C. 801, DOE will report to Congress on the promulgation of this rule prior to its effective date. The report will state that it has been determined that the rule is a ''major rule'' as defined by 5 U.S.C. 804(2).

IX. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of today's final rule.

List of Subjects in 10 CFR Part 430

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, Imports, Intergovernmental relations, Reporting and recordkeeping requirements, and Small businesses.

Issued in Washington, DC, on October 20, 2011.

Henry Kelly,

Acting Assistant Secretary of Energy, Energy Efficiency and Renewable Energy.

For the reasons set forth in the preamble, DOE amends part 430 of chapter II, subchapter D, of title 10 of the Code of Federal Regulations, to read as set forth below:

PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

■ 1. The authority citation for Part 430 continues to read as follows:

Authority: 42 U.S.C. 6291–6309; 28 U.S.C. 2461 note.

■ 2. Section 430.2 is amended by adding the definition of ''ballast luminous efficiency'' in alphabetical order to read as follows:

§ 430.2 Definitions.

* * * * *

Ballast luminous efficiency means the total fluorescent lamp arc power divided by the fluorescent lamp ballast input power multiplied by the appropriate frequency adjustment factor, as defined in Appendix Q1 of subpart B of this part.

* * * * *

■ 3. Appendix Q to subpart B of part 430 is amended by adding introductory text after the heading to read as follows:

Appendix Q to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Fluorescent Lamp Ballasts

Comply with Appendix Q until November 14, 2014. After this date, all fluorescent lamp ballasts shall be tested using the provisions of Appendix Q1.

* * * * *

■ 4. Appendix Q1 to subpart B of part 430 is amended by adding introductory text after the heading to read as follows:

Appendix Q1 to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Fluorescent Lamp Ballasts

Comply with Appendix Q1 beginning November 14, 2014. Prior to this date, all fluorescent lamp ballasts shall be tested using the provisions of Appendix Q.

* * * * *

■ 5. Section 430.32 is amended by:

■ a. Revising paragraph (m)(1) introductory text.

■ b. Adding paragraphs (m)(8), (m)(9), and m(10).

The revision and additions read as follows:

§ 430.32 Energy and water conservation standards and their effective dates.

* * * * *

(m)(1) *Fluorescent lamp ballasts (other than specialty application mercury vapor lamp ballasts).* Except as provided in paragraphs (m)(2), (m)(3), (m)(4), (m)(5), (m)(6), (m)(7), (m)(8), (m)(9), and (m)(10) of this section, each fluorescent lamp ballast—

* * * * *

(8) Except as provided in paragraph (m)(9) of this section, each fluorescent lamp ballast—

(i) Manufactured on or after November 14, 2014;

(ii) Designed—

(A) To operate at nominal input voltages at or between 120 and 277 volts;

(B) To operate with an input current frequency of 60 Hertz; and

(C) For use in connection with fluorescent lamps (as defined in § 430.2)

(iii) Shall have—

(A) A power factor of 0.9 or greater except for those ballasts defined in paragraph (m)(8)(iii)(B) of this section;

(B) A power factor of 0.5 or greater for residential ballasts, which are defined in (m)(8)(vi) of this section;

(C) A ballast luminous efficiency not less than the following:

BLE = A/(1+B*average total lamp arc power ∧ −C) Where A, B, and C are as follows:

Description	A	B	C
Instant start and rapid start ballasts (not classified as residential) that are designed to operate	0.993	0.27	0.25
4-foot medium bipin lamps.			
2-foot U-shaped lamps.			
8-foot slimline lamps.			
Programmed start ballasts (not classified as residential) that are designed to operate	0.993	0.51	0.37
4-foot medium bipin lamps.			
2-foot U-shaped lamps.			
4-foot miniature bipin standard output lamps.			
4-foot miniature bipin high output lamps.			
Instant start and rapid start ballasts (not classified as sign ballasts) that are designed to operate 8-foot high output lamps.	0.993	0.38	0.25
Programmed start ballasts (not classified as sign ballasts) that are designed to operate 8-foot high output lamps.	0.973	0.70	0.37
Sign ballasts that operate 8-foot high output lamps	0.993	0.47	0.25
Instant start and rapid start residential ballasts that operate	0.993	0.41	0.25
4-foot medium bipin lamps.			
2-foot U-shaped lamps.			
8-foot slimline lamps.			
Programmed start residential ballasts that are designed to operate	0.973	0.71	0.37
4-foot medium bipin lamps.			
2-foot U-shaped lamps.			

(iv) Instant start, rapid start, and programmed start are defined in Appendix Q1 of subpart B of this part. Average total lamp arc power is as defined and measured in accordance with Appendix Q1 of subpart B of this part.

(v) Sign ballasts have an Underwriters Laboratories Inc. Type 2 rating and are designed, labeled, and marketed for use in outdoor signs.

(vi) Residential ballasts meet FCC consumer limits as set forth in 47 CFR part 18 and are designed and labeled for use in residential applications.

(9) The standards described in paragraph (m)(8) of this section do not apply to:

(i) A ballast that is designed for dimming to 50 percent or less of the maximum output of the ballast except for those specified in m(10); and

(ii) A low frequency ballast (as defined in Appendix Q1 to subpart of this part) that:

(A) Is designed to operate T8 diameter lamps;

(B) Is designed, labeled, and marketed for use in EMI-sensitive environments only;

(C) Is shipped by the manufacturer in packages containing 10 or fewer ballasts; and

(iii) A programmed start ballast that operates 4-foot medium bipin T8 lamps and delivers on average less than 140 milliamperes to each lamp.

(10) Each fluorescent lamp ballast—

(i) Manufactured on or after November 14, 2014;

(ii) Designed—

(A) To operate at nominal input voltages of 120 or 277 volts;

(B) To operate with an input current frequency of 60 Hertz; and

(C) For use in connection with fluorescent lamps (as defined in § 430.2);

(D) For dimming to 50 percent or less of the maximum output of the ballast

(iii) Shall have—

(A) A power factor of 0.9 or greater except for those ballasts defined in paragraph (m)(8)(iii)(B) of this section;

(B) A power factor of 0.5 or greater for residential ballasts, which meet FCC Part B consumer limits and are designed and labeled for use only in residential applications;

(C) A ballast luminous efficiency of not less than the following:

Designed for the operation of	Ballast input voltage	Total nominal lamp watts	Ballast luminous efficiency	
			Low frequency ballasts	High frequency ballasts
One F34T12 lamp	120/277	34	0.777	0.778
Two F34T12 lamps	120/277	68	0.804	0.805
Two F96T12/ES lamps	120/277	120	0.876	0.884
Two F96T12HO/ES lamps	120/277	190	0.711	0.713

* * * * *

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